Broads Authority
12 July 2013
Agenda Item No 16

Implications of Breydon Water Hydromorphic and Engineering Study
Report by Environment and Design Supervisor

Summary: The contracted JBA Consulting study has provided high quality information about the localised, short-term impacts arising from the modelled management options of the historic training wall structures in Breydon Water. Assessment of the sediment dynamics in Breydon Water suggest that the site is relatively morphologically stable, and the scale of suggested management options would not significantly impact future navigational management or the conservation status of the site (upon finalisation of appropriate tests against the Habitats Regulations). The suggested options and outline costs for management of the structures are detailed, as are options for navigation channel management.

Recommendation: That the Authority provides its views on:

(i) the management options for the channel structure (section 5.1 to 5.4);

(ii) the management options for dredging in the main navigation channel and the position and width of the main navigation dhannell (section 5.5 to 5.10).

1 Background

1.1 Following the June 2012 transfer of Breydon Water and its associated structural assets, a financial, public safety and environmental liability assessment was required to understand the impacts of managing the navigation. To address the environmental uncertainty, a modelling study of the impacts of various management options of the built structures and the navigation channel was commissioned. Of particular concern was the extent to which both the Turntide Jetty and the former Dickey Works currently had a river channel training function and what would be the impact of replacing or removing them. Variation in water flow and sediment deposition/erosion arising from the modelled management options on the position of the navigation channel through Breydon Water was also investigated.

1.2 JBA Consulting, in conjunction with Deltares and Bright Angel Coastal Consultants were commissioned to undertake a hydromorphic and engineering investigation of the area. The aim of the project was to evaluate the current hydrodynamic and sediment transport processes occurring within the estuary and to investigate how these might change under various estuary management options. The options assessed included the removal and shortening of the Turntide Jetty; reinstatement of the Dickey Works training

structure; and a capital dredging programme to maintain the channel at a 2m recreational navigable depth and a 4m channel depth for commercial vessels.

1.3 Numerical modelling of the estuary has been undertaken using the Delft3D model, which performs multi-dimensional (in this case 3D) hydrodynamic calculations, able to simulate estuarine flows, sediment transport and morphology. This methodology provides a robust means by which to assess the nature of flow and sediment transport processes within Breydon Water. The model replicated the observed hydrodynamics of the system. While the long-term sediment trends cannot be easily reproduced, the existing numerical model can be confidently used to infer more localised changes, such as the impact of either altering structures or dredging the navigation channel through the estuary. Full details of the model development, datasets used and model calibration have been presented at a workshop on 18 April 2013 and are too voluminous to repeat in this report. A copy of the final draft of the full project report can be downloaded via the weblink listed in the background papers at the end of this report.

2 Model Outputs - Turntide Jetty and Dickey Works

2.1 The modelling indicated that if the existing Turntide Jetty was to be completely removed, a change to the velocity and flow direction at the confluence may occur, resulting in a possible migration of the River Yare channel across the current River Waveney channel position. There would also be likely impacts of a sediment bar forming in the Waveney channel and some erosion of the mudflats on the true right bank of the Waveney, opposite Turntide Jetty. Erosion and loss of mudflats would impact upon the Special Area of Conservation (SAC) features for the wading birds.

2.2 Model outputs suggest that a half sized Turntide Jetty structure would however minimise the potential for channel migration, adequately deflecting the River Yare flows towards Breydon Water, whilst also providing bank protection at the confluence spit against future erosion.

2.3 For the former Dickey Works the modelling suggests a replacement structure would not have a great influence in maintaining a stable channel and consequently may be removed with minimal impact. Full replacement of a new structure on the previous footprint would marginally increase flows in the main channel, but the relatively fixed nature of the current channel position, and the constraining nature of the floodbanks on either side of the river, means a channel training structure would provide little additional benefit under existing conditions.

3 Dredging Requirement, Sediment Dynamics and Shoreline Erosion

3.1 An assessment was undertaken of the dredging requirements to maintain a navigation channel for recreational and commercial vessels, which have a 2m and 4m depth requirement respectively (below the mean low water level). Following the presentation of draft figures for dredging requirements, additional review of the data has shown that initial calculations were based on

incorrect baseline water levels. Mean low water was found to be an insufficient baseline to determine navigational depths, whereas a figure representing the 95th percentile of low water heights during the main boating season (April – October) was a more appropriate level. The dredging requirement assessment established that the depth of the existing navigational channel largely surpassed the 2 m depth required for recreational vessels. Whilst some dredging would be required, this would be approximately 9,000 m^3 to achieve specification. The required dredging to meet a 4m navigational depth within the existing marked channel was significantly higher, calculated to be approximately 260,000 m^3. A review of the bathymetric data suggests change to the morphology of the navigation channel has been largely restricted to the western and eastern end of Breydon Water with sedimentation occurring in localised patches, particularly around Breydon Bridge. Several strands of evidence arising from this study suggests Breydon Water is ebb tide dominated, with a relatively low influence of marine sedimentation in the estuary, the latter being restricted to the most downstream end of the estuary.

3.2 The method of dredging, placing or removing sediment has been assessed, particularly to identify the best approach to minimise re-sedimentation and environmental impacts. Both the method of dredging and disposal of sediment can play a large part in the potential re-sedimentation of the estuary. This can, in turn, have an influence on the surrounding environment and may trigger additional regulatory restrictions due to a greater impact on the wider estuary. The principle of minimisation of the amount of sediment to be dredged to achieve specification is therefore particularly relevant in Breydon Water, both from a cost and environmental protection perspective.

3.3 An analysis of the input and output sediment concentrations taken during the monitoring period suggests the net inputs appear to match the net outputs. If this trend was observed throughout the full neap/spring tidal cycle it would suggest the sediment flux within Breydon Water may be balanced during typical conditions, at least at a regional level. However it is important to note that monitoring has only captured a snap-shot of the tidal cycle, and more comprehensive monitoring would be required over the full 14 day spring-neap tidal cycle as well as stochastic or flood event to develop a full sediment budget.

3.4 The historic trend analysis (undertaken in Section 3.1.1 and Section 6 of the final report) is therefore a valuable tool as it captures the response of the system over a long term. Looking at historical evidence of the position of the main channel, this does not appear to have altered position significantly in the last 120 years. Additionally, the comparison of 2006 and 2013 hydrographic surveys has shown that there appears to be a net accumulation, over that period, of sediment within the navigation channel of the lower estuary. This observation suggests deposition of sediment occurring outside the modelled predictions, for example through flood events, highlighting a limitation in the long-term predictive power of the model over all sediment transport conditions.

3.5 Shoreline erosion around the perimeter of Breydon Water was investigated through a vulnerability assessment to identify locations which have a greater potential for erosion. The full methodology is described in section 3.4 of the final report. Figure 1 shows the overall vulnerability assessment plan. As eroded sediment can contribute to the dredging requirements, this feature of the contract has added considerably to our understanding of the site and has suggested areas for proactive erosion management. Additionally, the impact of changes to sediment dynamics within Breydon, through modifying structures, or dredging programmes, can be understood in the context of impacts on shoreline and mudflat erosion.

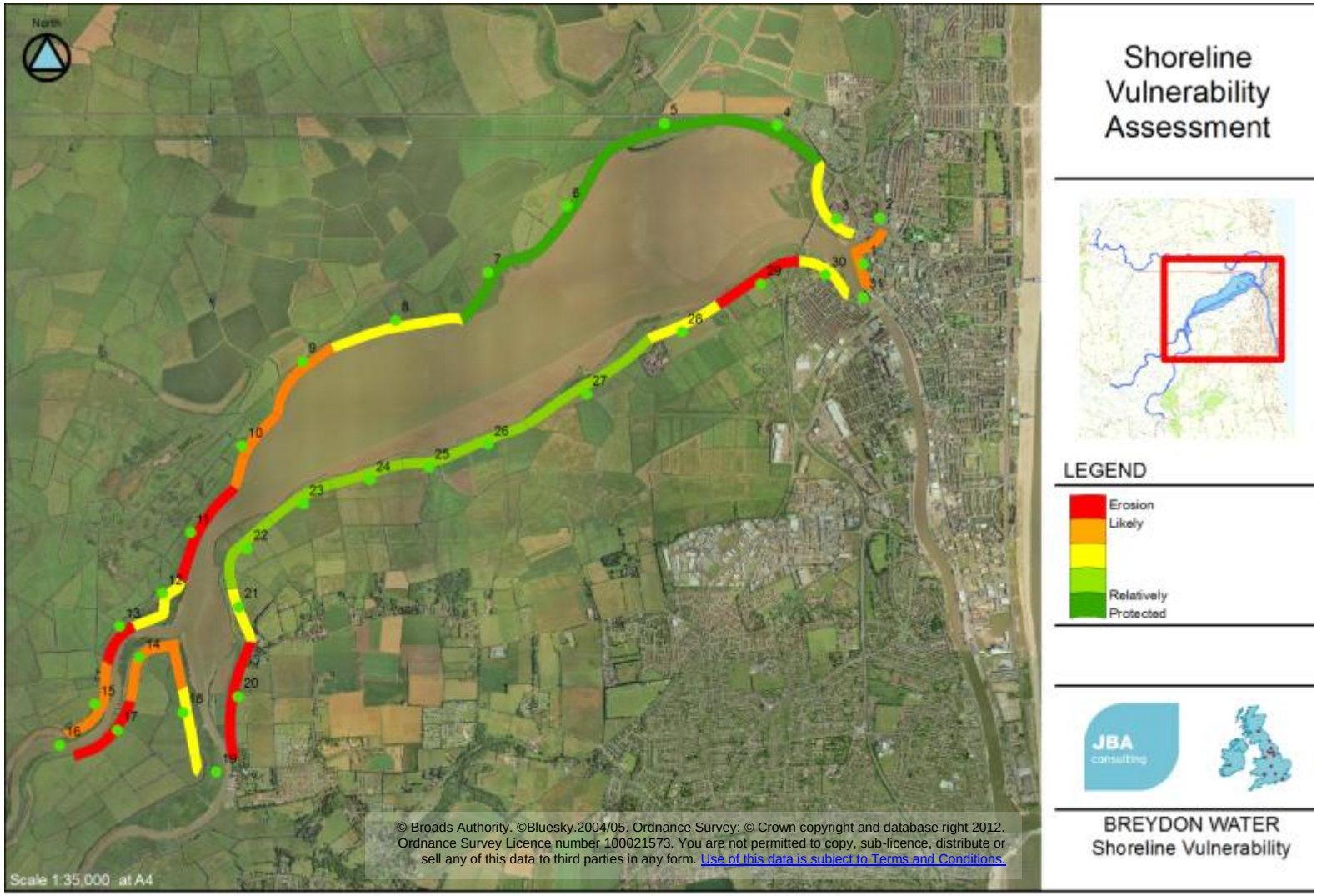

Figure 1. Shoreline vulnerability assessment

4 Obligations under Water Framework Directive

4.1 All management options for the structures and dredge requirements have been subject to a Water Framework Directive (WFD) compliance assessment to determine the impacts on the existing hydromorphology and ecology. The assessment focuses on the relationship between geomorphological processes and their implications for the physical, biological and chemical parameters that influence water body status in the context of the WFD and Habitats' Directive. The tidal processes are heavily ebb dominated and this greatly influences the sedimentary regime that has effectively maintained Breydon Water as open mudflats. The estuary is effectively designed to export sediment. Any changes that increase the rate of sediment export should be viewed as potentially detrimental for environmental/ecological protected features and therefore mitigation measures should be considered.

4.2 All proposed construction activities are relatively small, in the context of the overall scale of Breydon Water, and in relation to previous interventions that make it a 'highly modified water body'.

4.3 This assessment process therefore points to the following:

(i) Changes to local geometry around the Dickey Works and the Turntide Jetty are unlikely to lead to substantial morphological changes, but detectable longer-term changes should not be discounted. Their likely magnitude remains small, however; and this is likely to be at a level that is difficult to detect in terms of ecological or chemical change. These would be relatively insignificant in the context of overall levels of physical modification within the estuary. These modifications are unlikely to lead to a non-temporary deterioration in status at a water body level.

(ii) It should be anticipated that capital dredging to achieve 4m navigation depth would trigger a judgement of 'likely significant effect' under Regulation 61(1a) of the Habitats Regulations and, if so, an 'appropriate assessment' would be required. Mitigation measures may be available to satisfy an appropriate assessment, or such assessment may possibly not be applicable, particularly if the volume of material to be dredged is of a particularly small volume, and impacts can be predicted satisfactorily.

5 Report Conclusions

5.1 Turntide Jetty – Expected costs for annual safety management are predicted to be less than £500 per year over the next five years. If a more proactive approach to removal of the final 40 m of the jetty were to be taken, the Authority could use its own plant and staff with additional requirement to hire in specialist vibrating machinery to aid pile extraction. A contingency amount would also need to be budgeted for, to draft in divers with underwater cutting equipment, should physical extraction prove impossible. An estimated

budgetary figure for such removal, including staff time, contingencies and waste disposal, would be between £75,000 - £100,000.

5.2 Following discussion at the June Navigation Committee, the medium term plan (3-5 years) to retain the existing structure in its current form, providing appropriate navigational safety marks, was recommended. The timber condition of the piling and external cladding is satisfactory for current purposes. However, it was agreed that by end October 2013 a basic structural assessment should be carried out to determine weak points and give a more accurate assessment of the overall life expectancy. Following this initial detailed survey, regular re-surveys to monitor any change in condition should be programmed. It was also agreed that any maintenance work carried out on the structure should be of a sufficient specification to make the structure safe, rather than repair it. The long term plan would be to allow the long, thin, final 40m to degrade, and make good the main body of the jetty, when required.

5.3 Dickey Works – Given the current unknown condition of the structure beneath the waterline, the possible cost of removal of all navigation hazards associated with the Dickey Works could range from less than £15,000 if simple extraction using BA plant and staff can be achieved. If specialist equipment and cutting services are required, the cost to budget for would range from £50,000 - £75,000.

5.4 Now that we know the structure is not required for training the channel position, there is no navigational management requirement or desire to rebuild this structure. Given the report outputs, two potential options were presented to Navigation Committee for its future, principally with the driver of navigational safety. One was to maintain the current navigation safety marks and let the remaining timber work slowly degrade in-situ. The other is a more proactive option to physically remove the structure. The former was the favoured option, but it was agreed that by October 2013 it would be useful to have conducted a basic structural investigation to determine position and condition of piles and any remaining timber work. This information would then enable better evaluation of the most cost effective option, and balance this with the navigational safety of slow degradation or complete removal.

5.5 Dredging requirement – The discussion during the member workshop on 18 April (documented in the final contract report section 10 and Appendix F) suggested that the commercial dredge depth to 4 m is not a specification for the Authority to work to at this time. As such, the 2 m recreational navigation depth will be aimed for within the navigation channel. The predicted dredge volume to achieve this depth within the present marked channel position is 9,000 m^3.

5.6 Estimated cost of dredging to remove the 9,000 m^3 depends upon several factors, principally the dredge technique and the disposal/re-use options available. Basic cost of a BA operation, at a rate of £9 per cubic metre, to remove the 9,000 m^3 with a relatively simple mechanical method of dredging and land-based deposition would be in the order of £81,000. Sediment re-use

options utilising more specialised equipment or projects requiring more extensive environmental mitigation would increase this cost. The cost of the Authority gaining licence for and utilising the off-shore dredge disposal site have not yet been investigated, but would be a relatively straight-forward process.

5.7 The issue has also been raised in the final report of whether any planned sediment removal in Breydon Water would constitute a capital dredge, given the length of time since the last dredge campaign by the former Port Authority. These technical questions can only be answered in detail once a specific dredging plan is developed and further discussion is had with the regulators.

5.8 Additional questions over the position and width of the marked channel through Breydon Water, as inherited from the port, also require attention. A full review of the channel marker locations may enable a safe and accessible channel to be clearly demarked, whilst avoiding the need to dredge significant volumes of sediment from areas know to be prone to shoaling. Figure 2 below shows the measurements taken from GPS information to determine average channel width across Breydon Water.

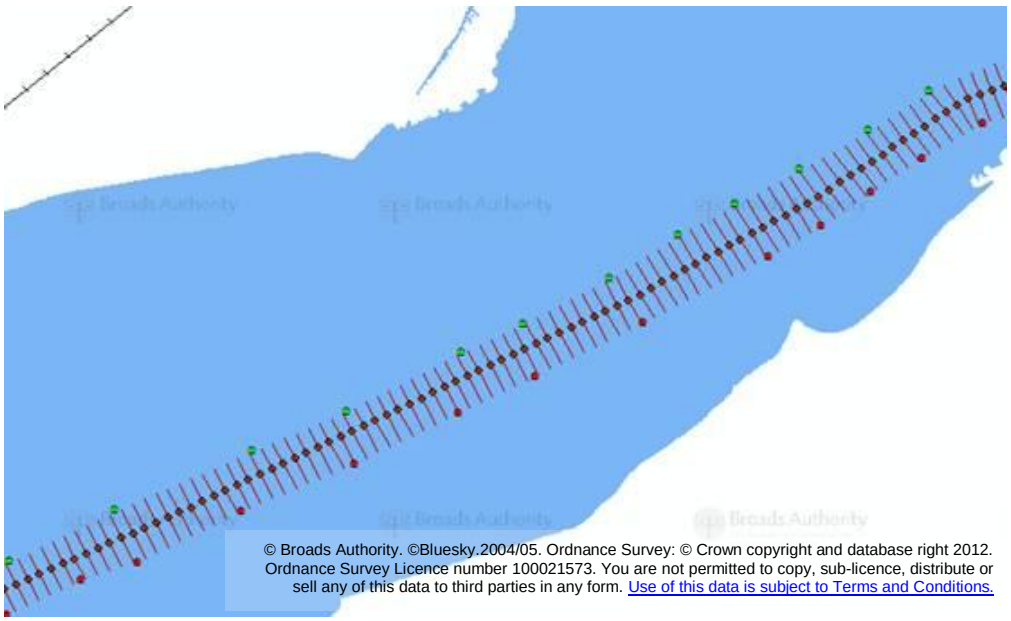

Figure 2. Port and starboard channel markers in the mid section of Breydon Water

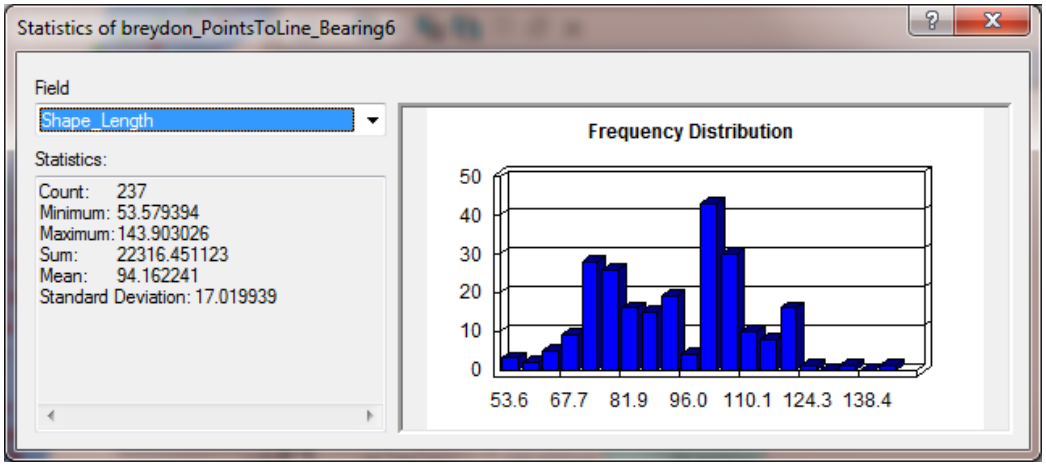

Figure 3. Frequency distribution data and graph of channel widths between the post lines.

5.9 The data presented in the figures above show that channel width in the area is highly variable, with the typical range being between 70 m and 120 m in the main channel through the centre of Breydon Water (Figure 3). The relatively narrow sections are near the Yare/Waveney confluence where the channel is constricted by flood banks on both sides. The location of the shoals requiring dredging to meet the current marked channel specification of 2 m depth have the potential to be managed in a dynamic way through smarter positioning of the navigation channel. This is only feasible, if realignment of the channel markers can produce a safe channel and the cost of moving markers is economical. Feedback from the Navigation Committee members was that dogmatically trying to manage a straight channel was perhaps overly costly and adequate marking would manage safety concerns. Posts present at the moment are a mixture of softwood and tropical hardwood. The long term strategy for markers in Breydon Water is to replace timber posts with steel, as these are less prone to the intense rot and decay brought on by marine boring invertebrates, which means over the long term, mobilisation and materials costs are lower.

5.10 Cost of a major marker repositioning programme would entail BA staff and plant, with additional budgetary requirement for replacement painted steel posts and provision for divers with hydraulic underwater cutting gear to remove stubborn or broken posts. There are currently just over 70 posts between Turntide Jetty and Breydon Bridge. A programme to move/replace 40 of the shorter posts in the centre of Breydon would work out at approximately £1,500 per post (materials and installation costs), with an additional amount for divers with cutting gear. Budgetary allocation at £80,000 or over would be realistic.

6 Summary

6.1 The JBA Consulting study has provided high quality information about the localised, short term impacts arising from the modelled future management options of the historic training wall structures. Retaining a half the current sized Turntide Jetty is a beneficial long-term strategy to maintain low maintenance navigation channels at the confluence of the rivers Waveney

and Yare. The remains of the Dickey Works serve no significant navigational benefits and the suggestion is that it could be feasibly allowed to deteriorate, or be removed, with no negative impacts observable on the protected status of Breydon Water. Capital dredging to create a 4 m commercial navigational channel is not currently required. Options to bring the marked channel into specification include dredging 9,000 m^3 from the current marked channel, or reduce the total dredge volume through strategic repositioning of some marker posts to minimise the dredging requirement, whilst maintaining a clearly defined passage across Breydon.

7 Financial implications

7.1 When previously considering the potential transfer of Breydon Water at negotiation stage, members noted a potential liability in excess of £1,100,000 over 10 years. It was subsequently agreed that the study reported above be undertaken in order to inform management assessment and decisions, prior to determining whether a reserve fund should be established.

7.2 This report has allowed the previous estimates to be updated, and reduces the likely financial requirement to under £250,000 over the same 10 year period. This is well within current budget allocation, but as mentioned above further site survey will be undertaken to confirm the ability of the Authority to complete some of the necessary work in house.

Background papers:	Breydon Water Hydromorphic and Engineering Study – Final draft
Author:	Dan Hoare
Date of report:	25 June 2013
Broads Plan Objectives:	NA1 and NA4
Appendices:	None