

MERSEY TIDAL POWER

FEASIBILITY STUDY: STAGE 3

Cost Management Report

Date June 2011

Report prepared by:



Project Sponsors:



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englandsnorthwest

www.merseytidalpower.co.uk

Prepared by	Reviewed by	Approved by	Verified by MTP Project Director
Colin Matley	Chim Chalemera	Rob Wood	Mary Holt

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		Peel Energy Limited Peel Dome The Trafford Centre Manchester M17 8PL Tel: 0161 629 8200 www.peelenergy.co.uk

Project Background

In the face of current and anticipated issues of security of supply and climate change, the need to find local sources of renewable energy has never been more urgent.

The Mersey Estuary has one of the largest tidal ranges in the UK, making it one of the best locations for a tidal power generation scheme. It has the potential to make a significant contribution to the Government's target to secure 15% of UK energy from renewable sources by 2020.

A large scheme could deliver enough renewable electricity to meet the needs of a significant proportion of the homes within the Liverpool City Region, as well as beyond. Any scheme put forward will need to take into account the ecological diversity of the Estuary, which supports internationally important bird habitats.

Phase 1 Pre-Feasibility Study - 'Power from the Mersey'

Peel, in partnership with the NWDA set out to explore the potential, the impacts and the implications of utilising the Mersey Estuary's renewable energy potential for the benefit of the Northwest region.

The Mersey Basin Campaign gave its full backing to the work and a consortium of consultants led by Buro Happold was commissioned in July 2006 to undertake a 'pre-feasibility' Phase 1 Study.

The primary objective of the Phase 1 Study was to undertake a full and open assessment of the options available for the generation of renewable energy and to undertake a preliminary assessment of viability.

A number of potentially viable schemes were identified. The continued development of marine power technology means that others may also need to be considered as the project moves into the next phase.

Meeting 2020 Renewable Energy Targets

An overall timetable was defined to ensure the project supports the policy objective of contributing to 2020 renewable energy targets. The key milestones of the project include submission of applications for planning or other statutory consents by 2012 and commissioning of the scheme by 2020.



Phase 2 Feasibility Study

Peel Energy and the Northwest Development Agency are progressing the project in line with the principles for sustainable development. A feasibility study has been commissioned to assess the options and identify a preferred scheme to take forward for submission of a planning application.

The feasibility study has been led by URS Scott Wilson, EDF and Drivers Jonas Deloitte, and supported by RSK, APEM, HR Wallingford, Regeneris, Turner and Townsend, University of Liverpool, Proudman and Global Maritime.

The feasibility study has been undertaken in three stages as follows:

- Stage 1: Definition of project strategies, data gathering and gap analysis, and selection of long list of suitable technologies
- Stage 2: Appraisal of the long list of technologies and formulation and appraisal of scheme options to identify a shortlist
- Stage 3: Further refinement and appraisal of the short list of scheme options and selection of the preferred scheme.

The project has been pursued in an open and transparent manner, building on the consultation and stakeholder engagement started in the Phase 1 study. An extensive programme of stakeholder engagement has taken place through project advisory groups, consultation with statutory and non-statutory consultees and public consultation targeted during appropriate stages of the project.

Mersey Tidal Power Scheme Objectives

The objectives of the Mersey Tidal Power scheme are:

- (a) To deliver the maximum amount of affordable energy (and maximum contribution to Carbon reduction targets) from the tidal resource in the Mersey Estuary with acceptable impacts on environment, shipping, business and the community either by limiting direct impact in the Mersey Estuary or providing acceptable mitigation and/or compensation;

and in doing so,

- (b) To maximise social, economic and environmental benefits from the development and operation of a renewable energy scheme, including where appropriate:
- (i) the development of internationally significant facilities and skills to support the advancement of renewable energy technologies and their supply chains,
 - (ii) improvements to local utility and transport infrastructure,
 - (iii) improvements to green infrastructure and environmental assets,
 - (iv) the development of a leisure opportunity and tourist attraction.

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Annexes:

Appendix A: Cost Models for Each Scheme Option

Appendix B: Schedule of Information Cost Models Based Upon

Note on Terminology

This technical report uses a different naming system to the Stage 3 Feasibility Report to refer to schemes variants, as follows:

- IBv2a = A1.02a;
- IBv2b = A1.02b;
- VLHBv2a = A2.01a; and
- VLHBv3a = A2.02a.

If a lower case letter is not used, this is because the operating regime (denoted by the lower case letter) is not relevant.

1 Summary

During Stage 3, the following three short-listed options have been developed and cost modelled, all of which are located along Line A:

- A1.02 – Ebb Flow Barrage
- A2.01 – Ebb Flow Barrage
- A2.02 – Ebb and Flood Barrage

During the latter stages of Stage 3, a further “preferred scheme” was also developed –A1.04 comprising an Ebb and Flood Barrage. A cost model has also been developed for this scheme.

COST SUMMARY

A summary of the capital construction costs for each scheme option is tabled below. Please note that each scheme includes for the construction of twin locks on the Wirral bank:

	A1.02 Ebb Flow Barrage (£m)	A2.01 Ebb Flow Barrage (£m)	A2.02 Ebb & Flood Barrage (£m)	A1.04 Ebb & Flood Barrage (£m) (Preferred Option)
Temporary Facilities	74.2	74.2	74.2	74.2
Reclaimed Areas & Navigation Requirements	735.1	735.1	735.1	735.1
Landside Facilities	14.7	14.7	14.7	14.7
Caissons	684.2	1,156.9	1,122.1	869.5
Power Generation Technology	510.0	750.0	750.0	510.0
Infrastructure & Utilities	62.5	62.5	62.5	62.5
On-Costs	41.1	31.6	24.0	41.1
Infrastructure Sub-Total	2,121.8	2,825.0	2,782.6	2,307.1
Preliminaries (12%)	254.6	339.0	333.9	276.8
Design & Supervision (12%)	285.2	379.7	374.0	310.1
Contingency (20%)	532.3	708.7	698.1	578.8
Inflation	Excluded	Excluded	Excluded	Excluded
TOTAL	3,193.9	4,252.4	4,188.6	3,472.8
EDF Estimated Installed Capacity (MW)	700	660	660	700
Capital Cost / MW	£4.563 / MW	£6.443 / MW	£6.346 / MW	£4.961 / MW

Please note that all the above costs include for the construction of twin locks on the Wirral bank. The following alternative navigation lock options also exist as follows:

- Extra over cost to add a single Liverpool bank lock - £230m, (this estimate being based on the single Liverpool bank lock design at Stage 2 but with a 50% reduction in reclaimed land area as drawn at Stage 2 (representing a £54m cost reduction).
- Extra over cost to extend the Manchester Ship canal by 4662m - £263m, (this cost being based on the indicative design put forward during Stage 2).

Detailed cost models for each of the above four schemes are contained at Appendix A.

2 Estimating Basis and Methodology

2.1 Estimating Basis

To support the Stage 3 option appraisal process, T&T have developed high level cost models to help test the viability of each scheme option.

These high level capital cost models are based on the design information to support the Stage 3 study together with verbal and e-mail correspondence provided by the Feasibility Study team. Power generation technology cost information has been provided by EDF. A detailed list of the information upon which the cost models are based is contained at Appendix B.

It is important to note that these cost estimates are based on early stage design information with limited design survey data. The estimates reflect the level and quality of information provided at this stage by the team and will be subject to significant design development (particularly the power generation, marine and civil engineering and infrastructure elements).

The costs currently published include a 20% contingency allowance for design development and pricing risk. This allowance does not include for scope change.

The estimates include for all construction and installation works and associated development costs including power generation technology costs. They also include for dredging to form new navigation channels as indicated on the drawings, ecology and habitat requirements, surveys and site investigation costs, land purchase costs, Mersey and other potential licence costs and design and legal fees.

The costs are priced at current 1st quarter 2011 pricing levels and exclude any allowance for inflation.

2.2 Estimating Methodology

Structures, marine engineering and civil engineering works - T&T have measured the major quantities of works required and as detailed on the feasibility study drawings and costed these using “all-in” rates developed using T&T existing cost data for similar major engineering schemes. T&T maintain a cost database from all projects undertaken, which provides cost data for comparison purposes from our global project base.

We have benchmarked the capital costs developed for the Mersey Tidal Power scheme options against the updated reported costs for the Severn Barrage Schemes which represent the most recent and relevant benchmark data. Our rates have also been validated using available benchmark data from third party sources for relevant major marine and civil engineering type projects undertaken by T&T over the last three years.

Power generation technology costs – The cost for manufacture and installation of the power generation technology plant is based on costs provided by EDF.

In addition to the above, various allowances and provisional quantities have been included for elements of work that are not yet defined in any detail but are likely to be required. These are identified within the Assumptions and Notes sheets that accompany each cost model.

A list of the information upon which the cost models are based is provided in Appendix B.

2.3 Assumptions

A number of assumptions have been made during the estimating process for each of the four scheme options. Details of these assumptions appropriate to each scheme are detailed within the Assumptions and Notes pages that accompany each estimate.

The key assumptions common to all four schemes include:

- We have included for the construction of a cofferdam temporary construction facility on the bank of the Mersey within all four schemes, which will be removed at completion of the construction programme.
- We have assumed that localised dredging is required to the caisson, lock and land reclamation construction areas as part of the construction enabling works in addition to specific dredging requirements shown on the feasibility study drawings.
- Within the Infrastructure and Utilities costs we have included a £5m allowance for network reinforcement costs and a £3m allowance for any other miscellaneous utility costs following discussion and consultation with the team.
- Compensatory Habitat Costs – The costs for each scheme vary based on the potential residual impact of each scheme as defined by the Ecology team.
- Surveying and Site Investigations - an allowance of £2m has been included in each scheme.
- Land Purchase Costs - an allowance of £1.5m has been included in each scheme.
- Licence Costs for river usage - an allowance of £0.5m has been included in each scheme.
- Sundries - an allowance of £1m has been included in each scheme.
- Community benefits – No capital allowance has been included in the schemes at this stage.
- Improvements to existing access roads – The landside facility drawings show new access roads which adjoin to existing highways from both the Liverpool bank and Wirral bank and these have been included for within the estimates. However no allowance has been included for improvements to the existing highways.
- Also, please note that Decommissioning Costs applicable when operation of the facilities cease have not been included within our capital cost models.

3 Sensitivity Analysis

A project of the magnitude of the Mersey Tidal Power scheme requires significant capital investment. To test the effect of potential changes to the measured works and the rates for major elements of cost we have undertaken a review of each of the original three Stage 3 schemes to assess the effect of the following;

- An increase or decrease to all the **concrete rates** included within the cost estimates by +/- 10% to test the cost impact of concrete as concrete represents the most significant resource cost across each estimate.
- An increase or decrease to all the actually **measured works** included within the estimates by +/- 10% to test the cost impact of measurement accuracy.
- An increase or decrease to **all the works** included within the estimates by +/- 10% to test the cost impact on the overall cost estimate.

The effect of these variables on the estimated scheme costs for each of the original three Stage 3 schemes is as expressed in the table below. Dependent on the status of these issues during the tender process for the works, such as the actual price of concrete at the time; these figures would either be applied or deducted from the capital cost as applicable.

Please note that these are gross costs inclusive of preliminaries, fees and contingency.

Scheme	Concrete Rate +/- 10 %	Measured Works +/- 10%	Overall Works Cost +/-10 %
A1.02 – Ebb Flow	£175.4m	£234.2m	£319.4m
A2.01 – Ebb Flow	£221.8m	£305.2m	£425.2m
A2.02 – Ebb & Flood	£218.0m	£299.9m	£418.6m

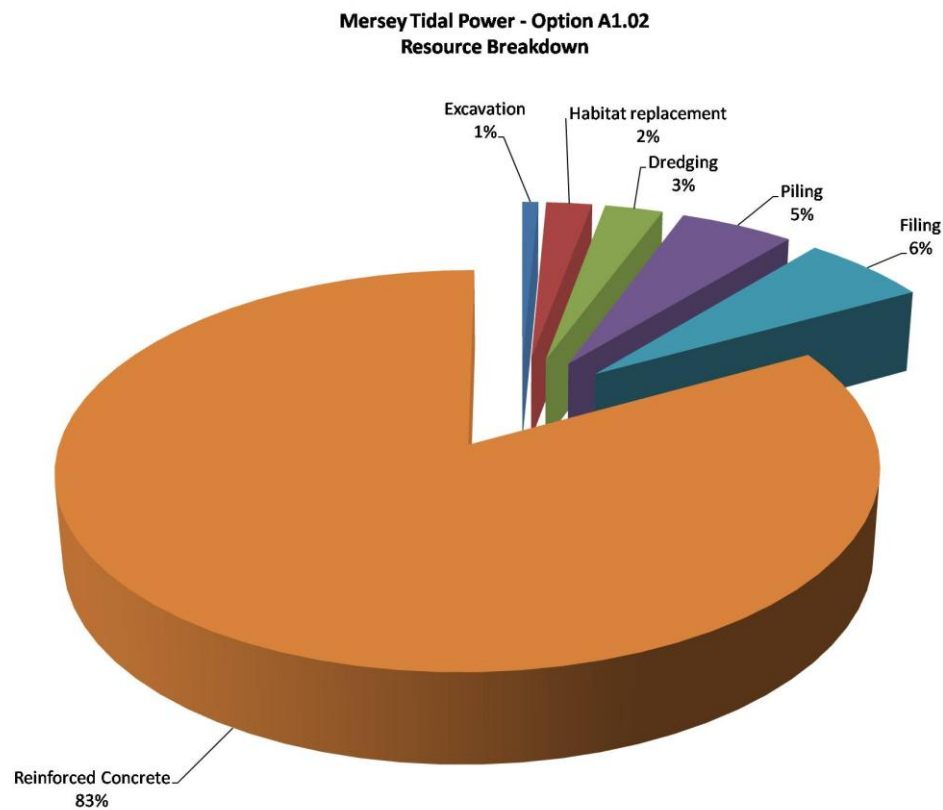
Whilst the adjustment of the Overall Works Costs has the largest effect on the estimated costs, due to the extent of the concrete works in each of the schemes the sensitivity of this 'resource' will have the single largest effect on the project.

To demonstrate the areas of most significant cost to support the above sensitivity analysis, included below are two graphical charts based on scheme A1.02 which show the areas of most significant spend at [1] Resource Level and [2] Facility Level.

Resource Costs represent the labour, plant and material costs to form the required construction works.

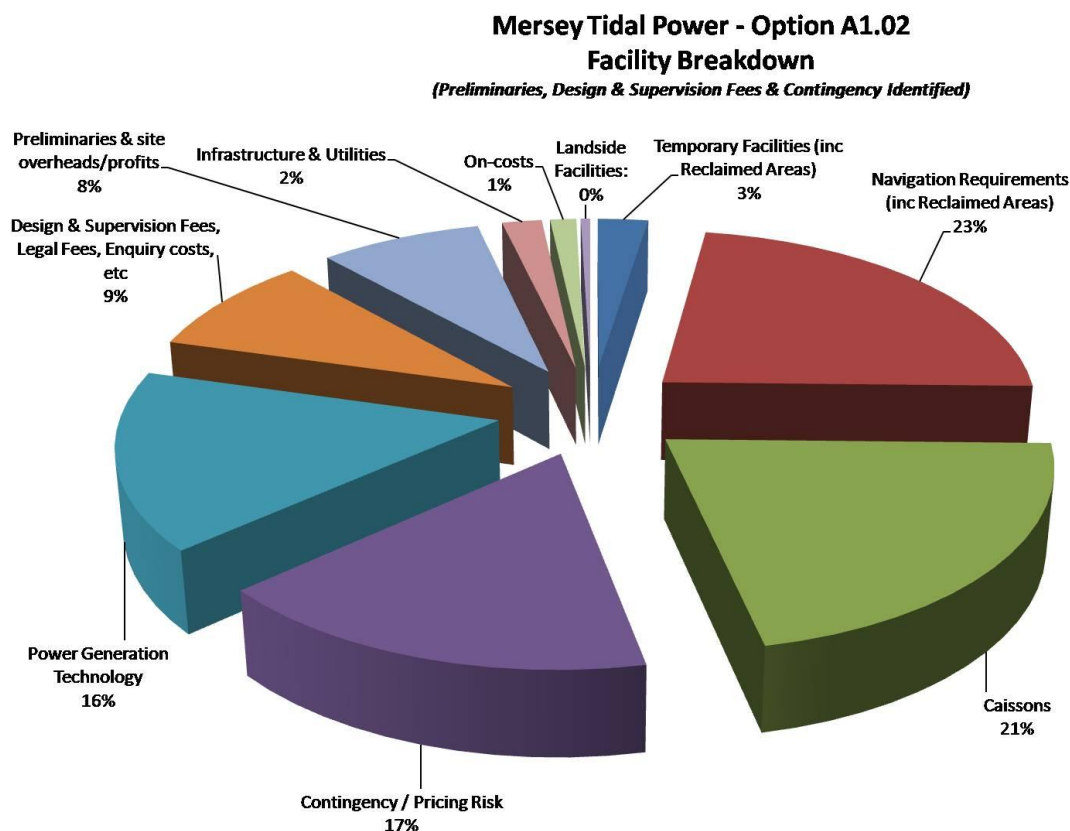
Facility Costs represent the major elements of the works comprising navigation requirements, caissons, generation technology, etc.

At Resource Level, concrete is by far the most significant cost item as can be seen in the graph below, followed by fill material and piling.



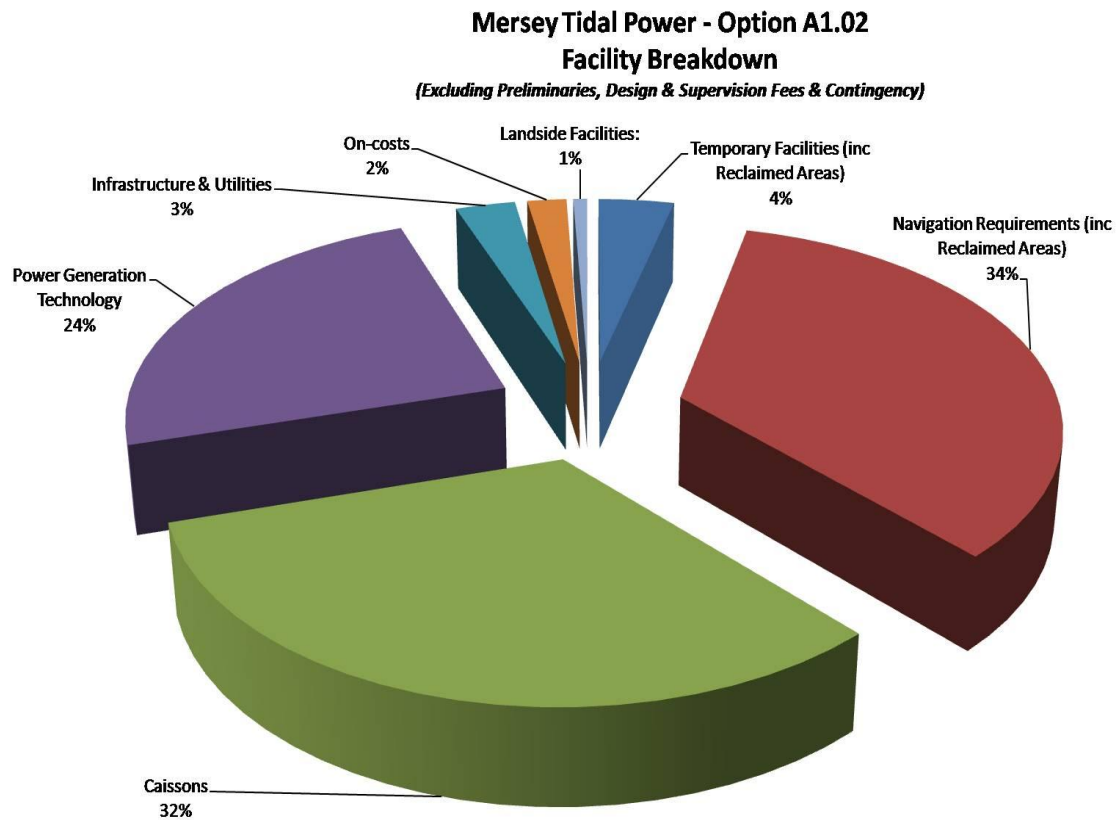
At Facility Level, the greatest area of significant cost is the reclaimed structures and navigation requirements to form the twin locks on the Wirral bank. The caissons followed by the power generation technology costs represent the two other areas of greatest cost.

Two charts are included below. The first shows Facility Level costs with preliminaries, design and supervision fees and contingency separately identified and the second showing actual facility costs only.



Notes:

- Reclaimed areas (Temporary Facilities) refers to the construction of the cofferdam and the North Reclaimed area shown on Dwg Ref: PD-0330-11-3000-P2
- Reclaimed areas (Navigation Requirements) refers to the formation of the Double South Lock Construction (Dwg ref: PD-0330-12-2023-P2), measured at 50% of the reclaimed area identified on Dwg Ref: PD-0330-11-3000-P2



Notes:

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4 Benchmarking against the Severn Barrage Scheme

4.1 Overview

The schemes identified for Stage 3 of the study consider a barrage solution across Line A running between New Ferry and Dingle. The technology proposed utilises either Ebb Flow or Ebb and Flood generation.

A summary of the costs of the Mersey Tidal Power project and the installed generation capacity is provided in the table below;

Scheme	Installed Cost (£m)	Capacity	Cost £m / Installed MW
A1.02 – Ebb Flow	£3,193.9	700 MW	£4.563 / MW
A2.01 – Ebb Flow	£4,252.4	660 MW	£6.443 / MW
A2.02 – Ebb & Flood	£4,188.6	660 MW	£6.346 / MW
A1.04 – Ebb & Flood	£3,472.8	700 MW	£4.961 / MW

4.2 Comparisons with the Severn Schemes

The scheme to create a barrage in the Severn Estuary for power generation has been mooted on a number of occasions. Under review since 1981, the most recent options were brought forward in 2007 and represent two technologies, a barrage and an enclosing lagoon.

A number of locations were identified as possible power generation sites, with the Cardiff – Weston link confirmed as that returning the greatest capacity in terms of generated power. The figures shown in the table below are taken from the December 2008 Black & Veatch report and represent a 1:1 ratio for compensatory habitat. Costs for navigation locks and gates are included in all options except Welsh Grounds.

Scheme	Install Cost (M)	Capacity	Cost/Installed MW
Cardiff-Weston Barrage	£19,600.0	8600 MW	£2.28m / MW
Bridgewater Lagoon	£3,400.0	1360 MW	£2.50m / MW
Welsh Grounds Lagoon	£4,100.0	1360 MW	£3.01m / MW
Shoots Barrage	£2,900.0	1050 MW	£2.76m / MW
Beachley Barrage	£2,100.0	625 MW	£3.36m / MW

4.3 Further Updates on the Severn Scheme Costs

Following the submission of the December 2008 Black & Veatch report, the costs for the Severn schemes have been subject to extreme scrutiny to assess value for money for such a significant capital investment. Reporting undertaken in October 2010 identified the scheme costs as being significantly greater than previously anticipated, as follows:

Scheme	Install Cost (£m) inclusive of Optimism Bias	Install Cost (£m) exclusive of Optimism Bias	Capacity	Cost (£m)/Installed MW exclusive of Optimism Bias
Cardiff-Weston Barrage	£34,300	£23,200	8600 MW	£2.698 / MW
Bridgewater Lagoon	<i>Reviewed costs not reported</i>			
Welsh Grounds Lagoon	£10,100	£6,800	1360 MW	£5.000 / MW
Shoots Barrage	£7,000	£4,700	1050 MW	£4.476 / MW
Beachley Barrage	£5,100	£3,500	625 MW	£5.600 / MW

4.4 Findings

The current estimated installed cost per megawatt for the Mersey Tidal Power scheme options for A2.01 and A2.02 exceed all of the options identified for the Severn Barrage when compared on a like-for-like basis exclusive of optimism bias. However, A1.02 and A1.04, while exceeding those for the Cardiff-Weston Barrage and the Shoots Barrage, are less than the Welsh Grounds Lagoon and Beachley Barrage (when compared on a like-for-like basis exclusive of optimism bias).

4.5 Rates and Costs Benchmarking

Benchmarking the cost estimates for this project is difficult as there are few examples of constructed barrages; however, the following information is available within the published Black and Veatch Review of Severn Barrage Proposals report, dated 2008.

Item	Mersey Rate at 1Q11	Black & Veatch Report as at 4Q2008
Caisson Construction Yard	£74,200,000	£64,800,000
Concrete	£500 -750 / m3	£576 / m3
Sand Filling	£10 / m3	£8.60 / m3
Rock Fill	£35 / m3	£21.60 / m3

The Black & Veatch Report rates have not been normalised to 1st Quarter 2011 because inflation indices indicate that very limited change has occurred during this period.

5 Mitigation Options and Residual Uncertainties

5.1 Options for Mitigation of Impacts

The opportunity to mitigate the potential impact of certain items on the overall costs of the scheme options will be better understood during future stages of development when design information for the preferred scheme and solutions will be completed in more detail and definition. This design work will enable more detailed cost models to be prepared and then analysed as a result.

Within the Stage 3 cost estimates, provisional allowances have been included for a number of items as listed below and preparation of more detailed design information for these items would enable better defined costs to be developed. However it is important to note that none of these items listed below are of major significant cost.

- It is assumed that each scheme will require the construction of a cofferdam temporary construction facility on the bank of the Mersey, which will be removed at completion of the construction programme. Alternative methods could reduce the cost allowance included.
- More details on the Infrastructure and Utilities requirements to enable more accurate and firmer costs to be prepared, and also to enable the removal of the network reinforcement and other utility cost allowances.
- Compensatory Habitat costs are included in each of the cost models for the potential residual impact of each scheme as defined by the Ecology team. These requirements have been developed at a very high level and further definition is required during subsequent stages of design development and assessment of the preferred scheme.
- Requirement and areas for land purchase costs.
- Requirement and areas for river usage licensing costs.

5.2 Identification of Residual Uncertainties

The cost models developed are based on the Stage 3 design information for each scheme as produced by Feasibility Study team.

It is important to note that these cost estimates are at a high level as they are based on early stage design information with limited design survey data. The estimates reflect the level and quality of information provided at this stage by the team and will be subject to significant design development (particularly the power generation, marine and civil engineering and infrastructure elements).

As a result of the above, the cost models include a 20% contingency allowance for design development and pricing risk. This allowance does not include for scope change.

6 References

DECC (2008) *Analysis of Options for Tidal Power Development in the Severn Estuary - Interim Options Analysis Report, VOLUME 1*. Prepared by Parsons Brinckerhoff Ltd in association with Black and Veatch

DECC (2010) *Severn Tidal Power Feasibility Study Conclusions and Summary Report*

Appendix A: Cost Models for Each Scheme Option

Detailed cost models are contained overleaf for each of the four schemes short listed for development during Stage 3 as follows. These are all located along Line A:

- A1.02 – Ebb Flow Barrage
- A2.01 – Ebb Flow Barrage
- A2.02 – Ebb and Flood Barrage
- A1.04 - Ebb and Flood Barrage (Preferred Scheme)

Each cost model includes

- (1) Cost Option Summary
- (2) Estimating Basis
- (3) Estimating Methodology
- (4) Assumptions and Notes
- (5) Costed Quantified Schedule of Items.

Appendix B: Schedule of Information Cost Models Based Upon

A list of the information upon which the cost models are based upon is attached below.

Civil Engineering (Power) Drawings

A1.02

- PD0330-11-3000 P3 Ebb Flow Barrage General Arrangement
- PD0330-11-3001 P1 Longitudinal Section
- PD0330-11-3002 P1 Turbine Caisson Plan
- PD0330-11-3003 P1 Turbine Caisson Section
- PD0330-11-3004 P1 Sluice Gate Caisson
- PD0330-11-3005 P1 Blank Caisson

A2.01

- PD0330-11-3050 P2 Ebb Flow Barrage General Arrangement
- PD0330-11-3051 P2 Longitudinal Section
- PD0330-11-3052 P1 Turbine Caisson Plan
- PD0330-11-3053 P1 Turbine Caisson Section
- PD0330-11-3054 P1 Turbine Caisson Section (Piled Foundation)
- PD0330-11-3055 P1 Sluice Gate Caisson
- PD0330-11-3056 P1 Blank Caisson

A2.02

- PD0330-11-3100 P1 Ebb and Flood Flow Barrage General Arrangement
- PD0330-11-3101 P1 Longitudinal Section
- PD0330-11-3102 P1 Turbine Caisson Plan
- PD0330-11-3103 P1 Turbine Caisson Section
- PD0330-11-3104 P1 Turbine Caisson Section (Piled Foundation)
- PD0330-11-3105 P1 Sluice Gate Caisson
- PD0330-11-3106 P1 Blank Caisson

Civil Engineering (Marine) Drawings

- PD0330-12-2023 P2 Navigation Option 3 Twin South Lock General Arrangement
- PD0330-12-2022 P1 Navigation Option 1 North lock GA
- PD0330-12-2024 P1 Navigation Option 4 Manchester Ship Canal Extension Bund
- PD0330-12-2001 P1 Navigation Option 1 Single South Lock and North Lock –which shows potential area for construction purposes

Landside Facilities

- PD0330-13-3001 P1 Location Plan Landside Facilities General Arrangement
- PD0330-13-3002 P1 South Bank Landside Facilities General Arrangement
- PD0330-13-3003 P1 North Bank Landside Facilities General Arrangement
- Landside Facilities Schedule of Areas prepared by Scott Wilson as e-mailed on 25/1/11.

Utilities Information

- PD0330/10/2A01 P1 HV Cable Routing

Power Generation manufacture and installation costs

EDF Power Generation Manufacture and Installation costs included in Mersey Tidal Power Stage 3 Development of Tidal Barrage Scheme Options report, Annex F.

