**MERSEY GATEWAY**

# APPENDIX E

# WAVE HEIGHT ASSESSMENT

**C O N T E N T S**

Page



**ATTACHMENTS**

## 1. INTRODUCTION

This report presents a desk study estimate of wave heights at the location of the Mersey Gateway.

## 2. ESTIMATE WAVE HEIGHT AT BRIDGE LOCATION

### 2.1 Data

2.1.1 Topographic Survey – February 2005
File 05A 136.dwg by Survey Operations

2.1.2 Admiralty Chart 3478 Edition No. 3, 17 May 2001

2.1.3 Windspeed Data

2 years of wind data from Meteorological Office file 'sea location model data.csv' for the period March 2005 to March 2007 (held in Gifford File B4027C – Mersey Gateway – Current Folder/Task Work Area/Hydrodynamics/ Wind Data).

### 2.2 Method

2.2.1 Method is in accordance with Reference:-

D Yarde et al (1996) as published in

"Revetment Systems Against Wave Attack – A Design Manual" – Kirsty McConnell, HR Wallingford – Thomas Telford.

Section 7.3 "Prediction of Waves on Inland Waters".

### 2.3 Windspeed Data

Local windspeed data from Met Office (see 2.1.3) and also BS 6399 – 2 : 1997 Code of Practice for Wind Loads.

2.3.1 Design Wind Speed

$U_d = V_b \ S_a \ S_d \ S_p \ S_f \ S_w$

2.3.2 Basic Windspeed

$V_b$ = 22 m/s

$S_a$ = 1.0 (site at mean sea level)

2.3.3 Direction factor : fetches are East-West

$S_d$ = 1.0

$S_p$ = from "Revetment Systems Against Wave Attach" Table 7.2:-

| Return Period (Years) (RP) | $S_p$ |
|---|---|
| 1 | 0.67 |
| 5 | 0.83 |
| 10 | 0.88 |
| 20 | 0.95 |

$S_f$ duration factor = assume 30 min

$S_f$ = 1.03

$S_w$ over water speed-up factor

| | | | | |
|---|---|---|---|---|
| Fetch | 2 km | $S_w$ | = | 1.16 |
| | 4 km | $S_w$ | = | 1.24 |

2.3.4 Windspeed vs fetch and return period

| **Fetch** | **RP** | **$U_d$ (m/s)** | | **m/s** |
|---|---|---|---|---|
| **2 km** | 1 | 22 x 1.0 x 1.0 x 0.67 x 1.03 x 1.16 | = | 17.6 |
| | 5 | | | 21.8 |
| | 10 | | | 23.1 |
| | 20 | | | 24.4 |
| **4 km** | 1 | | | 18.8 |
| | 5 | | | 23.3 |
| | 10 | | | 24.7 |
| | 20 | | | 26.1 |

$$H_s = 0.00178\ U_d\ \sqrt{F}\ /\ \sqrt{g} = \frac{\text{m/s}\quad \text{m}}{9.81\ \text{m/s}^2}$$

2.3.5 Significant wave height $H_s$ vs Fetch

| **Fetch** | **RP** | **$U_d$** | **($\sqrt{F}/\sqrt{g}$)** | **Hs (m)** | **Beaufort Scale** |
|---|---|---|---|---|---|
| **2 km** | 1 | 17.6 | 14.3 | 0.45 | 8 |
| | 5 | 21.8 | 14.3 | 0.56 | 9 |
| | 10 | 23.1 | 14.3 | 0.59 | 9 |
| | 20 | 24.4 | 14.3 | 0.62 | 9 |
| **4 km** | 1 | 18.8 | 20.2 | 0.68 | 8 |
| | 5 | 23.3 | 20.2 | 0.84 | 9 |
| | 10 | 24.7 | 20.2 | 0.89 | 10 |
| | 20 | 26.1 | 20.2 | 0.94 | 10 |

## 3. BEAUFORT SCALE

See Appendix A obtained from Meteorological Office website.

## 4. WAVE HEIGHT COMPARISON

Compare wave heights using met office data 2005-6: See spreadsheet attached (Appendix C).

| Beaufort | Windspeed | Significant Wave Height $H_s$ (m) Fetch | |
|---|---|---|---|
| | m/s | 2km | 4km |
| F 0 | 0 – 0.2 | 0.01 | 0.01 |
| F 1 | 0.2 – 1.5 | 0.04 | 0.05 |
| F 2 | 1.5 – 3.3 | 0.08 | 0.12 |
| F 3 | 3.3 – 5.4 | 0.14 | 0.19 |
| F 4 | 5.4 – 7.9 | 0.20 | 0.28 |
| F 5 | 7.9 – 10.7 | 0.27 | 0.38 |
| F 6 | 10.7 – 13.8 | 0.35 | 0.49 |

## 5. ARE WAVES DEPTH LIMITED?

**Water Depth vs Tidal Level**
See chart extract and topographical survey (Appendix A):-

| | | | Fetch A | Fetch B | Fetch C |
|---|---|---|---|---|---|
| | | | 2 km | 3.4 km | 2 km |
| Approx. Max Bed Level m ODN | | | 4.0 m | 3.0 m | 1.2 m |
| MHWS | 5.1 mOD | | **1.1 m** ✓ | **2.1 m**✓ | **3.9 m**✓ |
| MHWN | 3.0 | | - 1.0 'Dry' | 0. | **1.8 m**✓ |
| MLWN | 0.4 | 0.5 | - 3.5 'Dry' | 'Dry' | 'Dry' |
| MLWS | 0.6 | | | | |

✓ = There is sufficient water depth around High Tide.

## 6. CONCLUSION: ESTIMATE OF SIGNIFICANT WAVE HEIGHT

**"Normal"** range (Beaufort F2 – F4) $H_s$ = 0.1 to 0.3 m

1 year return period (Beaufort F6) based on Met Data. $H_s$ = 0.5 m (approx)

**"Extreme"** range (Beaufort F8 – F9)

Greater than 1 year return period $H_s$ = 0.6 to 0.9 m (approx)

Remarks

- The results tend to overestimate wave height since the calculation has not included bed friction.
- Does not include wave/current interaction.
- These wave heights only occur around high tide.