Appendix 7.10 Further Applications ES Literature Search

Searches were undertaken on the internet, the Institution of Civil Engineers library catalogue, scientific journal search engines (www.sciencedirect.com, www.springerlink.com, www.elsevier.com) and through a visit to Liverpool University to search their journals database. Where papers were located the abstracts were reviewed to assess the relevance of the information, where appropriate full copies were then obtained for more detailed review.

In general searches were limited to the period from 2008 onwards reflecting the time at which the Orders ES was submitted though consideration was also given to the period after the preparation of the Case Study Report No B4027.TR03.04 dated October 2004 (Appendix 7.1).

The searches focussed on the Mersey Estuary, morphological change and any evidence of effects from building structures in estuarine environments.

Searches were made of the following journals:

a. Proceedings of the Institution of Civil Engineers
b. Geomorphology
c. Ocean Dynamics
d. Continental Shelf Research
e. Estuarine, Coastal and Shelf Science
f. Marine Geology
g. Transactions of the Institute of British Geographers
h. Coastal Engineering
i. Journal of Hydraulics Research
j. Sedimentology
k. Marine Environmental Research

Search terms used were:

a. Mersey
b. Mersey estuary
c. Bridge erosion
d. Bridge estuary
e. Estuary bridge construction
f. Engineering estuary
g. Scour
h. Bridge scour

Key papers that were reviewed were as follows:

Blott S.J., Pye K., van der Wal D., & Neal A., (2006) Long-term morphological change and its causes in the Mersey Estuary, NW England Geomorphology 81 185-206

This paper pre-dates the Orders ES but was not including the literature review carried out for the Case Study Report prepared in 2004. The paper discusses changes in the morphology of the Mersey Estuary and their possible causes, using similar methods to those used in the study for the Project including the Proposals. The paper concludes that the training walls and dredging in the Outer Estuary and Liverpool Bay were the most significant factors contributing to change. Other factors were of relatively minor importance. It was noted that between 1950 and 1977 the rate of sediment accumulation in the Inner Estuary declined as the estuary approached a new condition of dynamic equilibrium but that since 1977 there had been a slight net loss of sediment. Under these conditions it was considered that the changes in natural forcing factors such as sea level and storminess are likely to have a relatively greater effect on the estuary than in the past.

N.I. Pontee., P.A. Whitehead., C.M. Hayes., (2004), The effect of freshwater flow on siltation in the Humber Estuary, north east UK Estuarine. Coastal and Shelf Science 60 241-249

This paper notes that in 1977 McDowell and O'Connor postulated that movements of channels in the inner estuary were a response to variations in freshwater discharges.

Moore R.D., Wolf J., Souza A.J., & Flint S.S., (2009) Morphological evolution of the Dee Estuary, Eastern Irish Sea, UK: A tidal asymmetry approach. Geomorphology 103 588-596

This paper was reviewed because the estuary is located close to the Mersey. The paper notes that the Dee is flood dominant and that it is accreting, this is noted to be consistent with the large scale accretion that has been observed over the past two centuries. It is noted that the estuary may be approaching equilibrium and that the flood dominance and sedimentation rate may therefore decrease in the future. The paper goes on to note that an infilling estuary can eventually shift towards ebb dominance but the large tidal amplitude to hydraulic depth ratio of the Dee suggests tidal flats would have to be very extensive for this to occur. The modelling was based on 3-dimensional numerical modelling methods, with high resolution LIDAR surveys to underpin it.

Wang Y., Ridd P.V., Wu H., Wu J., & Shen H., (2008) Long-term morphodynamic evolution and the equilibrium mechanism of a flood channel in the Yangtze Estuary (China) Geomorphology 99 130 – 138

This paper is based on a study of flood channels in Yangzte. It was not considered to be of any specific relevance to the Upper Mersey.

Prandle D., (2006) Dynamic controls on estuarine bathymetry: Assessment against UK database Geomorphology 68 282-288

This paper discusses new theories which relate estuarine bathymetries to tidal dynamics (through the parameter Z, the mean tidal amplitude at the mouth) and the average river flow (Q). The principle outcomes are expressions for estuarine length, depth and axial profile. The results suggest that the prevailing sediment regimes are a consequence of these bathymetries. The paper was intended to "provide insight into the applicability of these expressions to encompass detailed local knowledge of specific estuaries, allowing for impacts of: engineering "interventions", "hard" geology, dynamics or mixing inconsistent with the theoretical assumptions, non-representative observational data, vagaries of sediment supply, wave impact, etc". The paper also noted the importance of flora and fauna and that if long-term bathymetric evolution cannot be predicted by extrapolation of prevailing net scour or erosion then scenarios combining climatic perturbations alongside changes in flora and fauna may need to be considered in the future. No subsequent paper developing this theory could be located.

Reeve D.E., & Karunarathna H., 2009 On the prediction of long-term morphodynamic response of estuarine systems to sea level rise and human interference Continental Shelf Research 29 938-950

The paper discusses the application of a "Boolean network approach" to assess the response of estuarine systems to sea level rise and human interference. The paper considered three estuary types and showed that the long-term response to sea level rise depends on the type of estuary and the availability of external sediment. With an abundant influx of external sediment then the estuary maintains its geomorphology and will reach a stable state. Where the supply of external sediment is inadequate then prominent features such as salt marshes and spits are likely to recede, or disappear altogether. Moderate human interference (dredging and structural construction) was not found to have a significant long-term impact with only a short-to-medium term impact arising on estuarine morphology.

Davies A.M., Xing J., & Jones J.E., (2011) A model study of tidal distributions in the Celtic and Irish Sea regions determined with finite volume and finite element models Ocean Dynamics 61 1645-1667

This paper covered the whole of the Irish Sea and adjacent regions and was not specifically relevant to the scheme.

Jones E.J., & Davies A.M., (2009) Storm surge computations in estuarine and near-coastal regions: the Mersey estuary and Irish Sea area Ocean Dynamics 59 1061-1076

The paper discusses the use of a storm surge model of the west coast of Britain incorporating a high-resolution representation of the Mersey estuary to examine storm surge dynamics focussed on a major surge event in November 1977. The work showed that, compared to previous modelling which did not include the Mersey Estuary, including the estuary had little effect on the overall outcome in the eastern Irish Sea. However, the paper notes that “at the entrance to the Mersey, its inclusion did influence the solution”. A detailed study of storm surge propagation in the Mersey was undertaken and this showed that the temporal variability of the surge was