7.0 Archaeological Monitoring Site Investigation by Margaret Gowen & Co. (see Volume 2, Section 4.3)
Archaeological Monitoring Site Investigations
Liffey Flood Defences
South Quays, Dublin

Licence Ref.: 10E108

By
Melanie McQuade
Margaret Gowen & Co. Ltd
Job No. 10020-R1

For
Moylan Consulting Engineers and Project Managers

On behalf of
Dublin City Council

20th July 2010
Illustrations

Figures

Figure 1  Site location shown on RMP map
Figure 2  Location of test pits 1-3
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1 Introduction

1.1 This report details the results of archaeological monitoring of Site Investigations works carried out along the site of the proposed Liffey Flood Defences on the south Quays of Dublin from George's Quay to Sir John Rogerson's Quay (Fig. 1).

1.2 The works area concerns three sites recorded on the RMP (Sir John Rogerson's Quay DU018-020-201, George's Quay DU018-020-458, City Quay DU018-020-479) and monitoring was requested by the City Archaeologist.

1.3 Monitoring was carried out for Moylan Consulting Engineers and Project Managers on behalf of Dublin City Council in dry sunny weather conditions from 17th – 24th June 2010 by the writer, Colm Moriarty and Linzi Simpson.

1.4 The foundations of standing buildings, a series of services and reclamation deposits were identified during monitoring. No features or finds of pre 18th century date were uncovered in the test pits and slit trenches, where the maximum depth of excavation was between 1.50m and 2m and did not reach below the depth of reclamation deposits.
remained an undeveloped flood zone for much of the 18th century. Not until the 1760s were many houses being built on the quay, and by the 1790s, it had become a fashionable suburb.

2.6 In the 19th century, the Liffey’s bed and the quay walls were deepened to accommodate the steam ships arriving into Dublin from 1815 (de Courcy 1996).

2.7 Recent excavations in the vicinity of the development area include a site at the corner of Luke Street and Townsend Street, to the south of the development area that revealed evidence for a 17th-century river frontage and dock. Here two parallel, north-south timber revetments were uncovered 3–4m below modern ground level (Walsh 1998:192, at www.excavations.com). A post-medieval graveyard was uncovered at a site located on the south side of Poolbeg Street, at its junction with Luke Street in an area reclaimed from the Liffey estuary, to the south of the development area (Channing 1992:074, at www.excavations.com). The burials there are likely to have been associated with an early 18th-century Lutheran church. However, nothing of archaeological significance was found at Tara Street Fire Station, further to the south, a location that was low-lying marshland prior to its reclamation in the late 17th century (Hurley 1996:112 at www.excavations.com). Monitoring undertaken at the location of the new pedestrian bridge spanning the Liffey from City Quay to Custom House Quay did not uncover anything of archaeological significance (O’Carroll 2003:509 at www.excavations.com) but a detailed underwater survey recorded the Quay Wall at this location (McCullough 2003:520 at www.excavations.com). Recent archaeological work on a large site occupying (from west to east) the former locations of Lloyd’s/Williamson’s and Lloyd’s ropeworks, the Hibernian Marine School, and Cardiff’s shipyard, led to the recording of 18th-century building foundations (Tobin 2003). At 17-19 Sir John Rogerson’s Quay the remains of a late 18th/early 19th century building were revealed. The building was a masonry structure founded on wooden piles. Several of these piles were re-used timbers derived from five or six different vessels of sizes varying from boat to large ship and others were structural members from a wharf/dock or pier (Scally 2008).
4 Monitoring results

4.1 The methodology agreed with the City Archaeologist, during a site walk over prior to the commencement of works, was that monitoring should take the form of site inspections. It was agreed that rather than monitor the excavation of all of the trenches and test pits (Figs 2-7) a good representative sample should be covered, what follows is a record of the test pits and slit trenches which were inspected by the archaeologists.

4.2 Test Pit 1

Located outside Tara Street Station and 1.55m from the quay edge (Fig. 2), this test pit measured 2m north-south by 1.02m wide and was 2m in depth. No service ducts were uncovered and the soil profile varied along the length of the test pit. The following soil profile was recorded at the northern end of the test pit:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m-0.20m</td>
<td>Pavement</td>
<td>Modern</td>
</tr>
<tr>
<td>0.20m-0.47m</td>
<td>Concrete slab</td>
<td>Modern</td>
</tr>
</tbody>
</table>

The quay wall was exposed at the northern end of the test pit, between 0.47m and 2m.

The following soil profile was recorded at the southern end of the test pit:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m-0.20m</td>
<td>Pavement</td>
<td>Modern</td>
</tr>
<tr>
<td>0.20m-0.56m</td>
<td>Dark brown silty clay</td>
<td>Modern</td>
</tr>
<tr>
<td>0.36m-0.48m</td>
<td>Cobbled surface</td>
<td>Modern</td>
</tr>
<tr>
<td>0.48m-2m</td>
<td>Sand infill</td>
<td>Modern</td>
</tr>
</tbody>
</table>

4.3 Test Pit 2

Located at the western end of the Ulster bank, on George’s Quay (Fig. 2), this test pit measured 1.77m north-south by 0.90m wide and was 2m in depth. The following soil profile was recorded:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m-0.20m</td>
<td>Pavement</td>
<td>Modern</td>
</tr>
<tr>
<td>0.20m-0.35m</td>
<td>Concrete slab</td>
<td>Modern</td>
</tr>
<tr>
<td>0.35m-0.55m</td>
<td>Bedding for concrete</td>
<td>Modern</td>
</tr>
<tr>
<td>0.55m-2m</td>
<td>Concrete plinth</td>
<td>Modern</td>
</tr>
</tbody>
</table>
4.6  Test pit 5

This test pit was located on City Quay c. 8m to the west of Slot Trench 4 (Fig. 3). It measured 1.90m long (north-south) by 0.75m wide and was 2m deep. The following soil profile was recorded:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Finds/ inclusions</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m–0.10m</td>
<td>Concrete Slab</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.10m–0.40m</td>
<td>Stone infill</td>
<td>Plastic etc</td>
<td>Modern</td>
</tr>
<tr>
<td>0.40m–1m</td>
<td>Loose brown sandy clay (infill)</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>1m–2m+</td>
<td>Dark black brown silty clay</td>
<td>Frequent small stone, redbrick and marine shell</td>
<td>18th/19th C reclamation deposit</td>
</tr>
</tbody>
</table>

Three plastic pipes were located at the northern end of this test pit immediately below the surface.

4.7  Slit Trench 4

This trench was located to the west of the new pedestrian bridge (Fig. 4). It measured 2m long by 0.70m wide by 1.10m deep and was orientated north-south. The following soil profile was recorded:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Finds/ inclusions</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m–0.10m</td>
<td>Concrete Slab</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.10m–0.40m</td>
<td>Stone infill</td>
<td>Bits of plastic etc</td>
<td>Modern</td>
</tr>
<tr>
<td></td>
<td>Loose brown sandy clay (infill)</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.90m+</td>
<td>Dark black brown silty clay</td>
<td>Frequent small stone, redbrick and marine shell</td>
<td>18th/19th C reclamation deposit</td>
</tr>
</tbody>
</table>
4.10 **Slit Trench 7**

Located to the west of the ESB subsation building (Fig. 5) this trench measured 3.10m (north-south) by 0.60m and was excavated to a depth of 1.50m. The following profile was recorded (Pl. 3):

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Finds/ inclusions</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m–0.10m</td>
<td>Pavement</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.10m–0.25m</td>
<td>Sandy gravel</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.25m–0.45m</td>
<td>Dark brown clay</td>
<td>Pebbles, red brick fragments</td>
<td>Modern</td>
</tr>
<tr>
<td>0.45m–0.75m</td>
<td>Yellow sand at southern end of trench, rest of trench same dark brown clay as above</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.75m–1.50m</td>
<td>Dark brown clay</td>
<td></td>
<td>18th/19th C</td>
</tr>
</tbody>
</table>

Service pipes were uncovered running east-west 1.65m – 2.05m from the southern end of the trench and 0.90m below present ground surface. Another east-west orientated service was uncovered at 2.30m.

4.11 **Test Pit 7**

Located on City Quay to the west of Slit Trench 7 (Fig. 5), this trench measured 2.50m (north-south) by 0.50m and was excavated to a maximum depth of 1.90m. The following profile was recorded:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Finds/ inclusions</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m–0.10m</td>
<td>Pavement</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.10m–0.32m</td>
<td>Gravel fill</td>
<td>None</td>
<td>Modern</td>
</tr>
<tr>
<td>0.32m–1.90m</td>
<td>Coarse sandy fill</td>
<td>None</td>
<td>Modern</td>
</tr>
</tbody>
</table>

Three east-west plastic service pipes were uncovered at the southern end of the trench where they lay 0.75m below present ground level. An iron pipe was uncovered at the northern end of the trench at 0.90m below present ground.
The brick foundations of the wall were flush with the east-face of the building. The base of this build was uncovered 0.90m below present ground. A 0.40m wide band of concrete was uncovered 0.20m below the base of the wall (at 1.10m) (Pl. 4). The western edge of the concrete was more or less flush with the east face of the brick wall and it was just 0.10m in depth.

The following profile was recorded at the southern end of the trench, which measured just 0.45m in width:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Finds/ inclusions</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m–0.10m</td>
<td></td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.10m–0.28m</td>
<td>Set stones</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.28m–0.67m</td>
<td>Light brown gravelly coarse sand</td>
<td></td>
<td>Modern fill</td>
</tr>
<tr>
<td>0.67m–1.50m</td>
<td>Dark brown silty clay with stone, occasional</td>
<td>Shell fragments and a lump of slag</td>
<td>18th/19th C</td>
</tr>
<tr>
<td></td>
<td>fragments of redbrick and sherdos of black</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ware</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.15 **Slit Trench 10**

Located at on the northern side of the road and the southwestern corner of the BJ Marine building, this trench was dug through path and cobble stones (Fig. 6). It measured 4.30m long, 0.40m wide and was excavated to a depth of 1.10m. The following soil profile was recorded:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
<th>Finds/ inclusions</th>
<th>Estimated date</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00m–0.13m</td>
<td>Concrete slab</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.13m–0.30m</td>
<td>Lean mix and concrete</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.30m–0.65m</td>
<td>Loose lean mix gravel and gravel fill</td>
<td></td>
<td>Modern</td>
</tr>
<tr>
<td>0.65m–1.10m</td>
<td>Gravel with crushed mortar fragments</td>
<td></td>
<td>19th C?</td>
</tr>
</tbody>
</table>

The northern 0.60m of the trench cut through the cobbled surface. The cobble stones were 0.18m in depth and were bedded on sand. The sand overlaid dark grey organic clay mixed with cinders. The foundations of the wall of the BJ Marine Building were uncovered 0.70m below present ground. They were constructed of stone and mortar and projected for 0.30m from the wall face (Pl. 5). A service box was uncovered and another service was located immediately south of the box at 0.80m below ground level.
References

de Courcy, J. W. 1996 The Liffey in Dublin Gill and Macmillan Ltd.


Websites consulted:

www.excavations.ie (accessed 2-3-2010)

with specific reference to:

Channing, J. 1992:074 Poolbeg St, Dublin

Hurley, M. 1996:112 Tara Street Fire Station, Tara Street/Pearse Street/Townsend Street, Dublin. 96E266

McCullough, D. 2003:520 River Liffey, Custom House Quay/City Quay, Dublin 03D0363; 03R107

O’Carroll, F 2003:509 River Liffey, City Quay/Custom House Quay, Dublin 03E1060.

NOTE: NEW MACKEN STREET BRIDGE AND ASSOCIATED ROAD WORKS NOT SHOWN ON THIS DRAWING.

Figure 7

KEY PLAN
8.0 Road Safety Audit by Waterman Boreham (see Volume 2, Section 4.8.1)
STAGE 1 ROAD SAFETY
AUDIT

PROPOSED SOUTH
CAMPSHIRE FLOOD
PROTECTION PROJECT
AT SOUTH CAMPSHIRE,
DUBLIN 2
WATERMAN-BOREHAM TRANSPORT PLANNING
REPORT FLYSHEET

Title: Stage 1 Road Safety Audit

Project: South Campshires, Dublin 2

Client: Moylan

Issue: Submission Issue

Project No: 210694

Prepared by  

Checked by  

Authorised for Issue by  

Date  

Date  

Date  
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</tbody>
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## APPENDICES

1. Audit Team
2. Safety Brief
3. Reference Plan
4. Designers Response Form
1. INTRODUCTION

1.1 This report results from a Stage 1 Road Safety Audit report was carried out on a proposed South Campshire Flood Protection Project at the South Campshires, Dublin 2.

1.2 The Audit was carried out during October/November 2010, and included a site visit during on the 29th October 2010. The weather at the time of the site visit was wet with rain during the visit. Traffic conditions were moderate to heavy throughout the visit.

1.3 The Audit Team membership was as follows (CV's provided in Appendix 1).

   Trevor McGarr – B. Eng, PG Dip, A. Eng, AMIEI (Team Leader)
   Ian Worrell - BScEng, DipEng, CEng, MIEI, DipPhysPlg (Team Member)

1.4 The Audit took place at the offices of Waterman Boreham Consulting Engineers on the 8th November 2010, following the site visit by the Audit Team. The Audit comprised an examination of the plans provided by the Design Team.

1.5 The following documents were provided by the Design Team:

   - Audit Brief;
   - South Campshire Flood Protection Project (SCFPP) Proposed Defence Alignment General Arrangement – Drg. No. 08-078-P100;
   - SCFPP Proposed Wall Alignment Sheet 1 of 6 – Drg. No. 08-078-P101;
   - SCFPP Proposed Wall Alignment Sheet 2 of 6 – Drg. No. 08-078-P102;
   - SCFPP Proposed Wall Alignment Sheet 3 of 6 – Drg. No. 08-078-P103;
   - SCFPP Proposed Wall Alignment Sheet 4 of 6 – Drg. No. 08-078-P104;
   - SCFPP Proposed Wall Alignment Sheet 5 of 6 – Drg. No. 08-078-P105;
   - SCFPP Proposed Wall Alignment Sheet 6 of 6 – Drg. No. 08-078-P106;

1.6 The terms of reference of the Audit are as described in NRA HD 19/09. The team has examined and reported only on the road safety implications of the scheme as presented and has not examined or verified the compliance of the design to any other criteria.
1.7 All comments and recommendations are referenced to the design drawings and locations have been indicated on the plans supplied.
2. **GENERAL**

2.1 The designers have not advised of any departures from standard.

2.2 No information was provided on any existing accident statistics in the vicinity of the site.

2.3 **Road Drainage**

No road drainage information has been provided. No assessment of the suitability of gully locations etc could be made. It was noted that a number of gullies along the South Campshires / Quays will need to be relocated to facilitate the proposed kerb realignment.

**Recommendation**

Proposals for road drainage provision should be clarified. It should be ensured that sufficient drainage is provided to prevent ponding adjacent to the proposed works.

2.4 **Existing Bollards**

No detailed information has been provided on the extent of existing bollards / street furniture to be removed. There may be conflict between cyclists / pedestrians and the remaining bollards / street furniture.

**Recommendation**

Proposals for removal of bollards should be clarified. It should be ensured that there is no conflict between pedestrians / cyclists and bollards / street furniture to remain.
3. JUNCTION LAYOUT AND ALIGNMENT

3.1 Problem at Location A – BJ Marina Access

The drawings indicated a cycle track is to be provided along the South Campshires / Quays which is to be supported. However, the proposed works do not provide for dropped kerb entry to the existing BJ Marina property. This may lead to inappropriate mounting of the kerb.

Recommendation

A dropped kerb/apron type access should be provided to the BJ Marina building within the vicinity of the proposed works.

3.2 Problem at Location B – STOP line location

It is unclear if appropriate sightlines / visibility can be maintained at Location B. The proposed STOP line should be located adjacent the proposed road edge in order to ensure adequate sightlines can be achieved.

Recommendation

The proposed STOP line should be relcoated and all significant obstructions should be sited outside of the visibility splays.

3.3 Problem – Potential Conflict between cyclist and vehicles

Given the relatively narrow width of the two lane roadway in certain sections of the proposed on-road cycle track works, there is an increased risk of cyclist / vehicle conflict.

Recommendation

The proposed on-road cyclist track could be raised above the road level in order to reduce the risk of conflict between cyclists and errant vehicles.

3.4 Problem at Location C– insufficient width of carriageway between Windmill Lane and Creighton Street.
The proposed location of an on-road cycle track adjacent a 4.1 m two lane roadway at the above location will result in an unacceptable risk of cyclist / vehicle conflict.

**Recommendation**

The proposed on-road cyclist track should be relocated / the existing on-street parking removed in order to ensure lanes of adequate width are provided.

3.5 **Problem at Location D – Cycle track On-road / Off-road changeover at City Quay**

It is unclear if the proposed kerbs are to be realigned to facilitate the propose Cycle track On-road / Off-road changeover at City Quay. In addition, adequate signage of the the proposed changeover should be provided.

**Recommendation**

The existing kerb line should be relocated to facilitate the Cycle track On-road / Off-road changeover at City Quay and the proposed changeover adequated signed.

3.6 **Problem at Location E – Butt Bridge**

The proposed northern kerb line at Butt Bridge involves the construction of a section of kerb perpendicular to the carriageway and may act as a trip feature for pedestrians / vulnerable road users.

**Recommendation**

The proposed northern kerb line at Butt Bridge should be amended to ensure a suitable tie-in arrangement to the existing kerb line.

3.7 **Problem at Location F – Bus Stop at BJ Marina**

The proposed works do not appear to accommodate the existing bus stop at BJ Marina and bus / cyclist conflict may result.

**Recommendation**

The proposed layout should be amended to incorporate the existing bus stop.
4. NON-MOTORISED USERS

4.1 Problem at Location G – Cycle-track tie-in arrangement

The extent of off-road cycle track could be increased and / or the length of the cycletrack cross over increased as the Old Buoy location indicted on Drg. No. 08-078-P106 is incorrect and the Old Buoy is actually located further east along the South Campshires.

Recommendation

The extent of off-road cycle track be increased and / or the length of the cycletrack cross over increased in order to reduce the risk of vehicle / cyclist conflict.
5. **SIGNS, MARKINGS AND ROAD LIGHTING**

5.1 **Problem – Cycle track signage and markings**

No cycle track warning signage or markings are indicated. This may result in an unsafe road arrangement and pedestrian/cyclist conflict may result.

**Recommendation**

The proposed cycle track is designated with appropriate signage and road markings.

5.2 **Problem Generally - Public Lighting**

The existing street lighting in the vicinity of the site may have to be amended and no details of new street lighting have been provided. Poor visibility in this area could result in hazardous conditions for pedestrians and other road users.

**Recommendation**

It should be ensured that adequate street lighting be provided.
We certify that we have examined the appended drawing and information. This examination has been carried out with the sole purpose of identifying any features of the design that could be removed or modified to improve the safety of the scheme. The problems identified have been noted within the report, together with suggestions for improvements which are recommended to be studied for implementation.

Signed: Trevor McGarr  
Date: 30/11/10

Signed: Ian Worrell  
Date: 30/11/10
APPENDIX 1

Audit Team
Name: Trevor McGarr

Position: Principal Design Engineer

Qualifications: B. Eng (Civil), PG Dip, A. Eng, AMIEI

Location: Dublin

Summary

An experienced Safety Audit Team Leader, regularly carrying out audits on a range of projects from major schemes to minor junction improvements. Trevor has responsibility to deliver assigned transportation related projects to clients' pre-determined expectations, from client liaison, project management through to technical output, including the undertaking of Road Safety Audits as either a Team Leader or Team Member.

Experience Summary

A Principal Design Engineer with over 10 year's post-graduate experience in Road Safety Audits, transportation engineering and planning. Trevor has considerable experience in assessing the traffic and transport impact on a wide range of projects including, major industrial/office, commercial, residential, leisure and retail developments. Working within a team of transportation planners and engineers involved in a wide range of projects throughout Ireland. He has undertaken the 3 day course on an Introduction to Road Safety Audits (November 2004), the 2 week course on Road Safety Engineering for Road Safety Auditors (February 2007) in addition to the Advanced Road Safety Engineering and Road Safety Auditing course (April 2008), and has carried out in excess of 100 Road Safety Audits.

Relevant Project Experience:
(Selection of Audits Undertaken)

Audit Team Leader

Carlow Relief Road
Stage 3 – 2km Link Road Section and Associated Junctions – Regional / Local Routes
December 2008

Newbridge, Co. Kildare
Stage 2 – Proposed Access Arrangements and Link Road Section – Regional / Local routes
June 2008

Cashel, Co Tipperary
Stage 3 – Amendments to Motorway Interchange and Auxiliary Lanes – National Primary Route
June 2009

Kiltouy Park, Letterkenny
Stage 3 – Access Roundabouts (3) and 2km Link Road Section – Regional / Local Routes
May 2009

Audit Team Member

Carlow Relief Road
Stage 2 – 2km Link Road Section and Associated Junctions – Local / Regional Routes
June 2007

N85 Remedial Works
Stage 3 – Traffic Management along new Link Road – Phase 1 and Phase2 – National Secondary Route
January 2009 and March 2009

N7 Nenagh Bypass
Stage 2 – Traffic Management woks along new Bypass tie-in – National Primary Route
December 2008

Midleton Co. Cork
Stage 3 – Proposed 2km Relief Road and associated Signal Controlled Junctions – Local / Regional Routes
March 2009
Audit Team Leader

Portlaoise, Co. Laois
Stage 1/2 and Stage 3 - Proposed Access
Roundabout – Regional Route
March 2009 and June 2009

Edenderry, Co. Offaly
Stage 2 and Stage 3 - Proposed Access
Roundabout into PFS - Regional Route
January 2008 and November 2008

Ballon, Co. Carlow
Stage 1 – Proposed Access Arrangements -
National Secondary Route
August 2009

Maynooth, Co. Kildare
Stage 2 and Stage 3 - Proposed Access
Arrangements to large Retail Development –
Regional Route
September 2007 and November 2008

Derryclooney, Co. Laois
Stage 1/2 - Link Road Section and Associated
Roundabout Junctions – Regional Route
December 2007

Kerdiff Park, Naas, Co. Kildare
Stage 3 – Proposed Signal Controlled Junction –
Regional Route
May 2009

Cashel, Co. Tipperary
Stage 3 - Proposed Access Roundabout – Regional
Route
November 2008

Kilkenny Road, Carlow
Stage 1 – Proposed Access Arrangements –
Regional Route
December 2009

NUI Maynooth, Co. Kildare
Stage 1 – Proposed Access Arrangements and
Appraisal of Pedestrian Facilities – Regional Route
September 2009

NUI Maynooth, Co. Kildare
Stage 2 – Proposed Access Arrangements and
Appraisal of Pedestrian Facilities – Regional Route
May 2010

Audit Team Member

New Ross, Co. Wexford
Stage 2 – Proposed Pedestrian Crossing - National
Primary Route
November 2009

Kiltoy Park, Letterkenny
Stage 1/2 – Access Roundabouts (3) and 2km Link
Road Section – Regional / Local Routes
February 2007

Kilrush, Co. Clare
Stage 1 – Proposed Access Roundabout – National
Primary Route
September 2009

Harristown, Dublin Airport
Stage 3 – Proposed Car Park Access Junction –
Regional Route
May 2007

Lanestown, Donabate, Co. Dublin
Stage 3 – Proposed Dual Carriageway Roundabout
Access Junction – Former National Route / Regional Route
June 2007

Thurles, Co. Tipperary
Stage 1 – Proposed Access Roundabout – National
Secondary Route
November 2009

Newry, Co. Down
Stage 2 – Proposed Access Arrangements –
Regional Route
May 2010

Carigtwohill, Co. Cork
Stage 1 – Proposed Access Arrangements –
Regional / Local Routes
June 2010
Name: Ian Worrell  
B.Sc.(Eng), Dip. Eng., CEng. MIEI, DipPhysPLg  
Position: Associate, Moylan Consulting Engineers  
Qualifications: Chartered Engineer (2004)  
Diploma in Civil Engineering (1996)  
Bachelor Science in Engineering (1996)  
Member Institution of Engineers Ireland (1996)  
NRA Approved Road Safety Audit Team Member (since 2009)

CAREER HISTORY

1996 – Present Moylan Associate

EXPERIENCE SUMMARY

An Associate and Senior Civil Design Engineer with Moylan with over 14 years post-graduate experience with responsibility for numerous traffic assessments, junction design, distributor and access road and parking facility provision, mobility management plans and Environment Impact Assessments during this time.

Involved in the commissioning of numerous road safety audits, accessibility audits and cyclist audits and the preparation of Designer responses to same.

Experienced civil engineering designer and team leader who has extensive expertise in the design of drainage systems, flood studies, and environmental management of surface water (SUDS).

Involved in the technical analysis of road designs carried out using 12D and AUTOCAD design packages.

Has undertaken the 3 day introduction to Road Safety Audits course (April 2009) and subsequently undertaken various road safety audits since this time as both observer and team member.

RELEVANT EXPERIENCE

- The Park Village, Carrickmines – responsible for the civil engineering design, mobility management plan and engineering sections of the EIS for a 70,000 m² mixed retail / office / residential scheme at Carrickmines. Preparation of tender documentation for roads and services enabling works package.

- Proposed Drogheda United Stadium – preparation of civil engineering design for mixed use commercial / retail scheme at Bryanstown, Drogheda incorporating a 10,000 all-seater stadium for Drogheda United. In addition, mobility management plans and traffic impact assessments for match day traffic management were prepared for inclusion with the planning submission to Meath County Council, which was subsequently approved.

- Cappagh, Finglas – civil engineering design for a 450 residential unit scheme with associated neighbourhood centre. The project includes significant off-site works – the upgrading and realignment of 800 m of the Cappagh Road, the provision of c. 500 m of up to 450 mm diameter offsite foul sewer and 1,400 m of 300 mm offsite surface water sewer along existing roadways. This project is currently on site.
• Airport Plaza, Cloghran preparation and submission of planning application for c. 2,700 long term parking spaces including all civil engineering design, transportation assessment and preparation of the engineering elements of the EIS.

• Corgan New Town, Clonee, Co. Dublin - Large medium density development which includes a mix of retail, office, leisure and amenity facilities, served by a new 13.5m wide primary distributor road with dedicated bus lane

• Lusk Relief Road - Designed and constructed to relieve traffic from the centre of the historic village of Lusk in north Co. Dublin. The route loops around the east side of the village, linking the main Dublin Road, to the south, with the Skerries Road to the north. The road comprises 2km of 9m wide two lane single carriageway, with four roundabouts and modification and upgrading of existing roads to tie into new roundabouts on the relief road. Responsible for the preparation of the Health and Safety Plan.

• The Park, Carrickmines - Traffic and civil engineering infrastructure design for major new commercial, employment and retail warehouse development comprising 142,000 sq m. Assistance in tender negotiations and preparation of contract documents. This project also included the upgrading of the Glenamuck Link Road which increased the road from single carriageway to dual carriageway.

• Navan Civic Space – Civil engineering design for of the upgrading of a town centre civic space to provide for 110 No. car parking spaces, public realm area upgrades and improved pedestrian and delivery access to existing businesses. In addition, the sub-standard existing public utilities including foul, surface water, water supply, electrical, telephone, gas and public lighting were upgraded as part of the works. The public and delivery access to the 51 existing tenants operating around the civic space was maintained during the construction work and an assessment of the delivery requirements and the liaison with the tenants throughout the entire construction process was provided.

• Civil engineering and transportation design for an Integrated tourism facility (including hotel and golf course) at Abbeyville, Kinsealy, including the preparation of a Transport Impact Assessment, mobility management plan and junction improvement upgrade to facilitate access to the site. In addition, a Road Safety Audit for the proposed junction upgrade was commissioned and designer response prepared.

• Civil engineering and transportation design for mixed use urban infill development of apartment / retail office up to six stories in height over a 1.5 level basement at Swan Dowling’s, Naas, including the preparation of a Transport Impact Assessment, mobility management plan and junction improvement upgrade for an infill town centre site.

• Civil engineering and transportation design for a retail development at Grey Abbey, Kildare Town, Co. Kildare, including the preparation of a Transport Impact Assessment, mobility management plan and junction improvement upgrade to facilitate access to the site. In addition, a Road Safety Audit for the proposed junction upgrade was commissioned and designer response prepared.

• Road Safety Audit – Team Member

Carried out the Audit team member role for the following audits with Waterman Boreham:

• N15, Ballybofey, Co. Donegal - Stage 1 July 2009
• R326, Convoy, Co. Donegal - Stage 1 July 2009
• Letterkenny, Co. Donegal - Stage 1 July 2009
• Castlefield, Clonsilla - Stage 1 August 2009
• Longford Bridge, Ashtown, Co. Dublin - Stage 3 September 2009
• Glen Ellen Distributor Road, Swords, Co. Dublin - Pre-Stage 3 November 2009
• N11, Fenns, Co. Wexford - Stage 2 November 2009
- Mell, Drogheda, Co. Louth - Stage 1 - February 2010
- Clongriffin Railway Station, Dublin - Stage 3 - March 2010
- Kinnegad, Co. Westmeath - Stage 1 - May 2010
- St. Mel’s, Longford, Co. Longford – Stage 1/2 – June 2010
- Convention Centre Dublin, Dublin 1 – Confin ed Stage 3 Audit – June 2010
- Crowenstown, Co. Westmeath – Preliminary Stage 1 Audit – June 2010
- Dundalk Shopping Centre, Roundabout Access – Stage 1 – September 2010
- Dundalk Shopping Centre, Signal Controlled Access – Stage 1 – September 2010
- Kinnegad, Co. Westmeath - Stage 3 - October 2010

- Road Safety Audit – Observer

  Attended as an observer for the following audits with Waterman Boreham / TMS Consultancy:
  - Tesco Maynooth, Co. Kildare – Stage 3 October 2008 - Waterman Boreham
  - Gorey, Co. Wexford – Stage 1 November 2008 - Waterman Boreham
  - Monread, Naas, Co. Kildare – Stage 1 December 2008 - Waterman Boreham
  - Cookstown Industrial Estate, Dublin – Stage 1 December 2008 - Waterman Boreham
  - Maynooth – Stage 3 April 2009 – TMS Consultancy – as part of Introduction to RSA Course
  - N52 Kells, Co. Meath – Stage 1 July 2009 – Waterman Boreham
**WATERMAN BOREHAM LTD**

**STAGE 1 AUDIT (PRELIMINARY DESIGN) or INTERIM AUDIT**

<table>
<thead>
<tr>
<th>Project No</th>
<th>210694</th>
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</thead>
<tbody>
<tr>
<td>Project Name</td>
<td>South Campshires, Dublin 2</td>
</tr>
<tr>
<td>Raised By</td>
<td>M Duignan - Moylan</td>
</tr>
<tr>
<td>Date</td>
<td>Oct 2010</td>
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</table>

Please complete sections 1, 2, 3 & 4 and tick the remainder if available

1) **Audit Brief** - *Attach Any Documentation As Required*

Stage 1 RSA on proposed flood protection works and alterations to the footpath and cyclepath along the south campshires, Dublin 2.

2) **Exclusions/Departures From Standard** - *Attach Any Documentation As Required*

none

3) **Background Information** - *Attach Any Documentation As Required*

4) **Relevant Information** - *Advise any factors which affect road safety such as adjacent developments, schools, retirement care homes etc*

- General arrangement drawing  
  - South Campshire Flood Protection Project (SCFPP) Proposed Defence Alignment General Arrangement - Drg. No. 08-078-P100;
  - SCFPP Proposed Wall Alignment Sheet 1 of 6 - Drg. No. 08-078-P101;
  - SCFPP Proposed Wall Alignment Sheet 2 of 6 - Drg. No. 08-078-P102;
  - SCFPP Proposed Wall Alignment Sheet 3 of 6 - Drg. No. 08-078-P103;
  - SCFPP Proposed Wall Alignment Sheet 4 of 6 - Drg. No. 08-078-P104;
  - SCFPP Proposed Wall Alignment Sheet 5 of 6 - Drg. No. 08-078-P105;
  - SCFPP Proposed Wall Alignment Sheet 6 of 6 - Drg. No. 08-078-P106;

- Location plan of site  
  - A3 or A4 drawing of scheme (to be marked up by audit team to show locations of problems identified, and attached to audit report)

- 3 year accident data, if available
- Traffic flow data, if available
- General scheme details to help give an understanding of purpose of scheme, i.e. design speeds, speed limits, traffic flows, ARCADY, PICADY, TRANSYT runs etc.
Reference Plan
Designers Response
Form
### ROAD SAFETY AUDIT RESPONSE - Feedback on Audit Reports

**Scheme:** South Campshires  
**Audit Stage:** Road Safety Audit - Stage 1  
**Date Audit:** November 2010  
**On Behalf Of:** Moylan

<table>
<thead>
<tr>
<th>Paragraph No. in Safety Audit Report</th>
<th>Problem accepted (yes/no)</th>
<th>Recommended measure accepted</th>
<th>Alternative measures (describe)</th>
<th>Alternative measure accepted by Auditors (yes/no)</th>
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<tbody>
<tr>
<td>2.3</td>
<td>Yes</td>
<td>Yes</td>
<td>Proposals for road drainage included on planning drawings.</td>
<td><strong>YES</strong></td>
</tr>
<tr>
<td>2.4</td>
<td>Yes</td>
<td>Yes</td>
<td>All existing bollards impacting on the proposed works will be removed. This is now reflected on the EIS drawings.</td>
<td><strong>YES</strong></td>
</tr>
<tr>
<td>3.1</td>
<td>Yes</td>
<td>Yes</td>
<td>This area is now revised and not applicable.</td>
<td><strong>YES</strong></td>
</tr>
<tr>
<td>3.2</td>
<td>Yes</td>
<td>Yes</td>
<td>The proposed stop line has been relocated.</td>
<td><strong>YES</strong></td>
</tr>
<tr>
<td>3.3</td>
<td>Yes</td>
<td>No</td>
<td>It is intended to use a proprietary separator to provide additional protection for cyclists along the length of the cycle route.</td>
<td><strong>YES</strong></td>
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<tr>
<td>3.4</td>
<td>Yes</td>
<td>Yes</td>
<td>The proposed roadway has been increased in width by removing the on-street parking in this location in order to reduce vehicle / cyclist conflict.</td>
<td><strong>YES</strong></td>
</tr>
<tr>
<td>3.5</td>
<td>Yes</td>
<td>Yes</td>
<td>The layout has been amended at this location to reflect this requirement.</td>
<td><strong>YES</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>Yes</td>
<td>Yes</td>
<td>It is intended to raise the area of existing on road parking to footpath level.</td>
<td></td>
</tr>
<tr>
<td>3.7</td>
<td>Yes</td>
<td>Yes</td>
<td>The existing bus is to be relocated in conjunction with Dublin Bus requirements.</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>No</td>
<td>No</td>
<td>The extent of the proposed works are as per the original plan and their no scope to increase same. The length of the taper is considered sufficient.</td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Yes</td>
<td>Yes</td>
<td>Cycle track warning and markings will be included at the detail design stage.</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Yes</td>
<td>Yes</td>
<td>Street lighting requirements will be reviewed at detailed design stage.</td>
<td></td>
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</tbody>
</table>

Signed: [Signature]  
Date: 30th November 2010  
Project Team Leader

Signed: [Signature]  
Date: 30th November 2010  
Safety Audit Team Leader

Please complete and return to Road Safety Auditor.
9.0 Accessibility Audit by Waterman Boreham (see Volume 2, Section 4.8.1)
SUBMISSION ISSUE

ACCESSIBILITY AUDIT

for

PROPOSED SOUTH CAMPSHIRE FLOOD PROTECTION PROJECT AT SOUTH CAMPSHIRE, DUBLIN 2

TLM/210694
Nov 2010
WATERMAN-BOREHAM TRANSPORT PLANNING
REPORT FLYSHEET

Title: Accessibility Audit

Project: South Campshires, Dublin 2

Client: Moylan

Issue: Submission Issue

Project No: 210694

Prepared by ... Date 30/11/06

Checked by ... Date 20-11-10

Authorised for Issue by ... Date 20/11/06
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<tr>
<td>4.0 Audit Team Statement</td>
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## APPENDICES

1. Audit Team
2. Reference Plan
1. INTRODUCTION

1.1 This report results from an Accessibility Audit which was carried out in relation to proposals for the South Campshire Flood Protection Project at the South Campshires, Dublin 2. The scope of the audit extends from Georges Quay to the east of Samuel Beckett Bridge on Sir John Rogerson’s Quay, over a total distance of approximately 1.1 km.

1.2 The Audit was carried out during October/November 2010, and included a site visit during on the 29th October 2010. The weather at the time of the site visit was wet, with heavy rain during the visit. Vehicular traffic conditions were moderate to heavy throughout the visit, whilst pedestrian and cyclist traffic flows were light along the entire route.

1.3 The Audit Team membership was as follows (CV’s provided in Appendix 1).

Trevor McGarr – B. Eng, PG Dip, A. Eng, AMIEI (Team Leader)
Brian McMahon – B. E., MSC (Transportation), MIEI (Team Member)

1.4 The Accessibility Audit took place at the offices of Waterman Boreham Consulting Engineers on the 16th November 2010, following the site visit by the Accessibility Audit Team. The Audit comprised an examination of the plans provided by the Design Team.

1.5 The following documents were provided by the Design Team:

- Audit Brief;
- South Campshire Flood Protection Project (SCFPP) Proposed Defence Alignment General Arrangement – Drg. No. 08-078-P100;
- SCFPP Proposed Wall Alignment Sheet 1 of 6 – Drg. No. 08-078-P101;
- SCFPP Proposed Wall Alignment Sheet 2 of 6 – Drg. No. 08-078-P102;
- SCFPP Proposed Wall Alignment Sheet 3 of 6 – Drg. No. 08-078-P103;
- SCFPP Proposed Wall Alignment Sheet 4 of 6 – Drg. No. 08-078-P104;
- SCFPP Proposed Wall Alignment Sheet 5 of 6 – Drg. No. 08-078-P105;

and

- SCFPP Proposed Wall Alignment Sheet 6 of 6 – Drg. No. 08-078-P106.
1.6 The team has examined and reported only on the accessibility implications of the scheme as presented and has not examined or verified the compliance of the design to any other criteria. All comments and recommendations are referenced to the design drawings and locations have been indicated on the plans supplied.

1.7 We have prepared our comments based on providing general scheme comments in section 2 and specific comments for each of the respective scheme drawing sheets contained within section 3.
2. GENERAL

2.1 Road Drainage

No road drainage information has been provided. No assessment of the suitability of gully locations etc., and manhole covers, could be made in terms of access by, and impact on, mobility/sensory impaired road users. It was noted that a number of gullies along the South Quays may need to be relocated to facilitate the proposed kerb realignment etc.

Recommendation: Relocated gullies should be sited clear of pedestrian crossings/tactile paving and also clear of cycle cross-over points. All gullies within the cycle lanes should be flush with the surface to avoid any potential hazard to cyclists.

Priority: Moderate

2.2 Existing Bollards

No detailed information has been provided on the extent of existing bollards to be removed. A large number of existing bollards are noted to be provided within the cycle lane, which may pose a hazard to cycle traffic. There may be conflict between cyclists / pedestrians and the remaining bollards.

Recommendation: Proposals for removal of bollards should be clarified. It should be ensured that there is no conflict between pedestrians / cyclists and remaining bollards.

Priority: High

2.3 Existing Bollards

There is minimal contrast on the existing bollards along the scheme length. This may give rise to a hazard to visually impaired road users.

Recommendation: All retained bollards along the scheme length should be provided with suitable contrast bands to improve visibility.

Priority: Moderate
2.4 Existing Street Furniture

No detailed information has been provided on the extent of existing street furniture to be removed or displaced as part of the scheme. There may be conflict between cyclists / vulnerable road users and the remaining street furniture.

**Recommendation:** Proposals for removal or relocation of street furniture should be clarified. It should be ensured that there is no conflict between pedestrians / cyclists and remaining street furniture. All street furniture should ideally be set back to the rear of the footway to provide adequate clearances to all road users, including the mobility and sensory impaired.

**Priority:** Moderate

2.5 Public Lighting

The existing street lighting in the vicinity of the site may have to be amended and no details of new street lighting have been provided. Poor visibility in this area could result in hazardous conditions for pedestrians and other road users.

**Recommendation:** It should be ensured that adequate street lighting be provided. Any revised lamp column locations should be sited to the rear of the footway to ensure adequate clearance is maintained.

**Priority:** High

2.5 Campshire Wall Openings

The proposed openings in the campshire wall along the length of the scheme may give rise to obstructive hazards for visually impaired road users, without sufficient contrasts in place.

**Recommendation:** It should be ensured that adequate contrast at these openings be provided.

**Priority:** High

2.6 Cycle track signage and markings

No cycle track warning signage or markings are indicated. This may result in an unsafe road arrangement and pedestrian/cyclist conflict may result. There are no direction markings or yield control markings provided at any of the cycle crossovers assigning priority to any traffic stream. There are no yield control
markings along the cycle lanes at the various pedestrian crossings to be provided, which may result in pedestrian / cyclist conflicts.

**Recommendation:** The proposed cycle track is designated with appropriate signage and road markings. Appropriate direction markings and control measures should be implemented.

**Priority:** Moderate

2.7 **Cycle track signage and markings**

There are no yield control markings along the cycle lanes at the various pedestrian crossings to be provided, which may result in pedestrian / cyclist conflicts.

**Recommendation:** The proposed cycle track should be provided with the appropriate designated signage and road markings.

**Priority:** Moderate

2.8 **Scheme Signage**

No details of scheme signage have been provided. No information is given in relation to sign faces, mounting heights and siting of signage.

**Recommendation:** Appropriate signage should be provided to ensure adequate directional information is given to all road users, as necessary. Consideration should be given to the provision of special signposting for all road users. The mounting heights of all signs should be provided so as not to pose a hazard to all road user groups.

**Priority:** Moderate
3. LAYOUT AND ALIGNMENT

Sheet 1 of 6

3.1 Proposed Planters
The proposed planters to be provided along the length of this quay may give rise to obstructive hazards for visually impaired road users, without sufficient contrasts in place.

Recommendation: It should be ensured that adequate contrast be provided.

Priority: High

3.2 Existing Bicycle Stands
The existing cycle stands on the eastern end of this quay may give rise to obstructive hazards for visually impaired and other road users, without sufficient contrasts in place.

Recommendation: It should be ensured that adequate contrast be provided.

Priority: Moderate

3.3 Proposed Dropped Kerb
The proposed dropped kerb access to be provided as access to the cycle racks may give rise to a hazard for vulnerable road users, without sufficient contrasts and slopes in place.

Recommendation: It should be ensured that adequate design slopes and contrasts provided.

Priority: Low

3.4 Existing Kerb Adjacent to Butt Bridge
The proposed northern kerb line at Butt Bridge involves the construction of a section of kerb perpendicular to the carriageway and may act as a trip feature for pedestrians / vulnerable road users.

Recommendation: The proposed northern kerb line at Butt Bridge should be amended to ensure a suitable tie-in arrangement to the existing kerb line to provide for a smoother alignment.
Priority: High

Sheet 2 of 6

3.5 Proposed Cycle Track and Crossings
The interaction between the end of the cycle lanes (to the west along City Quay) and the pedestrian crossing at the existing signal control junction is unclear. There is no tactile warning paving provided to highlight the crossing of a pedestrian crossing. This may lead to conflicts between cyclists and pedestrians and other road users.

Recommendation: Appropriate tactile paving, in line with relevant design guidance, should be provided.

Priority: High

Sheet 3 of 6

3.6 Pedestrian Crossing Arrangements
The tactile paving at the pedestrian crossing, to the north of the carriageway, does not extend sufficiently across the width of the footway to provide adequate guidance for visually impaired road users.

Recommendation: Appropriate tactile paving, in line with relevant design guidance, should be provided to the rear of the proposed footway. Tactile paving should be provided, for the correct form of crossing.

Priority: High

3.7 Public Lighting Columns and Poles to Rear of Crossing
The existing street lighting column and pole to the rear of the existing crossing may pose a hazard for pedestrians and visually impaired road users given the obstruction posed and the reduced clearances.

Recommendation: It should be ensured that adequate street lighting be provided. Any revised lamp column locations should be sited to the rear of the proposed footway to ensure adequate clearance is maintained.

Priority: High
3.8 Proposed Cycle Track and Crossings

Clear definition should be provided to any changes in direction along the cycle lanes to ensure appropriate flow movements are maintained. Additional markings and signage should be provided, as necessary.

Priority: Low

3.9 Potential Conflict between Cyclist and Vehicular Traffic

The relatively narrow width of the two-lane carriageway along this section of the scheme works give rise to an increased risk of cyclist / vehicle conflict.

Recommendation: The proposed on-road cyclist track could be raised above the road level in order to reduce the risk of conflict between cyclists and errant vehicles. Alternatively, the running carriageway width for vehicles should be increased to avoid encroachment onto the cycle lane.

Priority: High

3.10 Proposed Cycle Track and Crossings

The interaction between the end of the cycle lanes (to the west along City Quay) and the pedestrian crossing at the existing signal control junction is unclear. There is no tactile warning paving provided to highlight the crossing of a pedestrian crossing. This may lead to conflicts between cyclists and pedestrians and other road users.

Recommendation: Appropriate tactile paving, in line with relevant design guidance, should be provided.

Priority: High

3.11 Existing Bollards

(Item 2.3 refers) There is minimal contrast on the existing bollards along the scheme length. This may give rise to a hazard to visually impaired road users.

Recommendation: All retained bollards along the scheme length should be provided with suitable contrast bands to improve visibility.
Priority: Moderate

3.12 BJ Marina Access

The proposed works do not provide for dropped kerb or apron-type entry arrangement to the existing BJ Marina property. This may pose a trip hazard for pedestrians, whilst also posing an obstacle for cycles on the inside cycle lane in particular.

Recommendation: A dropped kerb/apron type access should be provided to the BJ Marina building within the vicinity of the proposed works to mitigate against this trip hazard. Appropriate tactile paving should also be provided, as necessary.

Priority: High

3.13 BJ Marina Access – Provision of Bollards

There are a number of bollards within the proposed cycle lane and across the BJ Marina Property access. These bollards pose a hazard to cyclists and existing pedestrian crossing movements.

Recommendation: The status of these bollards should be confirmed. Ideally these should be removed.

Priority: High

3.14 Bus Stop Adjacent to the BJ Marina Property

The proposed works do not appear to accommodate the existing bus stop adjacent to the BJ Marina property. Conflict between buses/ bus patrons and cyclists may result.

Recommendation: The proposed layout should be amended to incorporate the existing bus stop. Any proposals for a bus stop should incorporate the appropriate kerb types and markings etc.

Priority: High

3.15 Potential Conflict between Cyclist and Vehicular Traffic

The relatively narrow width of the two-lane carriageway along this section of the scheme works give rise to an increased risk of cyclist / vehicle conflict.
**Recommendation:** The proposed on-road cyclist track could be raised above the road level in order to reduce the risk of conflict between cyclists and errant vehicles. Alternatively, the running carriageway width for vehicles should be increased to avoid encroachment onto the cycle lane.

**Priority:** High

### Sheet 6 of 6

#### 3.16 Proposed Cycle Track and Crossings

There is no tactile warning paving provided to highlight the crossing of a pedestrian crossing. This may lead to conflicts between cyclists and pedestrians and other road users.

**Recommendation:** Appropriate tactile warning paving, in line with relevant design guidance, should be provided.

**Priority:** High

#### 3.17 Cycle-track tie-in arrangement

The cross-over location and taper for the cycle lanes etc at this location are quite short, resulting in the potential for pedestrian / cyclist conflicts.

**Recommendation:** The extent of off-road cycle track should be increased in length so that the cycletrack cross-over section increased to allow for a smoother transition.

**Priority:** Moderate
AUDIT TEAM STATEMENT

We certify that we have examined the appended drawing and information. This examination has been carried out with the sole purpose of identifying any features of the design that could be removed or modified to improve the safety and accessibility of the scheme. The problems identified have been noted within the report, together with suggestions for improvements which are recommended to be studied for implementation in line with the suggested priority status.

Signed: Trevor McGarr
Date: 30 – 11 – 10

Signed: Brian McMahon
Date: 30 – 11 – 10
APPENDIX 1

Audit Team
Name: Trevor McGarr
Position: Principal Design Engineer
Qualifications: B. Eng (Civil), PG Dip, A. Eng, AMIEI
Location: Dublin

Summary

An experienced Safety Audit Team Leader, regularly carrying out audits on a range of projects from major schemes to minor junction improvements. Trevor has responsibility to deliver assigned transportation related projects to clients’ pre-determined expectations, from client liaison, project management through to technical output, including the undertaking of Road Safety Audits as either a Team Leader or Team Member.

Experience Summary

A Principal Design Engineer with over 9 year’s post-graduate experience in Road Safety Audits, transportation engineering and planning. Trevor has considerable experience in assessing the traffic and transport impact on a wide range of projects including; major industrial/office, commercial, residential, leisure and retail developments. Working within a team of transportation planners and engineers involved in a wide range of projects throughout Ireland. He has undertaken the 3 day course on an Introduction to Road Safety Audits (November 2004), the 2 week course on Road Safety Engineering for Road Safety Auditors (February 2007) in addition to the Advanced Road Safety Engineering and Road Safety Auditing course (April 2008), and has carried out in excess of 100 Road Safety Audits.

Relevant Project Experience: (Selection of Audits Undertaken)

Audit Team Leader

Carlow Relief Road
Stage 3 – 2km Link Road Section and Associated Junctions – Regional / Local Routes
December 2008

Newbridge, Co. Kildare
Stage 2 – Proposed Access Arrangements and Link Road Section – Regional / Local routes
June 2009

Cashel, Co Tipperary
Stage 3 – Amendments to Motorway Interchange and Auxiliary Lanes – National Primary Route
June 2009

Kiltou Park, Letterkenny
Stage 3 – Access Roundabouts (3) and 2km Link Road Section – Regional / Local Routes
May 2009

Audit Team Member

Carlow Relief Road
Stage 2 – 2km Link Road Section and Associated Junctions – Local / Regional Routes
June 2007

N85 Remedial Works
Stage 3 – Traffic Management along new Link Road – Phase 1 and Phase2 – National Secondary Route
January 2009 and March 2009

N7 Nenagh Bypass
Stage 2 – Traffic Management works along new Bypass tie-in – National Primary Route
December 2008

Midleton Co. Cork
Stage 3 – Proposed 2km Relief Road and associated Signal Controlled Junctions – Local / Regional Routes
March 2009
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<tr>
<th>Audit Team Leader</th>
<th>Audit Team Member</th>
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<tr>
<td>Portlaoise, Co. Laois</td>
<td>New Ross, Co. Wexford</td>
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<td>Stage 2 - Proposed Access Arrangements - Regional Route</td>
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<td>NUI Maynooth, Co. Kildare</td>
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<td>Stage 2 - Proposed Access Arrangements and Appraisal of Pedestrian Facilities - Regional Route</td>
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<td>May 2010</td>
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</table>
Name: Brian McMahon
Position: Senior Engineer
Qualifications: B. Eng. MSc (Transportation), MIEI
Location: Dublin, Ireland

Summary
Brian works within the traffic and transportation section of the Dublin office and is responsible for carrying out junction design, technical analysis and report writing. The role lends support to the Associate and delegates work to Engineers, Graduate Engineers and Technicians and is responsible for coaching staff in these positions.

Experience Summary
Working within a team of transportation planners and engineers involved in a wide range of projects throughout Ireland. Brian is involved in the carrying out of technical analysis of development projects using computer programmes such as TRICS, ARCADY, LINSIG V2, and TRANSYT. Brian writes reports including Transport Impact Assessments, Environment Impact Assessments, and Roads Safety Audits.

Brian qualified from University College Dublin with an honours degree in May 2004 and qualified with a Masters in Transportation and Environmental Engineering from Trinity College Dublin in November 2008. Brian also undertaken the NRA approved 3 day course on an introduction to Road Safety Audits (September 2006).

Relevant Project Experience
Clonmelon, Co. Westmeath
Stage 1 - Proposed Access Arrangements
October 2006

Carrick-on-Shannon, Co. Leitrim
Stage 1 - Proposed Roundabout and Access Arrangements
March 2007

Farranacardy, Co. Sligo
Stage 1 - Proposed Access Arrangements
April 2007

Tullamore Regional Hospital
Stage 1 - Proposed Mini-Roundabout
April 2007

Crossdowney, Co. Cavan
Stage 1 - Proposed Access Arrangements
May 2007

Harrietstown Car Park, Dublin
Stage 3 - Proposed Access Arrangements
May 2007

Ballieborough, Co. Cavan
Stage 1 - Proposed Highway Works
December 2006

Celbridge, Co. Kildare
Stage 1 - Proposed Roundabout and Access Arrangements
April 2007

Newtown, Co. Tipperary
Stage 1 - Proposed Access Arrangements
April 2007

Celbridge Signal Controlled Junction
Stage 2 - Town Centre Redevelopment
April 2007

Mallagh, Co. Cavan
Stage 1 - Commercial Access Arrangements
May 2007

Killarney, Co. Kerry
Stage 1 - Proposed Access Arrangements
June 2007
Ballinsbola, Co. Wexford
Stage 1 - Proposed Access Arrangements
June 2007

Kingscourt, Co. Cavan
Stage 1 - Proposed Access Arrangements
June 2007

Carlow Relief Road, Co. Carlow
Stage 2 - 2km Link Road Section and Associated
Junctions
June 2007

Bantry, Co. Cork
Stage 1 - Proposed Access Arrangements
September 2007

Rossalawn, Portlaoise
Stage 1 - Proposed Access Arrangements
November 2007

Newbridge, Co. Kildare
Stage 1 - Proposed Access Arrangements
November 2007

Derrycloney, Co. Laois
Stage 1 - Proposed Access Arrangements
December 2007

Ashbourne, Co. Dublin
Stage 1 - Proposed Access Arrangements
January 2008

Graystones, Co. Wicklow
Stage 1/2 - Signal Controlled Junctions
May 2008

Ballaborough, Co. Cavan
Stage 1/2 - Proposed Development Road
July 2008

Ballinrobe, Co. Mayo
Stage 3 - Proposed Access Arrangements
July 2008

Abbeyfeale, Co. Kerry
Stage 3 - Proposed Access Arrangements
October 2008

Cashel, Co. Tipperary
Stage 3 - Proposed Access Arrangements
November 2008

Dundalk Roundabout, Co. Louth
Stage 1/2 - Traffic Management works on existing
roundabout junction
December 2003

Glasthule, Co. Dublin
Stage 1 - Proposed Access Arrangements
June 2007

Rathangan, Co. Kildare
Stage 1 - Proposed Access Arrangements
July 2007

Gooseberry Hill Quarry
Stage 1 - Highway Layout
August 2007

Citywest Convention Centre
Stage 1 - Proposed Access Arrangements
September 2007

Skerries, Co. Dublin
Stage 1 - Proposed Access Arrangements
November 2007

Lisduff, Co. Waterford
Stage 1 - Proposed Access Arrangements
November 2007

Edenderry, Co. Offaly
Stage 1, 2 & 3 - Proposed Mini-Roundabout Junction
January and November 2008

Roscrea, Co. Tipperary
Stage 1 - Proposed Access Arrangements
February 2008

Powerscourt, Co. Wicklow
Stage 1 - Proposed Access Arrangements
July 2008

Drogheda, Co. Louth
Stage 1/2 - Proposed Access Arrangements
July 2008

Gorey, Co. Wexford
Stage 1/2 - Proposed Road Alignment
October 2008

Mount Carmel, Co. Dublin
Stage 2 - Proposed Hospital Access Arrangements
and Road Improvements
October 2008

Newtown Mountkennedy, Co. Wicklow
Stage 1/2 - Proposed Access Arrangement
November 2006

Portlaoise, Co. Laois (2 sites)
Stage 1/2 - Proposed Access Arrangement
June 2009
Reference Plan
10.0 Dublin Coastal Flooding Protection Project, Final Report April 2005, by Royal Haskoning (see Volume 2, Section 3.3.1)
Final Report
Volume 1 - Main Report

Dublin City Council
Fingal County Council
29 April 2005
Final Report
9M2793
Document title: Final Report
Volume 1 - Main Report

Document short title:
Status: Final Report
Date: 29 April 2005
Project name: Dublin Coastal Flooding Protection Project
Project number: 9M2793
Client: Dublin City Council
Reference: 9M2793

Drafted by: Owen Mc Manus/Ian Cooke/John Greenyer
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1 INTRODUCTION

1.1 General

In September 2002, Haskoning (formerly Posford Haskoning) submitted their proposal to Dublin City Council for the role of service provider on the Dublin Coastal Flooding Protection Project. In November of the same year they were identified as the preferred bidder by Dublin City Council, which preceded a period of negotiations. The negotiations concluded with the appointment of Haskoning in April 2003, as the service provider for the project. A pre-commencement meeting was held in Dublin on the 11th April 2003, which addressed the main stakeholders associated with the project. Following that meeting the project team mobilised in Dublin on the 12th May 2003 with substantial commencement of the project occurring on the 19th May 2003.

The report is presented in three volumes:

- Volume 1:- Technical Report and Executive Summary
- Volume 2:- Appendices
- Volume 3:- Drawings

In it is inevitable in reports of this nature, that a terminology is adopted which reflects the nature of the work undertaken. The wider readership of this report may therefore be unfamiliar with such terminology. Consequently, a glossary of terms used and found in this document is included to aid the reader in the understanding of the technical terminology.

Figures and sketches are presented in Appendices and are numbered sequentially to reflect the Chapter number in which they appear. For example, Appendix A contains Figures 1.1 to 1.5 all of which relate to Chapter 1.

1.2 Scope, Objectives and Project Aims

The Dublin Coastal Flooding Protection Project has been implemented in direct response to the extreme tide and flood event that was experienced across Dublin City and Fingal County during the 1st February 2002. This tide was the highest on record since 1922, being in excess of 1 metre above the predicted tide for that day. It caused extensive flooding and disruption at a number of locations across Dublin City and within Fingal County. The Dublin Coastal Flooding Protection Project is primarily aimed at addressing the risk from tidal flooding around the coastline and within the tidal reaches of a number of the rivers and canals. More specifically the project area encompasses:

- The coastline from the Martello Tower to the North of Portmarnock, to the east pier at Howth Harbour.
- The coastline from the Martello Tower on the South side of Howth Head to the Dublin city boundary at Merrion, including the Bull Island and the Dublin Port area.
- The tidal reaches of the River Liffey to Islandbridge Weir.
- The tidal reaches of the River Dodder to Ballsbridge Weir.
- The River Tolka to Annesley Bridge (subsequently Haskoning agreed to model up to Distillery Weir).
• The tidal reach of the Royal Canal to Strand Road.
• The tidal basin of the Grand Canal as far as the 1st lock.

A plan showing the extent of the above project area is presented in Figure 1.1.

Figure 1.1 - Project Extent

The main objectives and aims of the Dublin Coastal Flooding Protection Project are to:

• Undertake a strategic examination of the risk to Dublin from coastal flooding.
• Identify appropriate strategies and polices to combat and manage the risk.
• Identify short term urgent works on experience gained from the February 2002 event.
• Identify medium to long term options to reduce and/or manage the risk.
• Learn from the past.

In order to achieve these specific study objectives and aims, a number of study tasks and goals must be achieved. These include:

• Capture and analyses all relevant project data.
• Consult and liaise with all other DCC and FCC flood risk initiative projects.
• Carry out a public information campaign, including the creation of a web site
• Undertake a detailed asset condition survey of the coastal and tidal defences within the project area.
• Undertake a probabilistic assessment of existing tidal records.
• Undertake mathematical modelling for use in the development of a forecasting system.
• Identify areas at risk to coastal flooding and quantify the extent of those risks.
• Assess the impact of those flood risks identified.
• Identify risk reduction works and assess the merits of each to identify a preferred option(s).
• Develop preferred option(s) into work packages and prioritise.
• Investigate and provide a specification for the development of an Early Warning System.
• Identify a long term strategy for the area.

Each of the above specific goals and tasks are incorporated within the project programme and methodology to ensure that the overall project aims are achieved. The overall project and methodology has been broken down into four phases and more details of these, the project methodology and programme are presented in Chapter 4.

1.3 Sponsoring Authorities

The primary sponsoring authority for the Dublin Coastal Flooding Protection Project is,

• Dublin City Council (DCC).

In addition there are a number of co-sponsoring authorities to the project and they include,

• Fingal County Council (FCC).
• Department of Communications, Marine and Natural Resources (DCMNR).
• Office of Public Works (OPW).

An extensive list of project stakeholders has also been developed and they are regularly consulted and involved in the project as and when input from their particular field of expertise is required.

1.4 The Dublin Coastal Flooding Protection Project in the Context of the European SAFER Initiative

1.4.1 INTERREG III B

INTERREG III is an EU Community Initiative to promote transnational co-operation on spatial planning by encouraging harmonious and balanced development of the European territory. The overall aim is to ensure that national borders are not a barrier to balanced development and the integration of Europe and to strengthen co-operation of areas to their mutual advantage. **INTERREG III B** represents Transnational co-operation on spatial development between national, regional and local authorities and a wide range of non-governmental organisations. The objective is to achieve sustainable, harmonious and balanced development in the Community and better territorial integration.

1.4.2 SAFER

Standing for Strategies & Actions for Flood Emergency Risk management, SAFER is an Interreg III B approved project comprising five partners:

• Gewasserdirektion Neckar, Germany (Lead Partner)
• Dublin City Council, Ireland
The SAFER Project is an innovative proposal to develop a best practice approach to flood risk management based on three themes:

Flood Hazard Information
- hazard maps, flood frequency determination etc.

Flood Emergency Response
- technical defences (barriers, soft defences, demountable defences.
- seamless systems from flood early warning; to call out and response; and recovery.

Flood Partnerships
- with national & regional government and agencies; & communities

The Dublin Coastal Flooding Protection Project (DCFPP) forms a major constituent of Dublin City’s work on the SAFER project and also within an overall Dublin Flooding Initiative:

It provides, for the first time, the flood hazard information on Dublin’s coastal flooding risk; this flood hazard information will enable flood risk management plans to be formulated and put in place. The study, mainly through its various workshops, has also fostered many of the working relationships with other regional and national stakeholders. This work has provided the first steps to identifying the flood partnerships.

The DCFPP has formed links with the other DCC flooding projects and is foremost in promoting an interim early warning system addressing coastal flooding.

The overall SAFER structure is shown in the flowchart below.
1.5 Description of the Project Area

The extent of the project area has been outlined in Section 1.2 above and is shown on Figure 1.1. It includes both the coastal boundaries and also river and canal boundaries over their tidal reach. The nature of the coastline and river/canal boundaries and their respective quays and defences vary in type throughout the study area. An extensive inspection of the project area has been undertaken and the results presented in a database, which is discussed in more detail in Chapter 3 – Asset Survey in the technical section. However, it is felt that a brief description of the project area should be given within the report and this is presented below. The text that follows should be read in conjunction with the Figures 1.2 to 1.5 and photographs presented in Appendix A.

1.5.1 Fingal County Council

i) Portmarnock to Baldoyle – Photographs A1 – A8 & Figures 1.3 & 1.4

The northern end of the study area commences at the Martello Tower, see Photographs A1 and A2 and Figure 1.3. Here, the coastline is defined by high promenade walls with some pedestrian access points (Photograph A3) leading to the beach in the village of Portmarnock. The study area then extends along Velvet Strand sand dune system which contains two golf courses. The sand dune system is a mature and well developed system although there is evidence of erosion in a number of places. This has been addressed on the seaward side over a number of lengths by placing old timber rail sleepers along the toe in a vertical position, see Photograph A3. On the Baldoyle Estuary side rock and building rubble has been placed over part of the length of the dunes to help protect them, although erosion on this side must be considerably less due to the sheltered nature of the estuary. Photograph A4 shows the Strand Road that runs out of Portmarnock along the northern end of the Baldoyle Estuary. Photograph A5 is taken at the roundabout just south of Portmarnock, at the junction of Strand Road and Coast Road, see Figure 1.3, where flooding of the road and roundabout occurred. The problem here has been reported as being due to drainage from the fields which becomes tide locked at the outfall into the estuary at this location. The water as a result gathers on the road and roundabout which are low in level. However in addition to this, a low spot between the wall and adjacent embankment was noted just off photograph A5, which could also have resulted in some overtopping at that location.

Continuing south along the Coast Road to Baldoyle, the coastline comes close to the road in a number of locations, with some places protected against erosion and others not, see Photographs A6 and A7. No significant defence structures were noted along this length and the road looks low enough for flooding to occur, indeed it is reported that the road and two adjacent properties were flooded. Photograph A8, see Figure 1.4, shows the North Fringe drainage scheme works which are currently underway in Baldoyle. As can be seen from the photograph, the scheme will provide a new promenade and seawall slightly seaward of the existing. However, the existing wall is also being maintained to act as a secondary defence that will be of considerable benefit from a flood protection point of view.
ii) **Baldoyle to Howth Harbour – Photographs A9 – A11 & Figure 1.4**

Photographs A9 and A10 show the sand-dune system, which fronts the properties along the Burrow Road east of the Sutton Golf Links. The dune system would provide a degree of protection against wave action along this length, although there was noted to be a number of vehicular access paths through the system which it is believed will act as flood paths to Burrow Road, see Chapter 3. In addition to the dunes the properties appear to have a wall around them but it is not thought to be flood defence in nature, although it would provide some benefit. Photograph A11 looks east along the port area from the western pier at Howth Harbour, which is the limit of the project extent on the northern side of Howth Head. This length of the project area contains wall and revetment type structures.

iii) **Martello Tower, Howth Head South Side to Sutton Cross – Photographs A12 – A17 & Figure 1.4**

At the location of the Martello Tower and for some distance along the coastline to the north west, the land is high and not at risk of flooding. However, there are a number of locations where coastal erosion is beginning to cause a problem, see Photograph A12. Whilst this does not pose a treat from a flood risk point of view as the ground levels are high in this area, continued erosion could eventually threaten the road. Beyond the junction with Strand Road and St Fintan’s Road, the ground levels begin to reduce and the coastline consists of a vertical concrete and in places block wall, see Photographs A13 and A14 and Figure 1.4. A number of gaps exist in this wall to allow pedestrian and vessel access to the beach, see Photograph A14. Further west at the junction of Strand Road with Greenfield Road, the wall ends and is replaced by natural bank, which is in places protected by building rubble and shingle, see Photograph A15. A number of properties which lie on the southern side of Sutton Cross junction, have gardens that back onto the foreshore. However, the majority of these have some form of wall at their seaward boundary limit albeit they vary in type and condition, see Photographs A16 and A17.

iv) **Sutton Cross to Kilbarrack Road (Fingal County Council Boundary) – Photographs A18 & A19 & Figures 1.4 & 1.5**

Fingal County Council reported that there was no flooding along the length of Dublin Road as far as their boundary with Dublin City Council at the Kilbarrack Road. It is likely that this is a direct result of the protection that Bull Island offers this length of the project area against wave activity. Photograph A18 shows the start of this section at the western end of the Sutton Cross properties, see Figure 1.4. The typical land water interface over most of this length generally consists of a vertical quay or steep revetment type structure with low wall on top, see Photograph A19.
2 FEBRUARY 2002 EVENT

2.1 General Description

On the 1st February 2002 an exceptionally high tide occurred at Dublin, which resulted in significant flooding throughout parts of the city and Fingal. The period around the end of January and beginning of February 2002, was a period of spring tide conditions associated with the full moon at that time. The highest tide predicted for Dublin port around that period was on the Thursday 31st January at 13.12 hours and was predicted to be 4.46m LAT (1.95m ODM). The actual tide recorded at that time was 4.69m LAT (2.18m ODM). The next highest tide was predicted for 14:00 hours on the 1st February at a level of 4.44m LAT (1.93m ODM). The actual highest level that occurred around that time was 5.46m LAT (2.95m ODM) at 14:30 hours. This was some 1.02m higher than the highest predicted value around that time based on the Dublin Port Tide Tables. Later analysis of the tidal records and predictions of the astronomical tide for that day based on this analysis would tend to indicate that the astronomical tide level was slightly under predicted in the port tables and that the surge was closer to 0.96m. Figure 2.1 shows a comparison between the predicted tide for Dublin and the recorded value for 31st January and 1st; 2nd & 3rd February 2002. The surge residual shown is the difference between the two and represents the observed surge for Dublin Port. A value of just over 1m can clearly be seen on the 1st February 2002 and is based on the actual less the Dublin Port tide tables predicted astronomical tide for the day.

Figure 2.2 shows the peak of the recorded tide in Dublin Port. It can be seen from the figure that there were two significant peaks. The first, having a level of 5.42m LAT, occurred around 13:40 hours, after which the tide level fell to around 5.28m LAT at about 14:08 hours, before rising again to its highest level of 5.46m LAT at 14:28 hours. Figure 2.2 also shows that the tide rose above 5.0m LAT (2.49m ODM) at around 12:43 hours and stayed above that level until 15:07 hours, a period of almost 2.5 hours.

From Figure 2.1, it can be seen that the peak of the surge event coincided more or less with the peak of a relatively high spring tide, and it is certain that this has resulted in such extreme combined tide levels. Whether a 1m surge is of itself a significantly unusual event is dealt with in the probabilistic analysis reported in Chapter 7 in the technical report, however, its coincidence with the peak of a spring tide would result in a significantly more unusual combined event.

The mechanisms resulting in such a surge in tide level are not fully clear although a better understanding is enabled as a result of the analytical work undertaken in Chapter 7 (technical). From the description of the weather conditions given in Section 2.2 around the time of the flooding, it is extremely likely that the surge component was driven by the extreme low pressure system which had been formulating to the northwest of Ireland over a period of days before the event. It was this low pressure system, which fell to a low of just 930mbar which was the driver for the high surge levels experienced at Dublin, even though the pressure at Dublin was in the region of 986mbar. The continuous low pressure system in the Atlantic generated conditions which propagated into the Irish sea in the form of a surge wave. This combined with strong winds, which around the 1st February were up to gale force from south to south westerly, increased the sea level significantly.
Rainfall and river flows were not significant contributing factors, see Section 2.4 below for description of conditions around that period.

2.2 Weather Conditions

The following description of the weather conditions for the 24-hour period, preceding and including the events of 1st February 2002, has been supplied by staff at Met Eireann from their Monthly Weather Bulletin No’s 189 and 190, covering January 2002 and February 2002 respectively.

2.2.1 The General Situation

For several days preceding the 1st February storm surge event, there was an area of low pressure near Ireland causing stormy weather. On the 1st February a very deep depression (Figure 2.3) with a central pressure of 930hPa (930mbar) passed to the north west of the country. Bands of heavy and thundery rain, together with southwesterly gales, affected most parts of the country during the day (Figure 2.4). However, the most disruption was caused by the combination of very low pressure and the exceptionally high tides measured around the coastline, especially in the Irish Sea.

The worst affected area was Dublin, where severe flooding occurred after the highest tides measured in over eighty years caused sea defences to overtop and rivers and canals to overflow. Structural damage was also recorded as a result of the exceptionally high tides.

2.2.2 The Detailed Meteorological Situation

On Thursday 31st January 2002 a frontal trough crossed Ireland as a deepening depression approached from the Atlantic. Cold overnight with slight ground frost and a few showers, mainly on the northwestern coasts. A spell of heavy and persistent rain moved into the southwest early in the morning and spread across the country during the day, clearing to scattered showers and short sunny spells in the afternoon. Light to moderate southerly winds overnight became strong to gale force later with some severe gusts during the day.

Rainfall: 5mm – 10mm at many stations, with 17mm – 23mm in south and southwest.
Temperature: maximum 9°C - 12°C, minimum 2°C - 6°C. Ground temperatures down to –4°C in Kilkenny.
Sunshine: Nil – 1hour.

On Friday 1st February 2002 a storm depression to the northwest of Ireland moved steadily northeastwards, as its associated frontal trough crossed Ireland during the day. Winds were up to storm force at times, while rain was heavy in places, especially in southern areas. Rain cleared to showers later, some thundery, as winds eased slightly. Mild throughout.

Rainfall: 10mm – 20mm in many areas, over 30mm in south and southwest.
Temperature: maximum 11°C – 13°C, minimum 4°C – 8°C. Ground temperatures 2°C – 7°C.
Sunshine: Nil – 2hours.
2.3 Marine and Irish Sea Conditions

Data has been obtained for the Marine Institute M2 buoy which is located in the Irish Sea just off Dublin Bay. The buoy provides data on a number of meteorological and marine parameters, the main ones of which are atmospheric pressure, wind speed and direction, wave height and period. Data on the 1st February 2002 indicates that from about 0700 hours to 1500 hours significant wave heights were in excess of 3.5m and reached up to 4.4m on a number of occasions. The buoy does not record wave directions, however, this is likely to be similar to the wind direction around the time, which was predominately from a southerly direction. These wave heights, while not very extreme, are not insignificant.

The M2 buoy is located some distance offshore and therefore the recorded wave climate is likely to reduce as it propagates towards the coastline and into the bay. This is due mainly to wave refraction as the wave fronts interact with the seabed, wave breaking over the Kish and Burford banks, and shoaling as waves traverse the nearshore bathymetry. Nevertheless the conditions on that day are likely to have resulted in a nearshore wave climate that would have caused problems at a number of locations, particularly over the peak of the extreme tide, when water depths and hence wave heights would have been at their greatest.

2.4 Fluvial Conditions

Rainfall and river flows were not significant contributing factors to the flooding on the 1st February 2002. Rainfall data obtained from Met Eireann for Dublin Airport shows that only 1.8mm of rain fell in 3.5 hours on the 31st January and 10mm in 3.4 hours on the 1st February 2002. Such a low rainfall would not have contributed to the flooding on the day. Moreover, records for the month of January 2002 do not indicate any periods of intense or prolonged rainfall which would have contributed to significant runoff or higher than usual river flows.
3  FEBRUARY 2002 FLOODED AREAS

3.1  Introduction

Using reports compiled by Fingal County Council and Dublin City Council staff on the flooding around the time of the 1st February 2002 event, and through subsequent discussions with those staff, a number of areas have been identified as having been subject to some form of flooding or disruption. These flood areas are described below. It should be noted that the text below and the flood areas identified on the figures presented in Appendix C, represent those that are understood to have been affected during the February 2002 event and are not thus indicative flood risk maps. The areas affected include:

3.2  Fingal County Council

3.2.1  Portmarnock to Baldoyle

i)  Coast Road

- The road and roundabout at the junction of Coast Road with New Road and Strand Road Portmarnock, was flooded, although no properties were flooded at this location. The problem here has been reported as being due to drainage from the fields which can become tide locked where the outfall discharges into the estuary. As a consequence the water backs onto the low-lying road and roundabout. However, during a site inspection a low spot was noted where the masonry wall meets an earth embankment south of the roundabout on the Coast Road. This may have been a contributing factor to the flooding that resulted at this location on the 1st February 2002, see Figure C1.2 and Photograph A5. In October 2004 this location was again flooded. Inspections during that flood event indicated that the road flooded before escaping through the gap mentioned above. This would tend to indicate that either the water was escaping through the masonry boundary wall or backing up through the outfall at this point, or some combination of both. Nevertheless, all three mechanisms mentioned above will need to be address if future flooding is to be alleviated.

- A stretch of the Coast Road south of the Mayne River was flooded. The mechanism of flooding along this location was not confirmed, however the road level at this location appears low and at one spot is protected by a gabion wall with a concrete post fence, see Photograph A7. A survey undertaken by Fingal County Council (FCC) after the flood indicated the highest point along the gabion wall to be around 2.7mODM with the road being lower at around 2.5mODM. The tide level recorded in Dublin Port was 2.95mODM and therefore it is highly probable that the water simply weired onto the road at this point and flowed back along the road towards the Mayne River, see Figure C1.2 and Photograph A7. Having said that the road was again flooded at this location in October 2004, albeit to a lesser extent and on that particular occasion water did not over top the gabions. Inspections during that flood event revealed that water was also seeping through the old masonry wall and therefore the condition of the wall also required careful attention as well as the defence level.
• Two properties, Nos 1 and 2, were flooded on Coast Road. These properties are located adjacent to the flooded section of road mentioned above, see Figure C1.2. While it is likely that water may have entered the properties from the road, the FCC survey also indicated the ground levels along the rear of these properties to be low in places. It is therefore likely that water flooded them from a number of directions. In addition there were reports of effluent in the flood water which could have been due to water backing up their septic tanks.

3.2.2 Sutton

i) Burrow Road

• Flooding was noted on Burrow Road in the region of the Avalon Apartments. Whilst a number of gardens were flooded, no reports were received that properties were flooded along this road. The water is believed to have penetrated the dune system and flowed down an access road leading from the beach on to Burrow Road, see Figure C1.3.

ii) Sutton Dinghy Club

• The Sutton Dinghy Club was extensively flooded. The club is relatively low lying and the flooding resulted primarily from the collapse of a boundary wall fronting the club, see Figure C1.3.

iii) Strand Road

• Strand Road was flooded for some distance from its junction with Greenfield Road.
• Property No’s 2 to 18 had their gardens flooded but it is believed the properties themselves did not flood.
• Property No 1 was flooded in addition to its gardens.

The extent of the above flooding is presented on Figure C1.3.

The frontage at this location is relatively exposed to wave activity. A block and concrete wall exists along much of this frontage, however there are several openings along the wall to allow pedestrian and vessel access to the foreshore, and indeed, the wall at one of these access points was damaged during the February event. This has since been repaired, see Photograph A14. In addition to the access points, a number of drainage holes exist at regular intervals along the wall. Towards the junction with Greenfield Road, the wall ends and is replaced by a lower bank armoured with building rubble. This bank is much lower than the top of the block wall. It is likely that the main source of flooding at this location was due to wave action through the openings in the wall and over the bank. The gardens of the properties along Strand Road are lower than the road and so the road was the main flood defence element along this length.

iv) Greenfield Road & Sutton Cross

• Property opposite the church, was flooded following failure of the property seawall.
• Other properties on the seaward side of Sutton Cross had their gardens flooded.
The flooding along this location is shown on Figure C1.3. Only one property was flooded following collapse of the boundary wall that backs onto the foreshore. The flooding mechanism along this frontage is primarily as a result of wave action being driven up the beach on the enhanced tide. The location is still relatively exposed, being just outside of the protection offered by Bull Island.
4 FORECAST SYSTEM & EARLY WARNING RESPONSE

4.1 Forecast system

4.1.1 Introduction

The forecasting of extreme tide levels and potential coastal flooding events draws on the individual elements of the study. These elements, namely:

- The joint probability analysis of tides and surges to determine the return period of the February 2002 event also enables the prediction of extreme tide levels, against which the standard of protection of the current defences can be assessed.
- The defence asset survey database identifies the current state of the defences.
- Numerical modelling of tides, waves and overtopping provide significant detailed information about the distribution of the wave and tidal conditions across the study frontage under normal and extreme tides.
- Numerical modelling of overtopping provides information against which the standards of defence can be compared, and from which the trigger level criteria are derived.
- Flood compartment mapping enables the assets at risk to be identified in a consistent manner, as well as being able to assess the effectiveness of the options proposed to mitigate future flooding.

Each element of itself, whilst important as a decision making tool, does not provide sufficient information to enable a coherent forecast to be made of potentially destructive tides and wave conditions.

The forecast system employs the TRITON user interface to combine the results of the individual components in a manner that provides Dublin City Council with better flood forecasting of future events.

4.1.2 Development of transfer functions

Transfer functions are used to convert offshore conditions to nearshore conditions without the need to rely on the constant use of numerical models. The running of the various numerical models in real time immediately prior to a flood event would be too slow to provide practical advanced warning of the flood event. Pre-developed transfer functions on the other hand provide a practical and more effective means of setting up and running a forecast system using real time data. The transfer system does not require any model processing time, but simply requires input forecasts from the UKMO model, which can then be read through the transfer functions to give an instant estimate of the nearshore conditions from which a warning may be triggered.

A range of different transfer functions have been developed through the numerical modelling work described in the earlier chapters. This range includes transfer functions to,

- Convert offshore surge forecasts into nearshore surge estimates around the project area
- Convert offshore wave forecasts into nearshore wave climate forecasts
• Convert wind speed and direction forecasts into nearshore wave climate at specific locations as required
• Convert nearshore wave climate and water levels forecasts into overtopping estimates.

4.1.3 Flood warnings

In the UK, the Environment Agency currently employs a flood warning system that is built upon a four-tier warning approach, with each tier getting progressively more serious. These are:

• Flood Watch
• Flood Warning
• Severe Flood Warning
• All Clear

For the purposes of the Dublin system the Triton system flood warning trigger values have been based on the four tier system, although it should be noted that the Flood Warning Category is subdivided into two as shown in Table 4.1 below, to enable staged warnings (or more targeted warnings) to be issued to parties at risk. The probity of such an approach is to be agreed prior to the system going live.

Table 4.1 - Flood Warning Categories

<table>
<thead>
<tr>
<th>All Clear</th>
<th>This indicates that there is no imminent risk of water levels reaching a point that requires further monitoring.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood Watch</td>
<td>This indicates that overtopping is likely to occur at a level that could affect pedestrians and or motorists using walkways and roads adjacent to the seawall.</td>
</tr>
<tr>
<td>Flood Warning A</td>
<td>This indicates that flooding is expected and that properties will be affected. It is considered that this would represent the first row of houses adjacent to a sea defence being flooded.</td>
</tr>
<tr>
<td>Flood Warning B</td>
<td>This category would be used if a second area including small numbers of properties were to flood at a higher trigger level than for a normal flood warning, but for which a severe warning is not justified because the total risk is not sufficiently high.</td>
</tr>
<tr>
<td>Severe Flood Warning</td>
<td>This indicates that there is an extreme risk associated with flooding. The value will be set such that if greater than 100 properties were at risk of flooding than this would initiate a severe flood warning.</td>
</tr>
</tbody>
</table>

Note: The symbols shown above are those employed by the UK Environment Agency and are included here as examples of how the various warning categories are differentiated visually.
4.1.4 Trigger criteria

In workshop No.1, the concept of Trigger Criteria was introduced to the stakeholders and a discussion held on what should constitute appropriate criteria. In August 2003 the Environment Agency published a new version of “The Flood Warning Code System”, which gave simple definitions for each of the four tiers of flood warning. In October 2003 a new work order was published by the Environment Agency, for which our best interpretation defines the triggers for flood watch, flood warning and severe flood warning as follows:

i) **Flood Watch:** The trigger for Flood Watch is a forecast that flooding of low impact land is expected.

ii) **Flood Warning:** The trigger for Flood Warnings is a forecast that flooding of property or high impact land use is expected.

iii) **Severe Flood Warning:** The trigger for a Severe Flood Warning is a forecast that flooding of property or high impact land use is expected together with imminent danger to life.

These definitions can be broadly viewed as being in agreement with the definitions in Table 4.1. However, as the defences have been assessed in terms of their current standards of defence, there is no advantage to be gained in refining the definition. Moreover, categorising an area as ‘low impact land’ may inadvertently convey the impression that dealing with flooding in such an area would not be considered as high priority.

As the DCFPP study has progressed it has emerged that the most important criteria upon which to base the warnings in Table 4.1 are:

- Water level
- Overtopping by waves

Furthermore the river discharges and the accuracy of the forecasts will be taken into account. The river discharges will be discussed in the following section (see section 4.1.5), whilst in the remaining only the coastal aspects will be discussed. Regarding the accuracy of the forecasts a safety margin will need to be taken into account to ensure that actions can be taken timely.

The above mentioned criteria could be used to trigger the categories set out in Table 4.1, provided the threshold or trigger level is set to an appropriate level to reflect the category in question. Within the system a threshold level for each of the above criteria will be set which could trigger each of the four categories. The appropriate level of the threshold would of course vary from location to location and is dependent on the following aspects and sub-aspects:

- Asset related aspects:
  - The height of the defence structure
  - The condition of the defence structure
  - The assets behind the defence structure

- Operations related aspects:
The time needed to issue warnings
○ The time needed to put demountable and temporary defences in place
○ The time needed for any other operational actions (see section 4.2)

As each criterion and each aspect is interrelated, over time the trigger values could be fine tuned through monitoring and feed back to improve the overall system in terms of accurate response. Initially the system will operate with default values.

A set up similar to the example shown below, see Table 4.2, can be used to issue appropriate flood warnings.

Table 4.2 - Flood Warning Trigger Levels (default values)

<table>
<thead>
<tr>
<th>Flood Warning Categories</th>
<th>Water level, ∆H (m)</th>
<th>Wave overtopping, q (l/s/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood Watch</td>
<td>0.50</td>
<td>0.10</td>
</tr>
<tr>
<td>Flood Warning A</td>
<td>0.35</td>
<td>1.00</td>
</tr>
<tr>
<td>Flood Warning B</td>
<td>0.25</td>
<td>2.00</td>
</tr>
<tr>
<td>Severe Flood Warning</td>
<td>0.10</td>
<td>5.00</td>
</tr>
</tbody>
</table>

Obviously the flood warning trigger levels are also time dependent. Since a 36 hour forecast is given with twelve three-hourly predictions, it may well be possible that the forecast results in more than one trigger. Each trigger will need to be taken into account and dealt with in the operational response bearing the previously mentioned aspects in mind.

As mentioned before the system will initially be delivered to the client with default values for the trigger levels. In subsequent development phases a fine tuning of the trigger levels will occur dealing with the aspects mentioned before. When the system is fully operational these trigger levels will be monitored and adjusted as required to improve accuracy within the system.

4.1.5 Future monitoring requirements

Forecast System

The forecast system will require a period of formal trial testing before going ‘live’ and being used to actively issue flood warnings. The trial period should, were possible, include a winter period, where the risk from flooding could reasonably be expected to be at its highest.

During the trial period, it is deemed important that the following aspects be tested:

a) Delivery of data from the UK Met Office to the PC server.
b) The validity of the proposed trigger level values i.e. the levels above which warnings will be issued. These values are defined by the end user.
c) The validity of the tide predictions compared to the actual values. Currently this will only be possible for the water levels at the Alexandra Basin Tide Gauge. As more tide level information becomes available, the levels predicted at intermediate warning points can be validated.
d) The validity of the UK surge and water level predictions.
Tide Gauges

Discussions are underway with the Marine Institute of Ireland for the installation of new tide gauges.

Flow Gauges

It is considered very important that a number of new/old flow gauges are installed/reinstated at or around the tidal limits of each of the three main rivers.

Future Proposals

The EWS proposals are currently being advanced to a joint partnership with Met Éireann, DCC and RH.

4.2 Early Warning System

4.2.1 The Components of an Early Warning System

For any flood forecasting and warning system to deliver benefit to the communities that it is intended to protect, it must be viewed as a coherent entity, if the overall objective is to reduce the risk to life and property of the general public. “The benefits of issuing flood warnings to the public are only realised if the dissemination is effective.” (Ref 1)

The established thinking on flood forecasting and warning systems looks at six components. These are:

- detection;
- forecasting;
- warning;
- response;
- evaluation; and
- improvement

The above components are linked and must not be considered in isolation. The first components are looked at in more detail below. The last two elements, i.e. evaluation and improvement, can only occur if adequate records of flood events are maintained.

Detection

At the coastal margin, detection takes the form of wind/wave/surge forecasts that are both forecast for specific sites and actual for locations distant from the target site. The distant locations help to verify the forecast. This requires forecast data (usually from the Met Office) plus tide gauge real time data.

Along rivers, detection will include access to flow and/or level data in real time together with forecast precipitation supplied by the Met Office. In Dublin weather radar is available although this is considered to be a real time system and generally only provides data up to two hours ahead of an event.
Detection of potential flood events in an estuarine environment requires a combination of the information required for detection of coastal and river flooding.

**Forecasting**

This compares what is happening (or forecast to happen) with the standards of existing defences. Forecasting looks at ‘where’ and ‘when’ the defences might be exceeded and for how long. Having forecast the exceedance, the next action must address the question of “what will the impact be?” To do this requires access to an asset survey database and flood risk maps.

**Warning**

A flood warning terminology adopted (and understood) by all “interested” parties is an essential pre-requisite for any warning system. Without this it will be impossible to convey the seriousness of a message from which the necessary actions must flow.

However the terminology is developed and defined, if it is specific to an individual system, there will always be the possibility that the warning will fail, because of a lack of understanding on the part of the person issuing the warning or on the part of the recipient. It is therefore imperative that the terminology used is common to all those who may potentially need to use it. This will include the responsible local authorities of Dublin City Council and Fingal County Council, the Police, the emergency services, utility companies, hospitals, regional flood committees’ etc.

Hence, when developing the terminology, the needs of three target groups must be taken into consideration. These include:

1. general public who require information between three and six hours in advance of flooding;
2. the broadcast media who will use the warning messages within their broadcasting schedule; and
3. professional and emergency service organisations who have an operational role to perform and who may require a lead time to carry out that role effectively.

The main requirement of this is a message dissemination system similar to the Environment Agency’s (EA) Automatic Voice Message system (AVM), although the number of message recipients and the available lead time will influence system selection. The system needs to disseminate messages in a variety of formats (voice, fax, Text message, pagers, SMS, email). The system works from databases of recipients, messages and locations that all need periodic updates.
Response

The response required from any particular warning will vary according to the target group to which the warning is directed.

- **Members of the public:** The general public should know what to do because they are aware of the meaning of warning messages and the response they should make. This could be reinforced by encouraging the preparation of personal/family flood plans. To further embed this in the psyche of the members of the public, there will be a need for regular (annual) public information campaigns.

  A natural reaction to the issuance of a warning is the need to confirm its validity. In England and Wales the Environment Agency (EA) has established “Floodline”; which is a contracted out service that can both endorse the flood warning messages as well as provide background information. The Scottish Environment Protection Agency has also joined the “Floodline” service.

- **Broadcast Media:** If the broadcast media are to be used in disseminating warning messages, a protocol must be established, under which, the media will receive warnings within a specific timescale. The protocol must also include an agreement from the broadcast organisations, not to exercise editorial control over the wording of the message; all of which would follow a standard format. This will require a procedure (or series of procedures) to be agreed with the flood warning organisation, detailing how the message is handled, who is responsible for its delivery and manner in which it is delivered.

- **Emergency Response Organisations:** The emergency services and other organisations responding to a warning will need to amend their operating procedures to accommodate the flood warning messages that they may receive. They may want to establish a “feedback” mechanism whereby their operational controllers can liaise with the flood warning operators.

  To operate a flood forecasting and warning service, there must be staff (appropriately trained) and available, who can respond whenever the predetermined threshold values are forecast to be exceeded. There needs to be adequate facilities from which the procedures can be delivered.

  It is important that the entire process of receiving and responding to warnings is fully documented and cross checked against related procedures. The procedures will need to be checked (by exercise) routinely.

  A log should be established to record all actions, from which evaluation and improvement can be initiated.

4.2.2 Requirements for Study Area

At an early stage in the development of an early warning system, the “target audience” for flood warnings should be identified. It is generally accepted that there are four distinct audience groups to which warnings may apply:
a) The members of the general public who are at risk, either because they live and work within a flood risk area or because they travel through such an area.
b) The professional services who provide the operational response to flooding and or the risk of flooding but who are not usually available 24 hours per day.
c) The emergency services who would deal with flooding as one of the range of hazards that they are trained and equipped to respond to.
d) The media organisations that would play an important role in the dissemination of warnings and in the updating of information throughout the event.

The type, number and distribution of the four groups need to be established in order that the size of any technological solution can be adequately scoped.

Experience has shown that the most effective way of determining the appropriate message format is through consultation with representatives from each of the above groups. The aim of these consultations is to ensure that the appropriate action is taken when flood warning messages are received.

4.2.3 Option for the Development of an Early Warning System

There is an extensive array of media whereby the delivery of the warning can be achieved to the target audiences. These include:

- **Telephone:** the mass use of the telephone within society, whether fixed landlines or mobile, means that it is a readily available medium for the dissemination of flood warning messages. A telephone based alerting/warning system would therefore be recommended as a major component in the arsenal available to the organisation issuing the warnings.

  To operate such a telephone based system a call centre approach or an automated dialling approach would be required, depending on the size of the calling database. Essential information required for the calling database includes:

  - A list of all the recipients of flood warnings;
  - A list of all flood locations that flood messages relate to;
  - Predetermined lists of recipients for each type of flood warning; and
  - The ability to handle text and voice messaging.

  It is feasible to record whether a recipient has received and/or acknowledged a message.

- **Personal Computer:** The wide availability of personal computers, both at home and in the workplace, means that the computer can be considered as a means of distributing flood warnings to a wide audience. As a messaging system it is similar to that described within the telephone system (above), and would enable messages to be sent to appropriate recipients via email.

  The advantages of the email system are that messages can be sent out using pre-arranged templates, and is a low cost option. The main disadvantage to using an email based system is that there is no comprehensive method to determine whether a message has actually been received by the recipient, although it is possible to set up an acknowledgement system for the recipients to respond with.
• **Television Text Messaging:** The advent of digital TV has enabled text messaging to be sent across the screen. There may however be broadcasting legislation that restricts or delays the implementation of this technology and therefore the option should be considered as a future enhancement rather than an initial requirement. Moreover, the success of this option is dependent on how many households have made the switch from analogue to digital signals.

• **Television and Radio Broadcasts:** The broadcasting of messages by radio and TV stations is an effective means of mass communication. The effectiveness varies according to the time of day the warning is broadcast. If it is to be used as a means of disseminating warnings, then both the flood forecasters and flood warning staff should liaise when compiling flood forecasts and warnings. Liaison and consultation with the broadcasting community is important from an early stage of planning the system. The broadcast media have a great desire for information and may fill any perceived gaps in information with their own interpretations which may lead to false impressions being created.

Both Dublin City Council and Fingal County Council should consider whether any message handling technology already in use, or planned, by the professional partners and emergency services could meet the needs of a flood forecasting and warning system. The aim of a flood warning system should be that there is as little intervention by third parties as possible i.e. between the professional and emergency service partners receiving the messages and the flood warning staff issuing the messages.

• **Direct Warnings:** Direct methods of warning such as via a network of community volunteers should also be considered whereby flood warning messages are cascaded to the recipients via two or three community representatives. Such an approach works well where there is an established community spirit. It can engender a sense of ownership within the community who become keen to see improvements identified and implemented. The disadvantage is that when there is a long period between flood events local interest in the system declines. Moreover the effectiveness is diluted in communities where the residents are away for much of the time. The community volunteers (flood wardens) do need to have a link and feedback mechanism with the flood warning organisation.

Other direct means of warning, such as the sounding of sirens, may be considered where appropriate. Installation, testing and maintenance of the system are required together with a public education campaign as to what the siren signal means.

Vehicle mounted loud hailers can also be an effective method of disseminating flood warnings. The route of vehicles can be pre planned and the messages pre-recorded. The time taken to deploy the vehicles must figure in the consideration of the viability of this approach. At peak travel times, congestion in Dublin could potentially delay the delivery of the messages. However, if this type of vehicle is already available it can be a cost-effective solution.

Irrespective of the dissemination system used research has shown that there is a need for recipients to be able to verify the flood warning information that they have received. One method to provide this information is via a dedicated call handling centre (Floodline...
as used by the Environment Agency (England and Wales) and SEPA). Research has again indicated that the greatest reassurance is provided by the recipients contacting another “human” rather than a technological answering machine. Call centres can be totally remote from the flood site, the use of carefully scripted prompt sheets, to be used by call centre staff, has been shown to satisfactorily answer the majority of public enquiries received. Any call centre used in this way must also receive a copy of all flood warnings and preferably receive some advance notice that warnings may be issued.

4.2.4 Fluvial Considerations

The requirements for a fluvial flood warning system do not vary significantly from those required for a tidal/coastal system. The main difference between the two types of flooding is that the lead time required for the issuing of fluvial flooding warnings is generally shorter than that of tidal/coastal. Dependent upon the lead time required by the warning message recipients and on the reliability of the fluvial flood forecasting system there may be a greater number of inaccurate warnings issued.

In all other respects the components of a fluvial flood warning system are as described in the sections above.

4.2.5 Links to ERP and MEP

The Emergency Response Plans (ERP) and the Major Emergency Plan (MEP) focus primarily on the situation when a Major emergency has occurred. Flood warning actually provides preparation time and enables actions to be taken when a major emergency is likely. Some flood warnings, particularly if the system is also used for fluvial flooding, will only affect one or two areas, in which case it may not be appropriate to classify them as a major emergency.

The definition of flooding and flood warnings as a major emergency must be established in order that the definitions can be applied consistently by all parties involved.

The response to major flooding is somewhat different to other emergencies in that the Flood Risk Areas that will be affected are predefined, hence the access and egress routes can also be predetermined.

Review of the ERP and MEP is being undertaken as part of the DCC SAFER work using the results of the flood risk assessment work to identify damage functions and appropriate responses. A review of the location of command centres and equipment depots referred to in the ERP and MEP should be undertaken to ensure that none lie within an area at risk. Utility supplies to command centres should also be reviewed and amended if necessary to ensure continuity of supply in the event of flooding.

4.2.6 Strategic Recommendations

From the review of the documents listed in Chapter 5 (technical), and the consideration of the components of a flood forecasting and warnings system, the following strategic recommendations can be made:

1 Identify who, where and when requires a warning and determine a system performance specification.
2 Identify the current or justifiable flood forecasting system for Dublin City Council area and the linkages that need to be made to translate forecasts to warnings.
3 Determine the most appropriate warning methodologies to meet the performance specification.
4 Identify the investment programme to procure and implement the chosen methodologies.
5 Review the existing operational arrangements within professional organisations and the emergency services to determine the impact of flood risk upon their operations.

4.2.7 Work required

In order to establish an effective flood forecasting and warning system, the following elements of work are required:

1. Identify locations that require flood-warning messages. This is partially accomplished by the Dublin Coastal Flooding Protection Project. Establishing the system for the rivers does not form part of this commission.
2. Identify “target audience” from each of four groups for each location.
3. Identify through liaison and consultation the most effective warning messages together with the target lead time that provides sufficient time to take effective action.
4. Review flood forecasting system and “trigger” and “threshold” levels to link to the flood warning system.
5. Identify appropriate technology to deliver the required number of messages to the identified recipients within the stated lead time. Identify costs and timescale to procure commission and implement the technology.
6. Identify existing operational procedures and future requirements to operate the flood warning system and carry out trials. The system to have the ability to record warnings issued and cancelled so that “real time” summaries can be produced as well as post event reports.
7. Establish routine (annual) test programme.
8. Implement system, record and review performance.
5 FLOOD ALLEVIATION OPTIONS

5.1 Introduction

5.1.1 Assessment Criteria

Design Criteria

All new options presented below have been designed to provide a standard of protection against events up to an including a 1:200 year event. This criteria has been deemed acceptable in light of the flood risk assessment work. Through discussions with the client it has been deemed acceptable to consider a design life up to 2031 which is a strategic milestone being considered for a number of other projects within the area including the GDSDS. Therefore the 200 year design event has been considered to this time scale and appropriate allowances for sea level rise included at set out in chapter 8.

Where necessary appropriate combinations of various parameters have been considered to provide a joint probability combined 200 year event. These combinations have been set out in chapter 5 for both tidal and wave combination to be used around the coast and also for tidal and fluvial discharge combination to be used in the tidal reaches of the rivers. A brief summary of the design philosophy is set out below.

Coastal Regions

Tide Levels:

<table>
<thead>
<tr>
<th>Location</th>
<th>200 year Level (Now)</th>
<th>200 year level (2031)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dublin Port Lighthouse –</td>
<td>3.13mODM</td>
<td>3.25mODM</td>
</tr>
<tr>
<td>North of Howth –</td>
<td>3.27mODM</td>
<td>3.39mODM</td>
</tr>
</tbody>
</table>

At all other locations tide levels were interpolated around the coastline as appropriate using the results of the FINEL tidal hydrodynamic modelling.

Acceptable Overtopping

Various limits for acceptable overtopping have been considered around the coastline depending on the location and option being considered. The general values considered include:

- Road or infrastructure directly adjacent to defence - <0.1 l/s/m.
- Road or infrastructure >20m back from defence - <0.5 l/s/m.

Intertidal Regions

For the intertidal regions of the rivers, options have been designed to withstand only the high tidally dominated scenarios. Therefore for design of tidal defence options within the tidal reaches, scenario 1 has been considered as it provides the most extreme levels for the tidally dominated scenarios.
5.2 Principal Findings of Asset Database and Emergency Works Report

5.2.1 General

This section of the report summarises the early findings of the Asset Database. In particular it considers the locations where some form of urgent action or emergency works might be required prior to completion of the overall study and the implementation of any recommended long term risk reduction measures. These locations were identified through our familiarisation of the project area, through discussions with DCC and FCC staff and through use of the condition survey asset database developed as part of this project. In response to these finding an emergency works report was completed, which recommended minor works at a number of locations. These options have now either been incorporated within the long term options or been superseded by them.

5.2.2 Identification of Database Actions and Urgent Works

Using the completed database an initial assessment of the condition of the defences across the project area was made and preliminary actions and priorities identified for those areas. A comprehensive table of actions was created from the database, by requesting a report for these actions and sorting them by area. The table is presented in Appendix C1 (technical) and sets out an initial assessment of actions and their priorities. This was used as a basis for identifying the main areas where urgent actions and emergency works might be required and was supplemented and enhance through information obtained from other sources. The use of the database to create the table clearly demonstrates the power of the database as a management tool.

The table presented in Appendix C1, contains a considerable number of actions, with varying degrees of priority. Each action identified was not investigated in detail as part of the emergency works report or now, instead only those listed with priority as “urgent” and using judgement a number of those with priority “high”, were considered for further evaluation.

Those which were considered further were broken into two categories, which included flood risk and other. “Flood Risk” considered those locations where there could be a risk to people and property should there be a repeat of an event similar in magnitude to the February 2002 event. “Other”, considered other issues such as poor condition of non flood defence structures, coastal erosion, health and safety etc and generally consisted of locations while not posing a flood risk, should be brought to DCC & FCC’s attention. In some cases both categories may apply.

Locations

1. Baldoyle Defence Code BAL OB 4, Figure A1.3 & Appendix C2 (technical)

This defence unit consists of the masonry wall at the location of the roundabout where the Coast Road meets Strand Road, see Figure 1.3 for location and Appendix C2, Photograph C2.1. It has been highlighted with an action due to the identification of a low spot where the wall meets an earth bank on the Coast Road and is thus a flood risk action. Flooding occurred here in February 2002 affecting mainly the road and the
action is to investigate whether this low spot was the flood mechanism. This action has been evaluated through the flood risk assessment work and remedial works to address the flood risk at this location have been developed and are presented in section 5.3.

2. Howth South West Defence Code HWW, Figure 1.4 & Appendix C2 (technical)

There are several actions categorised as high and a number as urgent along this defence length, see Figure 1.4 for location. Some of the actions are to investigate flood paths and a number are in relation to the condition of walls and suggest repairs should be undertaken. They include:

- **OA1, 3 & 4** which have been highlighted as requiring action in the form of repairs to cracking and undermining of the wall, particularly OA3, which suggests the wall is cracking and undermining and the action has been highlighted as urgent, see Appendix C2, Photographs C2.4, C2.6 & C2.7. In the short term the works along these units could consist of some concrete underpinning at length 3 and concrete repairs and re-pointing at other locations. However, implementation of any of the long term options recommended in section 5.3.4 for Howth South West would address these concerns.

- **OA1, 2, 10, 11 & 12** which have been highlighted as requiring action in the form of investigating possible flood mechanisms through openings in the wall and over the wall, see Appendix C2, Photographs C2.4, C2.5, C2.8, C2.9 & C2.10. These have generally been given a high priority. All have been investigated as part of the final flood risk assessment and alleviation measures developed and presented in section 5.3.4.

- **OB 9, 13 & 17** are identified as requiring action in the form of repairs to the walls, see Appendix C2, Photographs C2.11, C2.12 & C2.13. OB 9 and 13 have been classed as urgent, as severe cracking has been noted at these locations. While none of the above provide a flood risk, the main issue here is one of health and safety in that should the wall and hence bank fail there is a road located above which could be at risk. Actions - The surcharge on the wall should be investigated and concrete repairs to the cracks undertaken, pending more detailed long-term stabilisation works. Options to address these issues have not been included in chapter 5 of this report.

5.3 FINGAL COUNTY COUNCIL AREA.

5.3.1 BALDOYLE ESTUARY OPTIONS

The options for this area extend northwards from Baldoyle Town around the Baldoyle Estuary to the existing road that leads to the Portmarnock Golf course (Chainage 1630 to 4633).

Several locations along this extent require different options, many of which are ‘soft engineering’. The main issues addressed by these options are:

- Reducing the risk of still water and wave overtopping onto the existing main arterial carriageway running from Baldoyle to Portmarnock. The crest levels of existing
and/or new embankments will be raised to give sufficient freeboard for wave action and future sea level rise.

- Increasing the drainage capacity and water storage facilities at the northwest section of the estuary, adjacent to the Portmarnock Roundabout.
- Repairing, replacing existing masonry coastal walls and raising the crest levels

Each location and its options will be described in more detail below.

At this stage, options are not considered to protect the road leading to the Portmarnock Golf Course, as only the road is liable to flooding. The road levels along this section at one location are low, but rise up again to meet the golf club grounds, which are at a higher level and are not at risk of flooding. Along the road there is one property located at the entrance to the golf course, which would be at risk of flooding during more extreme tides.

An option has however been developed (Location 6) to consider a potential flood path from the golf course and along the access road to the residential properties in Portmarnock. This option has been described in more detail below.

**Location 1 – North of Baldoyle Town Centre (Chainage 1630 to 2293)**

The options for this area seek to improve the existing low lying flood defences, which lie along the Coast Road just north of Baldoyle Town. These defences comprise of a shallow grass bank with a slope of 1 in 5 and a crest level of 3.56mODM. At the southern side the bank connects into a high concrete wall just north of Baldoyle Town centre and into a wide vegetated area that contain a few residential properties further to the north. The Coast Road running behind this grass bank is the main arterial route between Baldoyle and Portmarnock. This route is busy throughout the day, so flooding of this road would cause considerable disruption to the local residents and businesses.

**Option 1 – Bermed Earth Bank**

This option consists of a bermed earth bank, on the seaward slope. The option contains a small toe berm at a level of 2mODM and at larger berm of around 2.5 metres at a level of 3.25mODM. The objective is to reduce any potential wave overtopping, which on extreme tides could cause significant flooding of this part of the road. The use of a bermed defence allows the design crest level of the earth bank to be kept to a minimum and a lower level than would be required with a traditional earth bank. The required crest level for this structure would be 4.1mODM. The reason for this is that waves will be forced to break over or onto the berm, which greatly reduces the wash energy and run-up seaward of the crest. The slopes should be constructed at 1 in 2 reducing the possibility of slips, and visual impact on the area.

It is intended that the bermed bank will be blended into the existing vegetated area, just to the north. Whilst the profile footprint of the bank is large, some 14m, it is felt that this bank will present a more environmentally sensitive option, than that of a more hard defence such as a wall. It will reduce wave reflections over a vertical structure and may encourage the growth of the existing saltmarsh in the area locally surrounding it.

The capital cost (including VAT) for this option is estimated at €365,000.
Option 2 – Earth Bank

Similar to Option 1, above, this earth bank is styled in the more traditional sense, and does not have a berm down its seaward slope. In order for this defence to be as effective in reducing wave overtopping as that of Option 1, the crest level of the bank is required at 4.4mODM. Although this raising of the bank will reduce the visual aspect into Baldoyle bay from the sea, it does reduce the overall footprint of the structure to 11m.

As with Option 1, the earth bank will be landscaped into the existing vegetated areas to the north and it is may help to encourage saltmarsh growth within the local area.

The capital cost (Including VAT) for this option would be €300,000.

Option 3 – New Sea Wall

This option consists of a new reinforced concrete sea wall with a crest level at 4.25mODM. The new vertical structure could have an influence on the foreshore in this area through increased wave reflections and hence scour during periods of high and extreme water level. It is interesting to note that that the foreshore fronting the walls to the south consists of shingle, with not saltmarsh and bed levels are much lower. The wall has therefore been buried sufficiently deep in the event that beach levels fronting the new structure dropped in the future. In addition to help minimise this risk some rock scour protection has been placed along the front of the new wall. This rock could also be covered over with topsoil, vegetation and new turf, on completion of the works to maintain the grassed natural of the area.

The southern end of this new wall would tie into the existing sea wall, which runs northwards from Baldoyle Town. Whereas at the northern end, the sea wall would tie into the existing vegetated bank.

The capital cost (Including VAT) for this option is estimated at €450,000.

Details of the works required within Location 1 are presented in the drawings 9M2793 – 100 to 101.

Location 2 – South of Mayne River (Chainage 2593 to 3011)

Location 2 starts at the northern end of the wide vegetated area (progressing north from Location 1) to the Mayne River. At the northern end of this vegetated area there are two residential properties within its boundaries, backed by the main carriageway, and each has threshold levels of 2.7mODM. During the February 2002 event this area became inundated and both the properties and road behind were flooded. Just beyond the location of these houses, where the vegetated area ends, the road is protected by a set of gabion baskets, with a crest level of 2.5mODM. To the seaward side of the gabions exists a wide expanse of saltmarsh, which would greatly reduce wave action on this frontage. The footpath level along the gabions is around 2.6mODM and effectively forms the defence in this area.

From the end of the gabion baskets to the Mayne River existing a masonry wall, which protects the arterial carriageway, with a crest level of around 3.5mODM. This wall does
not provide an adequate level of protection and would require raising. Indeed during the recent event of the 28th October the defence was not overtopped but the road adjacent was still flooded. This was noted to be due to water leaking through its joints and as such the overall structure is considered to be in a poor state of repair. It is not considered that this wall could be raised to the required level without significant rebuilding and improvement works and it is recommended that it be replaced.

**Option 1 – Earth Bank and Replace Existing Wall To Mayne River**

The perimeter of the existing vegetated area surrounding the residential properties consists of vegetated banks which are in a poor condition and are considerably lower than is required for this area. This option proposes reconstructing the existing earth banks, and increasing their crest level to 4mODM reducing the flood risk to the properties and the road. It is believed that during February 2002 these properties were also effected by water entering through their septic tanks, and therefore in order to protect the properties further, is recommended that they have non return valves fitted to all their drainage sewage outlets.

Along the length of the vegetated area to the south of these properties wave overtopping is not a major problem, as the wide expanse of land to the rear will soak up any overtopping water. The main flood risk will occur when the still water level exceeds the defence and direct inundation will occur. The new earth perimeter bank will start in the middle of the existing vegetated area. The ground levels to the south of this are sufficiently high for there to be no flood risk.

The rebuilt earth bank should protect both the residential properties, and as a consequence the road running adjacent to them. To further increase the flood protection, the earth bank will run around the perimeter, and in front of the existing short length of gabions which run just to the north of the vegetated area. During the February 2002 flood event this area was a low spot in the existing flood defences, which contributed to the inundation of the residential properties and the road.

The existing masonry wall leading northwards to Mayne River will be removed and a new recurve reinforced concrete wall with a crest level of 4mODM, will be put in its place. This wall will not replace the existing gabions, which will form the landward toe of the new embankment. It is therefore proposed to provide a new wall only over the length of the existing wall. This new earth bank will overlap sufficiently with the new retaining and flood wall structure.

Details of this option are shown in drawing numbers 9M2793 - 110

The capital cost (Including VAT) for this option is estimated at €1,300,000.

**Option 2 – Earth Bank and New Wall replacing Gabions and Existing Wall to Mayne River**

This option commences in a similar way to option 1, with a reconstruction of the earth banks that run around the perimeter of the vegetated and residential properties. However, unlike Option 1 the earth bank does not continue over the length of the gabions. Instead the new recurve concrete flood wall will commence over the length of the gabions, with a crest height of 4mODM and continue north to Mayne River. Once
this wall has been constructed, the earth bank will tie into the new wall to complete the
flood defences along this section of the coast line.

Details of the works required for option 2 within Location 2 are presented in the drawings
9M2793 – 111.

The capital cost (Including VAT) for this option is estimated to be €1,550,000.

Location 3 – North of Mayne River (Chainage 3074 to 3378)

The existing flood defence along this location is a shallow vegetated earth bank, with a
crest level of 2.8mODM, which runs up to the Coastal Road. It is not known if this section
of road did flood in February 2002, however, the road and ground levels would suggest
that this area is low lying enough to have been at considerable risk then, and again in the
future.

Option 1 – Earth Bank

This option proposes to construct a new earth bank over this location and tie it into the
natural vegetated earth defences, to the north and also the hard defences to the south
at Mayne River. The earth bank will have 1 in 2 slopes and a crest level of 4mODM. It
is not expected that significant wave action will exist here, nevertheless small freeboard
is included to all for modest wave action, shrinkage cracks and settlement.

As with location 1, it is considered likely that the bank will help to encourage the
establishment of new saltmarsh surrounding this area.

The capital cost (Including VAT) for this option is estimated to be €400,000.

Details of the works required within Location 3 are presented in the drawing 9M2793 –
120.

Location 4 – North Western End of Baldoyle Estuary (Chainage 3964 to 4174)

At this location there is an existing masonry wall which forms the boundary to the low
lying Coast Road (with road levels of 2.3mODM), and the saltmarsh on the seaward
side. The wall just stops short of the vegetated earth area to the south. This leaves a
gap which flood waters can pass through when tide levels are sufficiently high as
occurred during the February 2002 event, flooding the road. It is also believed that the
wall, as with the wall at Mayne River, is not impermeable and allows water to seep
through it on extreme tides, which provides an additional flood mechanism at this
location. On the seaward side of the wall, there is a water storage area and an existing
dilapidated drainage outfall, with a flap valve in very poor condition. FCC have indicated
that this out fall serves a very small localised catchment in this area, which included
some field drains from the adjacent field. The main flood issue in this area will be the
inundation through still water level rather than through wave action.

Option 1 – New Earth banks, new flood water storage area and raise road levels.

Initially this option was developed as two separate options, however it is now considered
that both should be combined but as a phased approach.
Phase 1 of this option considers the construction of an earth bank at a level of 3.75mODM to prevent ingress of tidal waters during extreme tides while at the same time creating a water storage area on the landward side. The earth bank would extend from the vegetated area to the south across the gap at the start of the masonry wall and cut across the corner of this area to tie into the wall to the west of the Portmarnock Bridge.

At present there is a small water storage area between the drainage outfall and the wall on the seaward side, the condition of which is very poor. The outfall from this area to the estuary, whilst flapped, is no longer functional and tidal water inundates it on all tides. This storage area is connected to a small localised drainage system which services the adjacent low lying area. This option uses the existing drainage system, and creates a second larger area for drainage water storage behind the new earth bank. The outfall will be replaced and extended beneath the new earth bank. A new Tideflex outfall valve would be installed on the new outfall. Rock will be placed on either side of the new outfall to prevent scour and undermining of the new earth banks.

The idea behind this option is to make a storage area for surface water runoff from the small localised system, at times when the outfall is tide locked. In addition, the current masonry wall should be repointed and refurbished to improve its condition.

Phase 2 of this option concentrates on the road levels in the vicinity of the roundabout at the junction behind the masonry wall, which are particularly low, with levels at around 2.3mODM. During the February 2002 flood event this area flooded considerably, and this in the main part is due to the road levels becoming lower in this area. This option requires the raising of the existing road levels to around 3mODM at the roundabout, with the levels falling away to meet with the existing road levels approximately 50m away, and upgrading the drainage gullies in this area.

The added benefit of this above and beyond that of simply undertaking phase 1, is that the water levels in the storage area would need to get to a level considerably higher than would be required with the existing road levels, before surge charge of the system and over spill onto the road occurred. This phase could be brought into use within 5 to 10 years after completing phase 1.

The total capital cost (Including VAT) for this option if carried out in one contract now is estimated to be €1,075,000.

If undertaken in a phased approach the estimated capital costs are as follows based on 2004 rates.

Phase 1 – New embankment, outfall, storage area and repairs to masonry wall - €345,000
Phase 2 – Raise road and roundabout - €765,000.

Details of the works required within Location 4 are presented in the drawing 9M2793 – 130.
Location 5 – Southern End of Portmarnock (Chainage 4174 to 4633)

This location is at the most northern part of the Baldoyle Estuary and is located between the Portmarnock Bridge and the road, which leads down to the Portmarnock Golf Course. Due to its location at the top of the estuary and because of extensive expanses of saltmarsh and grassed recreational areas, which front the area, it is not considered to be widely susceptible to wave action. Any wave action will be restricted by the fetch length within the estuary and the level of the saltmarsh and grassed areas.

The main flood risk threat will be through the inundation of still water levels. The existing masonry wall, which continues round from Location 4, bounds the existing carriageway, and is protected on the seaward side by a very wide grass area, with levels of around 2.8mODM.

Option 1 – New short walls and raise ground levels

This option localises the flood risk protection to the gaps in the existing walls. There are two pedestrian gaps along the existing wall protecting the road and the southern parts of Portmarnock. These gaps present a flood risk to the main arterial road behind, leading to Portmarnock town centre.

Therefore, it is proposed to close these gaps, by raising the ground levels locally and building new masonry walls, to match the existing walls, across the gaps. The new wall crest levels will match the existing masonry wall and are around 3.75mODM, and the crest of the ramped ground levels should be at approximately 3.5mODM. The raised ground levels will be graded in such a way to allow wheelchair access, as well as pedestrian access.

At the eastern end adjacent to the golf club access road, there exists a public house whose car park is low and was flooded in February 2002. Indeed this presents a possible flood path into the hinterland. Therefore at the location where the existing masonry wall finishes, it is proposed to extend a new earth bank around the public house and adjacent buildings and tie into an existing high bank at the top of the golf club access road. The crest level for this new earth bank should be 4mODM.

Details of this option are shown in drawing number 9M2793 – 140.

The capital cost (Including VAT) for this option is estimated to be €475,000.

Option 2 – New Earth banks

This option maximises the use of soft engineering, and links in with the existing earth banks that already protect the road leading south to the Portmarnock Golf Club. Therefore this option is a continuation of that earth bank and should be built to have a crest level of 4mODM.

The earth bank will continue around the perimeter of the existing public open space and tie into the existing concrete walls at the north west corner adjacent to Portmarnock Bridge. The crest level of the bank can reduce to 3.75mODM over the frontage of the open space, since more overtopping over this part could be permitted. However it would need to rise in level again as it approached the road near the bridge. The bank will
reduce the flood risk, not only around the public open space, but primarily to the road behind it and also the public house and many properties beyond the road which are at risk from a 200 year event now and more so in the future.

The capital cost (Including VAT) for this option is estimated to be €735,000.

Details of the works required for this option are presented in the drawings 9M2793 – 141.

**Location 6 – Southeast End of Portmarnock**

Location 6 is located at the most northern part of the Baldoyle Estuary. Parallel to the road leading to the Portmarnock Golf Club is an existing vegetated earth bank, which forms the boundary between the Coast Road and the saltmarsh on the seaward side. The crest of the earth bank decreases from 4.52mODM at the west end of the club access road to 3.40mODM at the boundary of the Portmarnock housing estates with the golf course. The earth bank truncates just south of the entrance of the Golf Club. South of the Portmarnock housing estates the earth bank has several drainage outfalls which extend through the earth mound and are not flapped. These drainage outfalls provide local drainage to the road leading to the golf course but during high tides the road can also flood by this path from the estuary.

The flood defence is not considered to be widely susceptible to wave action, since it is located at the end of the estuary where the wave action will be restricted by the fetch length within the estuary and the bed levels. The main flood risk threat in this area is the inundation through still water level.

Flooding can take place over the crest of the existing earth bank adjacent to the club access road at the southern end and through the drainage outfalls in the earth bank. In addition the earth bank ceases to exist on entering the Portmarnock golf club and over several lengths of coastline large volumes of water could inundate the golf course during an extreme event. Under these circumstance water could flow back from the south of the club access road and the golf course to the Portmarnock housing estates. These flood paths have been established and will be cut off by the proposed option.

**Option 1 – New earth bank, new road ramp and raise earth bank**

This option is subdivided in three parts.

Part 1 of this option proposes the construction of a new earth bank perpendicular to the club access road at the boundary of the Portmarnock housing estates with the golf course. This new earth bank will prevent flood water from flowing back from the Golf Course to the Portmarnock housing estates. The earth bank will have 1 in 2 slopes and a crest level of 3.75mODM. This part will link in with the new road ramp (part 2) on the club access road.

Part 2 of this option concentrates on raising the road level, by constructing a new road ramp, at the junction of the above mentioned new earth bank with the already existing earth bank parallel to the club access road. The road ramp will have 1 in 12 slopes and a crest level of 3.40mODM. The road ramp prevents flood water from flowing back from
the southern part of the access road and links in with the existing earth bank that already protects the road leading south to the Portmarnock Golf Club.

The third and final part of this option is the proposal to raise the crest level of the existing earth bank parallel to the access road to a level of 3.75mODM.

The total capital cost (Including VAT) for this option is estimated to be €615,000.

**Further Investigation**

In addition to the flood risk identified and addressed by the options presented above, an additional possible flood risk could exist through the small stream which discharges into the north end of the Baldoyle estuary under the Portmarnock Bridge. Assessment of the flood risk and collection of data with respect to this stream was not requested as part of this study. However, it is felt necessary to point out that there still could exist possible flood paths from the river into the back of the Portmarnock properties in this area. It is recommended therefore that initially a level survey along the banks of the river and to the rear of the properties which back onto it, is undertaken and the flood risk further evaluated before any potential options are considered.

**5.3.2 Baldoyle Town Option**

The options for this area can be split into two locations. The first extends from the masonry/concrete wall just north of Baldoyle Town, across a number of properties which back onto the estuary and finishes just north of the church in the centre of town where a new high masonry wall has been constructed recently. The second extends south from south side of the church in Baldoyle Town towards Sutton (Chainage 803 to 1630) and finishes just north of the dart station.

**Location 1 – North of the Church**

Over this frontage there are a number of possible flood paths, some leading out onto the main road and most leading into the gardens of the properties which back onto the estuary. For the most part the defences are reasonable good, as new masonry walls have been constructed over the frontage as part of the recently completed north interceptor sewer project. However a number of gaps still potentially exist.

Over the length of coastline on which the private properties back onto the estuary, it is considered that the responsibility for alleviating flood risk to these properties lies with the owners. Most of the properties appear to have benefited from a new boundary wall which was built as part of the north fringe sewer project and these walls do provide a relatively high standard of protection. However, each property has an access gap opening out onto the shore, which could pose a possible flood path. This could easily be solved by placing either a small flood gate or dam board across the access gap, which the owner could close or install as required. One property does not appear to have taken advantage of a new boundary wall and may require some new flood wall strengthening measures in the future. It is estimated for the purposes of this study that a sum of around €105,000 including vat would be sufficient to provide a number of flood gates and undertake some general improvement works in the future.
Further south the property adjacent to the church has a door opening out onto the top of a slipway. Again this could pose a risk if wave action were to run up the slipway towards the property. Again this could be dealt with by installing a small flood gate or dam boards over the opening.

The other flood risk locations include

- gap in masonry wall to north of Baldoyle Town. Proposed to close gap and remove access steps.
- Gap in wall at location of North Fringe Sewer outfall. Proposed to install dam boards over this gap which can be left in place and taken out as access requires.
- Two gaps in secondary wall along road between properties and the church. Proposed to provide small flood gates which could be closed should the need arise.
- Gap adjacent to slipway which leads onto concrete promenade running along the front of the church. The gap is sealed off with a pallisade fence and a small wall is proposed inside the fence to prevent possible flood waters flowing back along the seaward front of the church.

It is estimated that the above ad-hoc flood measures, not including the private houses, could be put in place for around €55,000 including vat.

Location 2 – South of Baldoyle Church to Sutton Dart Station

The options along this section of coastline focus on closing the gaps in the existing wall and raising it locally in places. The main issues addressed by these options are:

- Reducing wave overtopping, through existing gaps in the primary and secondary walls, and onto the existing main arterial carriageway running from Baldoyle to Sutton.
- Maintenance of pedestrian and vehicular access to the foreshore.

Each location and its options will be described in more detail below.

Along this stretch of coastline a new masonry and stonework sea wall and concrete promenade, has been constructed in the last 2 years as part of the North Fringe Sewer project, with the older masonry wall retained at the back of the promenade. These existing walls are built to an average crest level of 4 to 4.4mODM for both the primary and secondary defences. A 4m wide concrete promenade exists between both of these walls, and a number of pedestrian gaps exist through both walls allowing access onto the promenade and then onto the beach. These gaps present weak spots in the overall defence.

At all locations these gaps are positioned in parallel with each other, effectively resulting in a flood path through the seaward wall, across the promenade and out onto the road and land behind. This flood risk will be especially prevalent during times of higher than normal wave action. Wave action along this frontage will vary depending on direction of wind and hence wave direction and also depending on the location with respect to the entrance to the Baldoyle Estuary. For example the location directly opposite the entrance will be the most exposed to wave action, and particularly so when waves approach from an easterly direction. Moving further north or south from this location the waves will be subjected to diffraction as they enter the estuary and the waves will be...
smaller. The effects of this process have been considered when assessing the flood risk and also in developing the options. Outside of this zone directly opposite the entrance the flood risk only arises at the gaps, where as within the zone opposite the entrance under certain conditions there is a risk that the new wall will also be overtopped.

This new wall is the only protection for the arterial coastal carriageway, running from Sutton in the south to Portmarnock in the North and the extensive number of properties, which exist to its rear.

The main option proposes to raise both the seaward and landward walls where necessary over the zone directly opposite the estuary entrance. The amount the walls need to be raised will vary depending on the location of the wall in relation to the mouth of the Baldoyle Estuary. In some cases the wall will not need to be raised, as the existing wall is to an acceptable crest level. The condition of the existing sea wall is good, as it was constructed within the last 12 months. However, the landward or secondary wall is much older and therefore may potentially require some maintenance and repointing to ensure it is water tight.

All of the seaward gaps will remain open, to allow the continual pedestrian access down onto the beach. Several of the gaps on the landward side will be permanently closed, and the others repositioned in alternative locations. Thus staggered access points will be provided onto the promenade and then onto the beach. Where gaps are repositioned a new 2m wide pedestrian gaps will be provided and a new swing shut floodgate will be installed. These gates will remain open at all other times, apart from during a flood warning at which point they will be close. This will allow continual access onto the promenade, and to the beach, as necessary.

To enable free draining of water from the promenade, the existing ground levels have a natural fall towards the gaps, which will mean that as water overtops the wall or the gaps, it will be encouraged to flow back through the seaward gaps from the promenade. Once the flood event has passed this water will simply flow back out through the seaward gaps.

At the access slipway, just south of Baldoyle town centre, there is a large gap, to allow free access up and down the slipway from the carriageway. This access must be maintained, but presents a route for wave run up on the slip and hence flood water to pass onto the road. It is proposed to use two alternative options to ‘close’ this large flood risk gap.

**Option A**

The first option involves narrowing the existing gap in the landward wall to 12m, and installing four 3m long Dutch Dam demountable flood defences. These flood barriers will remain collapsed until required during any flood event.

**Option B**

The second option is to again narrow the existing gap in the landward wall to 8m wide, and installing two sliding flood gates. These floodgates will meet at a demountable post halfway between the two walls. This post can be unlocked and dropped down for
access down the slipway and will be stored in a socket beneath its erect position. In addition to the sliding flood gates it may be possible to use ‘swing shut’ flood gates as an alternative to the sliding flood gates but these may be more cumbersome to use.

A potential third option is to re-orientate the existing slipway to run alongside the seaward wall, rather than perpendicular to it. The present situation has the potential to allow direct waves run up on the slipway, through the gaps, and out onto the road behind. By moving the slipway parallel to the seawall and protecting it with a new masonry perimeter wall, the potential ‘rush up’ of waves could be negated. This option however would require major reconstruction work on what is a relatively new slipway and frontage and would also be costly. Therefore it is considered that it is not a viable option at this time and has thus not been considered further.

The capital cost (Including VAT) for this option with option A at the slipway is estimated at €725,000 and with option B at the slipway, €770,000.

Details of the works required are presented in the drawings 9M2793 – 200 to 220.

5.3.3 North Howth Options

The options for this area extend northwards from the western pier of Howth Harbour to the entrance of Baldoyle Estuary (Chainage 0 to 2933).

Over this frontage the coastline can be divided into three distinct areas. The first extending from Howth Harbour to the New Apartments which have been developed adjacent to and on the seaward side of the railway line (chainage 0 and 1263). The hinterland over this length is protected by a concrete promenade and set back wall and also by a short length of sand dunes and set back wall adjacent to the apartments. The second area extends from the apartments to the end of the high ground further west (chainage 1263 to 1970). Over this length the hinterland is high and most properties are set back on higher ground on the crest of coastal cliffs. However a number of properties are located at a slightly lower level and more near the foreshore and these are protected by high masonry and concrete walls as appropriate. The final area extends from the end of the high ground to the golf club at Gush Point (chainage 1970 and 2933). The hinterland over this length is lower and is protected primarily by sand dunes and secondarily by property boundary walls and an old sea wall much of which is now buried by the dunes. Much of these beach dunes are vegetated at the crest with marram grass, although they are susceptible to erosion and shift along their front face during extreme events.

The most significant issue along this frontage is one of coastal erosion, particularly over areas 2 and 3. Whilst most of the area is not at significant risk of flooding at present, continued erosion could change this situation in the future. From discussions with local residents, it is believed that the sand dunes along area 3 did not exist some 20 years ago and that the coastal defence back then was a masonry wall, which is now buried by the dunes. However, in recent times increased erosion of the front face of the dunes has been noted and they are becoming narrower. This project whilst investigating the flood risk as it exists with respect to the current conditions, has not investigated the geomorphologic processes that are at work in this area. This would require a specific coastal evolution and geomorphological study, which is beyond the scope of this current project.
Nevertheless, a number of options have been considered along this frontage in the context of minimising further impact on and thus helping to maintain the current defences. Furthermore consideration is given to improving the current boundary walls along the exiting properties and road in respect of flood defence.

The main issues addressed by these options are:

- Reducing flood water ingress into the set back properties along beach.
- Maintaining public amenity access to the beach and foreshore.
- Reducing dune erosion, where applicable, to provide natural flood protection to the area.

**Area 1 – Howth Harbour to Apartments (ch 0 to 1263)**

Over this area a promenade and high concrete wall at the back of the beach protects the DART coastal railway line, between Sutton and Howth. The promenade itself is protected by a concrete sea wall with a crest level of 3.3mODM, with promenade levels of 2.7mODM. The wall at the back of the promenade has a crest level of 5mODM.

At the extreme west of this section of coast, the promenade stops, with the back wall continuing along the line of the railway to chainage 1263. Over this area between the end of the promenade and the apartments the back wall is fronted by low level sand dunes, which meet the wall just west of the end of the promenade and which becomes considerably wider moving west. The level of the dunes around the toe of the wall, are approximately 3mODM. Flood risk evaluations of this area have shown the defences along this length to provide an acceptable level of protection and as such no flood risk exists. Therefore at present no flood alleviation options are proposed.

The location where the low sand dunes meet the railway wall near the promenade should be monitored, as this is the most vulnerable spot along this length in terms of coastal erosion.

**Area 2 – Area of High Ground**

Over this length of coastline the general hinterland is high and there are few flood related issues. Instead the main problem would be one of erosion and coast protection and as such most of the frontage is protected by masonry and concrete walls built along the toe of the cliffs. Behind the walls are several residential properties, many of these are set up on the crest of the cliff, some 20m above the beach level. The properties do have accesses down to the beach. For those properties located on the cliff crest there is no flood risk. Two properties however are located closer to beach level on the front side of the high ground. Both have a relatively high masonry wall fronting them and both have access openings onto the beach which could results in a potential flood paths. The risk of flooding in both cases would be localised to the houses in question and as such no options to address these individual properties have been considered in this report. To improve flood protection the properties in question could consider installing a flood gate across their access paths to the beach and in addition they should monitor the condition of their defence wall and the beach levels fronting the defences.
Area 3 – High Ground to Golf Club (ch 1970 to 2933)

Over this length the hinterland is protected by sand dunes fronting individual property boundary walls/defences. It is believed that these dunes have deposited within the last 20 years and now cover an old masonry seawall which used to be the coastal defence. During the February 2002 flood event the dunes prevented significant flooding along this length but were nevertheless severely damaged during the storm. In addition a number of low spots exist through the dunes at several locations which allowed ingress of flood waters through the dune system to a number of access gaps behind.

Currently the dunes are between 3.5m and 4.5mODM at the crest. The low spot levels are mainly due to pedestrian accesses across the top of the dunes. Most of the properties along this length have access gates or gaps leading onto the shore and low spots exist at most of these locations created by repeated pedestrian movements across the dunes to the foreshore. These furrows have the potential to allow flood waters to flow through to the road and properties behind. In addition there are a number of accesses leading out onto Burrow Road behind the properties. One of these is a large vehicular access gap which has a significant gap cut through the dune system. Flood water did escape through this gap in February 2002 and out onto Burrow Road although the flooding was not significant.

Whilst the main form of defence is the dune system, this is integral with the property defences and as such some measures can be considered to help maintain the integrity of the dunes and improve the protection offered by property boundaries. Therefore a number of options have been considered and have been broken into two options, each of which will require varying maintenance, management and resources. In addition to these options it is recommended that a detailed coastal evolution and geomorphological study be undertaken across this region to investigate the issues more fully and further develop appropriate coast protection options for the area as necessary. This is discussed further later.

Options to Maintain Primary Defences (Dune System)

The dune system is the primary defence along this length and is the best form of defence provided it remains intact. However, there is considerable evidence of erosion along the front face and to a lesser extent over the crest. The erosion along the front face is primarily due to wave action during stormy conditions, whereas the crest erosion is mainly due to pedestrian activity.

Options to address the front face erosion of the dune system in the longer term could include,

- Offshore breakwaters
- Fishtail groynes
- Beach renourishment
- Sand dune management system

In reality it is likely that an appropriate scheme will involve a combination of some or all of these.
However, any such scheme would require a detailed geomorphological study to investigate the present sediment movements in the region and also any impacts the proposed options might have on the region and further afield. Such investigations are beyond the scope of this study and it is recommended that they are carried out so that a better understanding of the processes in the area can be made which will aid the development of the most appropriate option to safe guard this area in the future. The costs associated with an appropriate scheme are likely to run into millions of euro and the cost of an appropriate investigation study likely to be in the region of €250 to 350K, including for detail bathymetric survey work and modelling (including vat). Whilst detailed cost estimates for such options have not been evaluated here it is recommended that an allowance of at least €0.85 to 3.1m (including vat) be made in any future cost budgets to undertake appropriate investigations and works should the need arise.

Nevertheless, a number of short to medium term measures can be implemented to help maintain and encourage the dune system growth. In particular measures can be put in place to reduce recreational erosion. These measures would involve some form of management system and might include:

- Fencing
- Board walks
- Marram grass planting
- Dune feeding (moving sand around)

Fencing could be used to restrict access across these dunes and help direct pedestrians through controlled gaps, which could be changed from time to time. Additional sand trap fencing could be erected at existing gaps and extending out from the front face to encourage the build up of sand both on the crest and on the front face. Marram grass could be planted across the dunes and in the fenced off low crested regions to further help sand to build up and the dunes to stabilise and grow. Further erosion is like to occur during storms and by recreational users, nevertheless the process would require ongoing management to be effective and the repair of damaged or removed fencing as required.

Pedestrian access could be maintained through specific gaps, like the one out to Burrow Road, in the middle of the dunes. However many residents have direct access on to the dunes from their garden and at these locations low spots are clearly evident. The residents may not wish to be directed to specific access points and so a series of access points in the form of suspended timber walkways could be constructed to allow access from the residential properties to the beach. These walkways will go over the crest of the dunes and be supported by timber posts and columns. These walkways would help prevent user erosion.

During an extreme event in October 2004, it was noted that the front face of the dunes was heavily eroded as a result of severe wave action. Whilst these options will maintain the existing dunes from regular minor storms and weather occurrences, they will not remove the risk of extreme events damaging the integrity of the sand dunes.

It is estimated that a programme of dune management works could be implemented over a number of years for the sum of around €85,000.
The results of this management could be monitored and conclusions drawn as to whether it was proving beneficial or not and this could help build the case for a much more detailed geomorphological study and the investigation of longer term options. Before any sand dune management works are implemented a small design study should be undertaken to investigate the appropriate location and layout of the works.

**Options To Improve Secondary Defences**

Options along this stretch options to improve the secondary boundary wall defences could involve localised flood protection to close access gaps leading to properties and out onto Burrow Road, which are generally located directly opposite low areas in the sand dunes. These flood protection measures would take the form of flood gates or demountable systems which would only be put in place by the property owner when needed. The flood gates across access paths out to the Burrow Road would however fall under the operational response of FCC. This response would be triggered by use of the flood forecasting system developed as part of this study.

The use of temporary and demountable defences could take the form of pallet barriers, dam boards or mobile dams. These flood defences require a significant amount of resource management to mobilise and demobilise.

Flood gates, depending on the gap to be closed can either be slid or swung shut. In terms of the flood gate required for the access to Burrow Road, which is 5m wide, a central post to support the flood gates would be required if the gates were of swing shut type.

These options would be effective in the short to medium term provided the dune system remains intact over that time. However, these may need to be re-evaluated following continued erosion of the dunes and new more substantial forms of flood defence may be required on the back edge at that time. This could take the form of a new sea wall, or a beach regeneration scheme.

There are approximately 19 gaps along this frontage, the majority of which lead into private properties. Of the 19, possibly 2 are access gaps which are likely to be maintained by FCC. One is a large vehicular access gap leading down to the beach from Burrow Road. It is recommended that a sum of approximately €560,000 including vat should be allowed for if new flood gates were to be installed at all gaps. Of this approximately €70,000 including vat should be allowed for to deal with the two access gaps.

5.3.4 Howth South West Options

The area considered over this frontage extends from the eastern end of the private properties on the seaward side of Sutton Cross (Chainage 0), east along Greenfield Road and then south east along Strand Road for approximately 700 metres until the ground levels rise sufficiently high to be free from coastal flood risk (Chainage 1100). The main issues along this frontage which need to be addressed are:

- The poor condition of the rubble revetment and crest level of the revetment along Greenfield Road. The lowest crest level of this revetment is approximately
2.86mODM and is considered to provide a standard of protection of less than 1 in 10 years. This revetment was considerably overtopped in February 2002.

- The land drainage pipes through revetment which have been installed to help drain surface water build up at the lowest point in the region which occurs at the junction of Greenfield and Strand Road. These are currently blocked preventing free drainage onto the foreshore.

- The poor condition and level of the seawall running along Strand Road and access gaps in that wall. In general the crest level of this wall is around 3.4 to 3.5 mODM and raised to between 4 and 4.3mODM over the last 250m. In respect of condition the coastal inspection had identified that repairs are required to much of this wall which suffers from cracks and in places scour along the toe.

A number of options have been considered and have been broken into two lengths. These lengths include:

- Chainage 0 to 450, over the length of the existing rubble protection.
- Chainage 450 to 1100, over the existing seawall along Strand Road.

For Chainage 0 to 450 three options have been considered and these include:

1. New rock revetment with concrete crest wall on seaward side of existing footpath. New slipway access with flood gates and new outfall chamber at drainage pipes (drg no 9M2793 – 300 & 301).

2. New rock revetment with concrete flood wall set back behind existing footpath. New slipway access with flood gates and new outfall chamber at drainage pipes (drg no 9M2793 -310 & 311).

3. New rock revetment with set back flood wall along Greenfield Road. New slipway access with flood gates and new outfall chamber at drainage pipes (drg no 9M2793 – 320 to 322).

For Chainage 450 to 1100 two options have been considered and these include:

4. New raised concrete seawall with rock scour protection along the toe. New slipway. Beyond Chainage 850, the existing masonry wall to be repointed and raised slightly to a uniform level (drg no 9M2793 – 330).

5. Repaired existing seawall and/or new existing seawall with rock scour protection along the toe and a new set back flood wall with provision of promenade facilities. New slipway. Beyond Chainage 850, the existing masonry wall to be repointed and raised slightly to a uniform level (drg no 9M2793 – 340 & 341).

For the complete frontage any of options 1, 2 or 3 can be combined with options 4 or 5 to provide a composite and uniform defence and reducing the risk of flooding considerably from less than a 1 in 10 year event to an event of greater magnitude than and 1 in 200 year return period.

A more detailed description of each option is presented below together with an estimate of the capital cost of each. The following text should be read in conjunction with the drawings mentioned above which can be found in Appendix G.
Option 1 – New Rock revetment and crest wall.

This option considers the replacement of the existing rubble protection along the location of Greenfield Road with a new formal revetment to prevent the risk of future coastal erosion. In addition it is proposed to construct a new RC crest wall at the back of the revetment and on the seaward side of the existing footpath.

The new revetment would have a crest level of 3.5mODM, a 1:2 slope and consist of primary rock armour in the range 0.25 to 1.5 tonnes. The toe of the revetment should be buried below the existing beach level and consist of a minimum of three rocks >= 1.5 tonnes. The existing beach profile should be reinstated over the toe on completion. The armour layer would be placed on a small underlayer of rock which in turn would be placed on a suitable geotextile. The new crest wall would have a crest level of 4.25mODM and should have a re-curved front face to help deflect any wave run-up over the revetment slope and crest, see Drawing Numbers 9M2793 – 300 & 301.

A beach access exists around Chainage 100, which allowed vehicular access to the foreshore. This will need to be maintained for use by FCC works department to maintain the existing or new structures and also for emergency vehicle access to the coast. It is proposed to construct a new concrete slipway with a 1:8 slope and edge walls to tie the revetment into on either side. The toe of the new slipway should extend below the existing beach level and the beach should be reinstated. In addition short concrete skirts should project down into the beach from the deck slab to prevent undermining should the beach levels drop under storm conditions. To ensure adequate access it is proposed to make the new slipway 3.5m wide. There would also be a requirement for a flood gate at the top to control wave run up under storm conditions. Due to the width of the proposed slipway it is proposed to provide two swing flood gates which can be closed onto a central support. It is proposed that the gates be left open under normal conditions and only closed when a flood warning is received. The central support can be removed when access is required to the beach, however it is recommended that it be left in place during normal conditions to act as a traffic barrier and hence restrict vehicular access to authorised vehicles only. This set up would maintain pedestrian access at all times.

At approximate Chainage 350, there exists two large concrete drainage pipes through the existing bank and rubble protection. The seaward side of these pipes open out onto the beach with no outfall chamber and are not flapped. At present they have been blocked with timber boards and are almost submerged in sand and shingle. Drainage through the pipes is therefore restricted to a slow seepage. On the landward side a drainage ditch has been cut into the ground from the road at the junction of Greenfield and Strand Roads, to allow any build up of surface water on the road to drain towards the pipes and out onto the beach. Levels at the road end of the channel are around 2.5mODM falling to about 1.6mODM at the inlet to the pipes. It is believed that the current channel, which also acts as a small storage pond, has managed to contain storm water run off in this area, however no analysis in terms of catchment runoff has been undertaken as it is considered to be beyond the scope of this project.

Considering the need to maintain this outfall, it is proposed to improve its efficiency by providing a new concrete outfall chamber on the seaward side with non return flap valves fitted to each pipe. To achieve this, the existing concrete pipes would need to be extended slightly and a new head wall and outfall chamber constructed within the
However a potential problem with the outfall chamber is the build up of sand and shingle within the chamber, due to wave action, which eventually would prevent drainage through the pipes as the flap could become blocked preventing it from opening. Regular maintenance would therefore be required to remove the shingle and keep the flap free from build up. To help minimise this maintenance it is proposed to have a fairly long (2.2m) chamber and provide a number of shingle filter traps or deterrents. These include:

- Ensuring the armour stones in the top layer of the revetment are placed in front of the end of the outfall chamber and above the invert level. This way the stones will help to prevent wave driven shingle from being washed into the chamber, although this will not completely prevent the problem but it will reduce it.
- Placing timber dam boards across the chamber approximately 0.8m back from the front edge. These dam boards should extend the full height of the edge wall and would help to catch additional shingle which has been projected over the rock at the front. To maintain drainage through the boards it is propose to cut several small holes, approx. 125mm diameter, into the bottom two rows of boards. This will maintain drainage but reduce the quantities of shingle which can be blown through the boards and into the rear chamber.

Whilst these measures will help reduce the build up, they will not stop it completely, and maintenance will still be required to clean out the chamber. Removal of the timber boards will help to make this job easier.

In addition to the new outfall chamber, the existing drainage channel could be widened to provide additional storage capacity during tide locked conditions. The storage pond shown is indicative only and had not been developed through runoff or hydrological analysis.

With this option it is proposed to close the informal access to the beach at Chainage 0 and allow access to the beach only via the new slipway. This reduces the need for an additional flood gate and beach access structure. A new footpath should however be provided behind the new wall between Chainage 0 and the new slipway, which will still allow pedestrians access to and from Greenfield Road at Chainage 0. If Option 1 connects to Option 5 at Chainage 450, then a floodgate will be required across the footpath. This would not be required with connection to Option 4.

The estimated capital cost of Option 1 is €3,530,000 including VAT.

**Option 2 – New Rock Revetment and Flood Wall Landward of Existing Footpath.**

As with Option 1, this option considers the replacement of the existing rubble protection along the location of Greenfield Road with a new formal revetment to prevent the risk of future coastal erosion. The difference with this option is that the proposed new RC crest wall would be set back behind the existing footpath rather than immediately to the rear of the revetment crest. The advantage being that the amenity in respect of view by those persons who use the footpath is less obstructed. In addition setting the wall back further from the revetment would result in a slightly lower crest level for the new flood wall of 4.0mODM, a reduction of 0.25m from Option 1. The only exception to this would be between Chainage 0 and 100, where it is suggested that a similar construction to
Option 1 should be used. The reason for this is to prevent the need for two additional flood gates which would be required at Chainage 0 and also at Chainage 100.

The ground levels along most of this section are above 3mODM, however from change 300 to 400 the top of the existing ground levels are below 3mODM. It is therefore recommended that in that area the ground levels are built up slightly and the new revetment should have a crest level maintained at 3.5mODM over the full length. At the rear of the new rock crest a small concrete edge detail would be required to segregate the fines from the larger rock voids. The revetment should have a 1:2 slope and primary rock armour in the range 0.25 to 1.5 tonnes would be required. The toe of the revetment should be buried below the existing beach level and consist of a minimum of three rocks $\geq 1.5t$. The existing beach profile should be reinstated over the toe on completion. The armour layer would be placed on a small underlayer of rock which in turn would be placed on a suitable geotextile, see Drawing Numbers 9M2793 – 310 & 311.

As with Option 1 a new vehicular access ramp/slipway would be constructed at Chainage 100 and similar modification made to the outfall pipes at Chainage 350.

With Option 2 it is anticipated that a flood gate would be required at Chainage 450, for connection to both Options 4 or 5 in order to maintain access across the footpath.

The estimated capital cost of Option 2 is €3,300,000 including VAT.

Option 3 – New Rock revetment with Flood Wall Along Greenfield Road

Option 3 is similar to that of option 2, however it is proposed to set back where possible the flood wall along the Greenfield Road in line with the location of the existing intermittent wall. This setup could also be used between Chainage 0 and 100, although a floodgate would be required at ch0 to allow access to the new footpath on the seaward side of the wall. The flood gates at Ch 100 at the location of the slipway could also be move from the top of the slipway to the gap in the new wall.

However, between Chainage 300 and 400, the wall could not be maintained along the road edge otherwise a flood gate would be required at the back edge of the drainage channel, which if closed on a storm surge tide, would prevent any surface water run off into the channel. Therefore in order to maintain some drainage capacity in this area for surface water run off from the road, there is a need to turn the wall back towards the seaward side of the grassed area. However, the wall would be kept as far back behind the existing footpath as possible. In order to achieve this, the inlet chamber to the pipes would have to be extended and rebuilt as well as a new outfall chamber similar to that proposed in Options 1 and 2.

The revetment proposed for this option would be the same as that for Option 2. However because the flood wall is set back much further from the crest of the revetment, i.e. it is not yet dependent on the revetment to ensure its integrity, it may be possible to develop this option in two phases. The first being the provision of the flood wall to reduce the risk of flooding. The second, say within 5 to 10 years, being the construction of the revetment to halt erosion and ensure the area is maintained for amenity use and also to safeguard the flood wall in the longer term. However, if possible it is recommended that both be implemented together or at least within a few years of each other to provide a complete and secure defence in this region.
As with options 1 & 2 a new slipway to maintain access to the beach at chainage 100 would be provided. At chainage 450 a flood gate would be required for connection into either of options 4 or 5, which extend beyond this point.

The estimated capital cost of Option 3, as a complete package, is €3,355,000 including VAT.

**Option 4 – New Concrete Seawall and Repointing of Existing Wall**

Option 4 is the first of two options proposed to improve the flood defence beyond Chainage 450. This option proposes to improve the defences along the line of the existing seawall. However, the existing sea wall is only about 3.45mODM and to provide a level of protection up to the 200 year standard recommended, the new defence would need to be constructed to a level of 4.4mODM. This would require a rise of around 1m over much of this frontage. It is not considered that this can be undertaken viably or effectively by raising the existing wall, which in places consists of a block work wall and in others a concrete wall which required some repair works.

Therefore it is proposed to remove the existing wall and replace it with a new more secure structure. Details of this wall are shown on Drawing Number 9M2793 – 330. The wall would have a recurved front face to further deflect waves impacting on the structure. The beach would need to be excavated down to a firm footing and placed on a layer of well compacted granular fill. At present no site investigations have been undertaken and so the condition of the ground in this region is not known. However, it is expected that the wall would need to extend to a minimum of about 1.5m below the existing bed level.

In order to protect the wall from scour in the future a layer of rock scour protection should be placed along the toe. This should be buried beneath the existing bed level and the beach profile reinstated. The rock should be placed on suitable geotextile to prevent the wash out of fines. The rock scour protection should be between 0.25 and 1 tonne in weight and be placed two layers thick on a core of compacted granular fill.

At around Chainage 450, the ground levels behind the existing wall and the road levels to the rear, are low, at approximately 2.8mODM. The levels rise along Strand road and at Chainage 600 the levels have increased to around 3mODM. Therefore between Chainage 450 and 600 the wall would stand some 1.6m high with respect to existing ground levels. This would obstruct pedestrian views across the bay. At Chainage 600 and beyond this wall the height would reduce to below 1.2m with respect to the ground levels and this would be more acceptable. If necessary some localised raising of ground levels between Chainage 450 and 600 could be undertaken to improve pedestrians view over the wall, although this would require a step down to the lower road levels.

At Chainage 575, there is an existing slipway gap. It is proposed that this be maintained and improved in a similar manner to the new slipway at Chainage 100. New walls would need to extend around the rear of the slipway and a new flood gate provided which could be closed when warnings are issued. Beyond Chainage 850, there is an existing masonry wall which is quite a bit higher than the adjacent wall and varies between 4 and 4.4 mODM. The wall is in reasonable condition, however it is suffering in places from scour at the toe. It is therefore proposed that the crest of this wall be broken out over its
complete length and raised to a uniform level of 4.4mODM. In addition where voids and cracks exist between the existing blocks, these should be pressure pointed. The scour toe protection should also be continued over the length of this wall to ch1100.

This option can be connected into either of Options 1, 2 or 3 as described earlier.

The estimated capital cost of Option 4, is €4,060,000 including VAT.

**Option 5 – Repaired/New Seawall with Set Back Flood Wall**

This option considers providing a new setback flood wall between Chainage 450 and 850. In this way the existing front seawall can be maintained at its original level of around 3.45mODM. By setting the wall back the overall level of the defence can also be reduced and the new set back defence level would be 4.1mODM, which is some 0.3m below that of Option 4. The new flood wall should be set back a distance of 6m from the existing seawall. In setting back the wall there is also the added benefit that a new raised pedestrian promenade can be provided which can be landscaped with suitable recreational features as required. To achieve this a new concrete slab can be provided between the new flood wall and tied into the top of the existing seawall via a new concrete cap. At this stage it is considered that the existing seawall can be repaired and maintained in the short to medium term, however it is likely that it will require replacement within the next 10 to 15 years. However to enhance its integrity during this time some rock scour protection should be placed along its toe.

Beyond Chainage 625 the existing grass verge between the seawall and the road comes to an end and the seawall runs along the edge of the road. Therefore there is no room to continue the set back flood wall in relation to the line of the existing seawall. Therefore it is proposed to construct a new sea wall seaward of the existing line. This way the set back flood wall can be maintained along the line of the Strand Road and a 6m wide promenade maintained over the frontage. The new seawall would be of mass concrete construction and built in a similar way to that of Option 4, with scour protection provided along the toe.

At Chainage 750 the existing seawall steps out again from the road, thus creating a verge which is currently used for parking. This then gradually converges back to the line of the road at Chainage 850. Therefore it is proposed that the new seawall be continued over this frontage and the set back flood wall maintained along the back edge of this verge along the road. Over this frontage in order to provide a suitably wide car park, the distance between the new wall and set back wall should be increased to 7m. This should provide sufficient room for a number of longitudinal parking spaces with room along the flood wall for travel, provided the car park is operated as a one way system. New flood gates would need to be provided at each of the entrance and exit location to the car park. Beyond Chainage 850, works similar to that described in Option 4 should be undertaken.

The estimated capital cost of Option 4, is €2,975,000 including VAT.
Summary of Option Costs

Table 5.1 – Overview of costs per option

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<th>Individual Option Cost €</th>
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</tr>
<tr>
<td>2 &amp; 5</td>
<td>2 – 3,300,000</td>
<td>5 – 2,975,000</td>
<td>6,275,000</td>
</tr>
<tr>
<td>3 &amp; 4</td>
<td>3 – 3,355,000</td>
<td>4 - 4,060,000</td>
<td>7,415,000</td>
</tr>
<tr>
<td>3 &amp; 5</td>
<td>3 – 3,355,000</td>
<td>5 – 2,975,000</td>
<td>6,330,000</td>
</tr>
</tbody>
</table>

5.4 Summary of Options

In this section a summary of the options listed above is presented. The costs outlined above are estimates of the capital expenditure for each option including VAT. However, other significant costs are likely to be required prior to reaching the construction stage. These costs might include such things as,

- Site investigation 5%
- Planning, legal, and compensation issues 4%
- Engineering Fees 5%
- Site Supervision 3%

At this stage in order to give a better overview of the total likely project costs to completion it is considered prudent to allow a percentage of the capital costs to cover these costs. The percentages above have been allowed at this outline stage and the summary table, Table 5.1, presented in this section includes an appropriate allowance based on these percentages to give a total likely cost per scheme.

Furthermore, at some locations a number of different options are available with varying costs. Firm recommendations as to which option should be carried forward at this stage has not been made, however the summary tables 6.1 and 7.1 provide a comprehensive summary of such things as costs, benefit cost ratios, environment issues, and priority in respect of location. In the summary table, Table 5.2, three total cost estimates have been carried forward and used to provide the benefit cost ratios presented in Table 7.1. These include the highest, medium and lowest cost of all the options developed for each location. From Table 5.2 it can be seen therefore that the total capital expenditure including site investigation and other issues lies within the range of €62,000,000 to €93,000,000.
6 ENVIRONMENTAL REVIEW

6.1 Introduction

This section presents a review of the potential environmental issues and impacts that may arise as a result of proposed flood defence options (or lack thereof) for the various flood areas within the study area. This section contains 7 paragraphs, the first of which provides an introduction to the project and the results that are presented. Paragraph 2 briefly describes the range of defence options based on the Engineering Report. Paragraph 3 describes the methodology used for the review. Paragraph 4 presents a brief summary of the baseline environment for each flood “compartment”. Paragraph 5 identifies the likely impact if no schemes are undertaken, whilst Paragraph 6 reviews and describes the potential issues and impacts associated with the various flood defence options. A summary and conclusions are presented in Paragraph 7.

6.2 Study Area

The extent of the project area is presented on Figure 1.1. The study area includes both the coastal boundaries and also river and canal boundaries over their tidal reach.

6.3 Proposed Options

The following provide a summary of the proposed options identified for the various flood compartments and areas.

6.3.1 Baldoyle Bay

Location 1 – North of Baldoyle Town Centre

Option 1 – Bermed earth bank.
Option 2 – Earth bank.
Option 3 – New sea wall.

Location 2 – South of Mayne River

Option 1 – Earth bank and new wall.
Option 2 – Earth bank and new wall replacing gabions.

Location 3 – North of Mayne River

Option 1 – Earth bank.

Location 4 – North Western End of Baldoyle Estuary

Option 1 – New earth banks, new flood water storage area and raise road levels.

Location 5 – Southern End of Portmarnock

Option 1 – New short walls and raise ground levels.
Option 2 – New earth banks.
6.3.2 **Baldoyle Town**

Option A – Dutch dam in sea wall gaps.
Option B – Sliding flood gates in sea wall gaps.

6.3.3 **North Howth**

No specific works are specified or currently required. However, options may need to be examined to address the front face erosion of the dune system in the longer term, including:

- Offshore breakwaters.
- Fishtail groynes.
- Beach renourishment.
- Sand dune management system.

6.3.4 **Howth South West**

For the complete frontage any of options 1, 2 or 3 can be combined with options 4 or 5 to provide a composite and uniform defence and reduce the risk of flooding considerably from less than a 1 in 10 year event to an event of greater magnitude than a 1 in 200 year return period:

Option 1 – New rock revetment and crest wall.
Option 2 – New rock revetment and flood wall landward of existing footpath.
Option 3 – New rock revetment with flood wall along Greenfield Road.
Option 4 – New concrete seawall and re-pointing of existing wall.
Option 5 – Repaired/new seawall with set back flood wall.

6.4 **Methodology**

6.4.1 **Introduction**

This section describes the method used for review of the potential impacts for the various schemes. This methodology does not extend into the detail of determining the impacts in a quantifiable manner, only identifying potential positive or negative effects, and potential issues.

The potential environmental impacts associated with both the options are identified through:

- Observations on site;
- A review of the existing data;
- Knowledge of and impact matrices related to other flood protection schemes.

An impact is determined based on the existing baseline environment and the alteration of any physical, chemical, biological or perceived characteristics of that environment.
6.4.2 Impact Appraisal

Where possible, beneficial and adverse impacts have been appraised based on their potential scale/magnitude, longevity and significance. Where potential adverse impacts were identified, possible mitigation measures have been defined. Where impacts were identified as irreversible these have been differentiated.

A subjective scale has been used to classify the potential significance of the impacts, using a seven point scale (from major adverse to major benefit), as shown on Table 6.1. The magnitude of each proposed impact is compared with the importance of the individual assets. The magnitude of impact is characterised as high, medium or low for both adverse and beneficial impacts, and its determination is based on the description below. The value of the features to proposed impacts is characterised on a five-point scale from international to low site-specific.

Table 6.1 - Derivation of Significance Criteria from Magnitude/Value Comparisons

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Value of Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>International/ National</td>
</tr>
<tr>
<td>High</td>
<td>Major</td>
</tr>
<tr>
<td>Medium</td>
<td>Major</td>
</tr>
<tr>
<td>Low</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Magnitude

The magnitude of the effect is the degree of change that it causes or is considered to cause compared to the baseline. In order to determine the degree (or magnitude) of change created by a certain effect, compared to baseline conditions, an indication of the existing baseline level and its variations (temporal and spatial) are determined. In addition, information relating to other anthropogenic effects that could occur on the resource in question from a necessary part of the determination of magnitude. However, it is the overall sensitivity of the feature to change, and how the feature is changed that predominantly factors in the identification of the magnitude of the affect. The sensitivity of a feature relates to the level of intolerance of the receptor to the effect being considered, or the degree to which the specific aspects that give the feature its value are altered. Table 6.2 provides a description of the 3 levels of quantification of magnitude with a general description of the meaning of each ‘level’ of magnitude as well as a description of its definition in terms of feature sensitivity.
### Table 6.2 - Derivation of Magnitude of the Effect

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Description</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>A significant change.</td>
<td>In ecological terms, the species/population is likely to be killed/destroyed by the effect under consideration.</td>
</tr>
<tr>
<td>Medium</td>
<td>Change that is noticeable.</td>
<td>In ecological terms, some individuals of a species/population may be killed/destroyed by the effect under consideration and the viability of a species population will be affected.</td>
</tr>
<tr>
<td>Low</td>
<td>Change which may only just be noticeable.</td>
<td>In ecological terms, some individuals of a species/population may be killed/destroyed by the effect under consideration but the viability of a species population will not be affected.</td>
</tr>
</tbody>
</table>

#### 6.4.3 Impact Characteristics

Based on the determined level of magnitude and the importance or value of the feature, the significance of the impact is then determined using the characterisation identified in Table 6.1. The basic definitions of significance (major, moderate and minor) are defined in Table 6.3.

Following the objective description of the impact, the impact can then be characterised in terms of its nature and magnitude or physical extent. The nature of predicted impacts would be described, as appropriate, using the following terms:

- Beneficial or adverse;
- Direct or indirect;
- Secondary;
- Short-, medium- or long-term;
- Permanent or temporary;
- Reversible or irreversible; and
- Cumulative.

### Table 6.3 - Terminology for Classifying and Defining Impacts

<table>
<thead>
<tr>
<th>Impact</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major beneficial</td>
<td>The impact provides a significant positive gain</td>
</tr>
<tr>
<td>Moderate beneficial</td>
<td>The impact provides some gain to the environment</td>
</tr>
<tr>
<td>Minor beneficial</td>
<td>The impact is of minor significance but has some environmental benefit</td>
</tr>
<tr>
<td>Negligible</td>
<td>The impact is not of concern</td>
</tr>
<tr>
<td>Minor adverse</td>
<td>The impact is undesirable but of limited concern</td>
</tr>
<tr>
<td>Moderate adverse</td>
<td>The impact gives rise to some concern but it is likely to be tolerable (depending on its scale and duration)</td>
</tr>
<tr>
<td>Major adverse</td>
<td>The impact gives rise to serious concern; it should be considered as unacceptable</td>
</tr>
</tbody>
</table>

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In general terms, it will be assumed, unless otherwise stated, that impacts are:

- Short-term during the construction phase (i.e. 18 months);
- Long-term during the operational phase;
- Local rather than regional; and
- Potentially reversible rather than irreversible.

6.5 Baseline Environment

6.5.1 Introduction

This section provides a brief summary of the baseline environment for each “compartment” or “scheme area”. Details used for this are based on a site visit, previous data collection, and other literature sources. Additional detailed data is presented in Appendix H1. Where available designated site synopses are presented in Appendix H2, however, due to an error on the Duchas website the NHA synopses cannot be obtained.

6.5.2 Baldoyle Estuary

Location 1 – North of Baldoyle Town

This area is located along the southern half of the Baldoyle Estuary, as shown in Figure 6.1. The shoreline is fronted by hard defences, behind which is a coast road linking Portmarnock to Baldoyle and Howth, backed by residential properties. There is a narrow promenade between two walls with a number of pedestrian access points to the beach. The inter-tidal beach is predominantly sand and gravel and there is no vegetation fronting the defences or on the defences themselves. As well as views across Balydoyle Bay, there are wide sea views of Ireland’s Eye and Howth. The area of Baldoyle Bay fronting this area is a designated Natural Heritage Area (NHA), Special Area of Conservation (SAC) and a Special Protection Area (SPA). Site synopses are present in Appendix F2.

Figure 6.1 - Location 1 Looking North and South Respectively
Location 2 – South of Mayne River

This location contains an area of high inter-tidal of Baldoyle Bay with a straight faced wall providing protection to the coast road immediately behind, as shown on Figure 6.2. A couple of properties are located behind the road, and the remaining land use is agricultural. There are no access points down onto the inter-tidal. The inter-tidal area is sandy and gravel. Saltmarsh vegetation and occasional trees and shrubs are located in the inter-tidal and immediate landward area. There are relatively extensive views across Baldoyle Bay and to Howth in the south. Views from the lower floor of properties are generally obstructed by coast protection walls. The area of Baldoyle Bay fronting this area is a designated Natural Heritage Area (NHA), Special Area of Conservation (SAC) and a Special Protection Area (SPA). Site synopses are present in Appendix F2.

Figure 6.2 - Baldoyle Bay Area
Location 3 – North of Mayne River

Similar in character to Location 2, this area also contains the outfall for the Mayne River, and is shown on Figure 6.2. This area supports a greater amount of saltmarsh vegetation as well as terrestrial vegetation. The Mayne River is a small watercourse that outfalls via a one way flap valve. The watercourse supports a low density and diversity of aquatic vegetation. There are relatively extensive views across Baldoyle Bay as well as Howth to the south. Views from the lower floor of properties are generally obstructed by coast protection walls, and also trees and shrubs. The area of Baldoyle Bay fronting this area is a designated Natural Heritage Area (NHA), Special Area of Conservation (SAC) and a Special Protection Area (SPA). Site synopses are present in Appendix F2.

Location 4 – Portmarnock Roundabout

This area lies in the far north west corner of Baldoyle Bay as shown on Figure 6.2. There are large areas of saltmarsh in the upper inter-tidal, which front a straight-faced wall behind which is situated the roundabout leading the coast road into Portmarnock. The roundabout is backed by trees and agricultural land, with occasional residential properties. A small watercourse outfalls via a one way flap valve. Behind the road it also contains a small storage area. Views are generally constrained by trees to the north and west, and the shrubs behind the inter-tidal saltmarsh, with more open views east toward Portmarnock and the upper areas of Baldoyle Bay. The area of Baldoyle Bay fronting this area is a designated Natural Heritage Area (NHA), Special Area of Conservation (SAC) and a Special Protection Area (SPA). Site synopses are present in Appendix F2.
Location 5 Southern Portmarnock

This area lies at the northern end of Baldoyle Bay as shown on Figure 6.2. It is fronted by a large area of saltmarsh covering the upper inter-tidal. This is backed by a large area of open land used for informal recreation, particularly by residents, with stands of trees and shrubs. Behind the open land is a wall behind which lies the coast road into Portmarnock and then residential properties. Residences are situated in front of the road. Views from the west look southward over the open land toward Baldoyle Bay, with more constrained views to the east due to established tree and shrub growth. The area of Baldoyle Bay fronting this area is a designated Natural Heritage Area (NHA), Special Area of Conservation (SAC) and a Special Protection Area (SPA). Site synopses are present in Appendix F2.
6.5.3 Baldoyle Town

This area is located at the south western edge of the Baldoyle Estuary, as shown on Figure 6.8. The shoreline is fronted by hard defences, behind which is a coast road linking Portmarnock to Baldoyle and Howth, backed by residential properties. There is a narrow promenade between two walls with a number of pedestrian access points to the beach as well as a narrow slipway. The inter-tidal beach is predominantly sand and gravel and there is no vegetation fronting the defences or on the defences themselves. As well as views across Baldoyle Bay and there are wide sea views of Ireland’s Eye and Howth. The area of Baldoyle Bay fronting this area is a designated Natural Heritage Area (NHA), Special Area of Conservation (SAC) and a Special Protection Area (SPA). Site synopses are present in Appendix F2.
6.5.4 North Howth

This northerly facing area contains a shallow sloping sandy beach backed by eroding sand dunes. The frontage and area is shown on Figure 6.8. This relatively thin strand of dunes vegetated by salt resistant plants is backed by a row of large residential properties each bounded by a wall. There are a small number of public access through the properties onto the beach, and access for most of the residences. These access points have resulted in eroded paths through the dunes. Views are generally north up the estuary with sea views to the north east. The area of Baldoyle Bay fronting this area is a designated Natural Heritage Area (NHA) and a Special Area of Conservation (SAC). Site synopses are present in Appendix F2.
Figure 6.8 - Baldoyle Town and North and South Howth Area
6.5.5 Howth South West

This area of coastline faces to the south west into Dublin Bay as shown on Figure 6.8. The shoreline consists of a sand and gravel inter-tidal area, backed by a seawall with revetment along the northern edge. There is a promenade and parking area behind the seawall, behind which lies a road and residential properties behind this. The inter-tidal area supports growth of seaweed. Views are across Dublin Bay, encompassing Bull Island and Dublin in the background. The inter-tidal and sub-tidal habitat fronting this area is part of the Bull Island Natural Heritage Area (NHA), Special Area of Conservation (SAC) and Special Protection Area (SPA). Site synopses are present in Appendix F2.

Figure 6.9 - North Howth looking East Along Dune System (2004 and 2005)

Figure 6.10 - South West Howth Looking South East along the Shoreline
6.6 DO NOTHING SCENARIO

6.6.1 Introduction

In this section, we identify whether any effects are anticipated in the future upon the existing environment and its assets. The major concern which underlines the purpose of the proposed coastal protection project is the issue of coastal flooding, and its various impacts upon the economic, social and environmental assets of the study area. The potential impacts associated with the various key areas are briefly identified in the following sub-sections.

6.6.2 Baldoyle Bay

The surrounding area of Baldoyle Bay is likely to be effected by flooding in the long term. In particular, a small number of residential properties would continue to be affected, and are likely to be increasingly affected (moderate adverse impact). Furthermore, the coastal road would flood during extreme events causing significant disruption to local traffic, inhibiting both residential and emergency access (major adverse impact).

No significant changes are anticipated in relation to the habitats within the study area, although there is a potential that the watercourse near the Portmarnock roundabout could over a long period of time become brackish in nature, however, it is the likelihood of the ingress of tidal waters that could affect the agricultural land behind the existing coastline, resulting in a loss to the agricultural asset of the area, but potentially increasing the area of saltmarsh within Baldoyle Bay.
6.6.3 Baldoyle Town

This area and frontage is protected by coastal defences, and consequently, the potential long term impacts would be dominated by flooding caused by overtopping. However, in the long term possible deterioration of the defences could result in potentially significant flooding events. Overall, impacts would mainly be related to the flooding of residential and commercial property (moderate adverse impact) and roads (moderate adverse impact), though the informal recreation asset of the promenade could deteriorate.

No significant long term changes are anticipated in relation to the nature conservation interests, or other aspects such as water quality.

6.6.4 North Howth

The area likely to flood is access points to the beach and roads (moderate adverse impact), consequently, this would continue in the long term. However, this area of shoreline is believed to be eroding, which is fairly clear on the dune system, and potentially further erosion could result in far greater flooding, with resulting impacts on properties and roads. Continued erosion would also be disastrous for this small dune system, but the causes are not known, e.g. whether it is due to recreational pressure, a change in coastal processes or sediment movements or a combination of those or other factors.

6.6.5 Howth South West

In the long term, the shoreline in this area would continue to experience flooding of the roads (major adverse impact) and subsequent impact on traffic and access. Potentially, long term deterioration in the coastal defences could result in far greater flooding with more serious impacts on residential properties (major adverse impact).

No significant long term changes are anticipated in relation to the nature conservation interests, or other aspects such as water quality within this area.

6.7 Option Appraisal

6.7.1 Introduction

This section identifies the potentially significant impacts associated with the identified options available for coastal and flood defence. The detail of each option is not available at this stage, however, a general indication of the key areas that may be affected can be presented based on the site visit, knowledge of the area, and other data obtained for this study. Where possible a determination has been made of whether an Environmental Impact Assessment (EIA) would be required for specific options.

Where a type of asset or physical function or long term, cumulative or in-combination effects are not described, this infers that no significant or noticeable impact is predicted. The current level of assessment is to ascertain the "key" issues likely for each scheme option, rather than a substantive and quantifiable assessment of each option.
Where relevant some options have been aggregated together, due in part because of the need for success in providing flood and coast protection for a flood compartment.

6.7.2 Baldoyle Estuary

Location 1 – North of Baldoyle Town Centre

All of the options would provide a sufficient standard of protection such that flooding would be prevented for extreme events up to a 1 in 200 year event. Consequently, flooding of the road and properties along this frontage would be prevented, thereby resulting in a moderate beneficial impact with respect to traffic and access, as well as to the local community and residents.

Due to the location of the works adjacent or within the Baldoyle Bay NHA, cSAC and SPA, it is likely that an EIA may be required for all options.

Option 1 – Bermed Earth Bank

Although this is a soft form of coast protection, the footprint of the bank would extend into the Baldoyle Bay NHA, cSAC and SPA. A loss of saltmarsh habitat would occur, albeit a very small percentage of that within the Bay as a whole. The loss of saltmarsh could potentially affect bird species for which the site is internationally designated. However, due to the proximity of the area to residential properties, footpath and road, the existing level of disturbance (assumed) may minimise the significance of this area for birds. Overall, it is anticipated that a minor adverse impact would occur, which would be slightly offset by the beneficial habitat created by the embankment.

Views from residential properties and the road could be obstructed by the defence due to a higher level than the existing situation. However, the obstruction would not extend far above the existing road level, and the soft landscaping would soften the character of the obstruction, consequently a minor adverse impact is anticipated.

Construction works would be minor in scale, with some traffic disruption, noise and other related disturbance, albeit for the short term. However, timing of construction could result in increased impact, particularly if it results in the disturbance to wintering wildfowl within the SPA.

Option 2 – Earth Bank

Similar impacts would be expected as those for Option 1. However, the footprint of the embankment is slightly less, resulting in a lesser, but similar in scale, impact on the saltmarsh habitat and designated site. This embankment would need to be higher so the obstruction to views would be slightly greater, but again similar in scale to the impact identified in Option 1.

Option 3 – New Sea Wall

The footprint of the wall would not extend noticeably within the Baldoyle Bay NHA, cSAC and SPA. Consequently, little or no loss of saltmarsh habitat would be expected, and no loss of feeding habitat for bird species and the designated interests, therefore, no impact is anticipated.
The raised wall would result in a visual obstruction of a similar magnitude to Options 1 and 2, albeit the height of the wall is slightly lower than for Option 2, however, the man made appearance of the wall is likely to result in a slight reduction in the visual amenity from the road and properties. Overall, a minor adverse impact is anticipated.

As with the other options, construction works would be minor in scale. Again, timing of construction could result in an increased impact, particularly if it results in the disturbance to wintering wildfowl within the SPA.

**Location 2 – South of Mayne River**

Both options would provide a sufficient standard of protection such that flooding would be prevented for extreme events up to a 1 in 200 year event. Consequently, flooding of the road and residential properties along this frontage would be prevented, thereby resulting in a moderate beneficial impact with respect to traffic and access, as well as to the residents.

Due to the location of the works adjacent or within the Baldoyle Bay NHA, cSAC and SPA, it is likely that an EIA may be required for both options.

**Option 1 – Earth Bank and New Wall**

Similar impacts would be expected as for Option 1 at Location 1. The existing interests are very similar, although the level of the embankment could be high in relation to the residences, though only from a ground floor outlook.

**Option 2 – Earth Bank and New Wall replacing Gabions**

Similar impacts would be expected as those for Option 1. However, the footprint taken for this option would be slightly less, due to the use of gabions along a stretch, resulting in a lesser, but similar in scale, impact on the saltmarsh habitat and designated site. This embankment would need to be higher so the obstruction to views would be slightly greater, but again similar in scale to the impact identified in Option 1.

**Location 3 – North of Mayne River**

**Option 1 – Earth Bank**

This option would provide a sufficient standard of protection such that flooding would be prevented for extreme events up to a 1 in 200 year event. Consequently, flooding of the road along this frontage would be prevented, thereby resulting in a moderate beneficial impact with respect to traffic and access.

Due to the location of the works adjacent or within the Baldoyle Bay NHA, cSAC and SPA, it is likely that an EIA may be required.

Similar impacts would be expected as for Option 1 at Location 1. The existing interests are very similar, although there are no residential properties that would be affected by the visual obstruction caused by the embankment.
Location 4 – North Western End of Baldoyle Estuary

Option 1 – New Earth Banks, New Flood Water Storage Area and Raise Road Levels

This option would provide a sufficient standard of protection such that flooding would be prevented for extreme events up to a 1 in 200 year event. Consequently, flooding of the road and properties along this frontage would be prevented, thereby resulting in a moderate beneficial impact with respect to traffic and access, as well as to the local community and residents.

This option would also prevent the tidal inundation of the agricultural land behind the road. However, there is insufficient information to ascertain whether the effects of this would be beneficial or adverse.

Due to the location of the works adjacent or within the Baldoyle Bay NHA, cSAC and SPA, it is likely that an EIA may be required for this option.

Similar impacts would be expected as for Option 1 at Location 1, as the existing interests are similar.

Location 5 – Southern End of Portmarnock

These two options would provide a sufficient standard of protection such that flooding would be prevented for extreme events up to a 1 in 200 year event. Consequently, flooding of the road along this frontage would be prevented, thereby resulting in a moderate beneficial impact with respect to traffic and access. In addition, the public house car park would also be protected from flooding.

Due to the location of the works adjacent or within the Baldoyle Bay NHA, cSAC and SPA, an EIA may be required for these options.

Option 1 – New Short Walls and Raise Ground Levels

The proposed footprint for this option would be on terrestrial land and is not anticipated to extend into the designated site area, consequently, no impact is anticipated.

Due to the low height of the walls and land raising, no alteration to the visual amenity or character would occur, and no impact is anticipated.

Construction works would be minor in scale, with some noise and recreational access being the notable issues albeit for the short term only. Timing of construction works could result in an impact due to disturbance to wintering wildfowl within the SPA, though this is considered to be unlikely.

Option 2 – New Earth Banks

Similar impacts and scale of impacts for Option 1 at this location are anticipated. However, due to the addition of the flood protection to the public open space, a minor beneficial impact would be expected on this amenity asset.
6.7.3 **Baldoyle Town**

These two options would close of the gaps in the existing defences thus preventing flooding occurring through the existing gaps. Consequently, flooding of the road and residential properties along this frontage would be prevented, thereby resulting in a moderate beneficial impact with respect to traffic and access, as well as to the local community and residents.

As none of the works are anticipated to take place within the designated site, it is unlikely that an EIA would be required.

**Option A**

The scheme would be undertaken within the footprint of the existing promenade, so no loss to habitats would occur, therefore, no impact is expected on the designated site and its interests.

Gaps for access would be provided, consequently no impedance would occur to recreational access and no impact expected.

The defences would be demountable, and therefore no visual obstruction or reduction in amenity would occur, except during extreme storm events, so no impact would be expected.

Construction works would be minor in scale, with some traffic disruption, noise and other related disturbance, albeit for the short term. However, timing of construction could result in increased impact, particularly if it results in the disturbance to wintering wildfowl within the SPA, however, this is unlikely.

**Option B**

Similar impacts and scale of impacts for Option 1 at this location are anticipated.

6.7.4 **North Howth**

No specific works identified or required at this stage. However, as part of any geomorphological studies in the future it is recommended that a detailed evaluation of environmental issues is undertaken in parallel.

6.7.5 **Howth South West**

Potentially some of the options are likely to require an EIA as they may extend into the Bull Island NHA, cSAC and SPA. Those options that remain alongside the designated site boundary without intruding into it are not likely to require an EIA.

All options would provide protection to the amenity, road, and residential properties along the Greenfield Road and Strand Road frontage, thus preventing the economic and social losses associated with flooding, as well as the impacts on access, traffic disruption, stress and other suffering within the local community and residents.
**Option 1 – New Rock Revetment and Crest Wall**

This option involves minor encroachment of the toe of the revetment and slipway into the designated site area. Most of this would then be covered by existing beach material. However, the incursion into the site boundary alone raises potential issues, however, the area of encroachment compared to the area of the designated site is extremely small, though could result in a limited loss of interest habitat, and subsequent loss of feeding area for wildfowl and waders. No detailed information is available regarding wildfowl and wader usage of the area that may be affected. However, due to the small scale of the loss and proximity to a recreational footpath, it is anticipated that a minor adverse impact may arise.

The existing frontage contains a footpath, which would be protected from flooding during extreme storm events. As the footpath is of local value and infrequently affected by flooding, this is considered to result in a minor beneficial impact on recreational amenity. This also includes the benefit of retaining slipway access for both recreation and maintenance/emergency access.

Due to the localised and limited extent of works (predominantly raising the revetment height), no noticeable change is anticipated to the shoreline or the hydrodynamic regime in the area, consequently, no impact is expected.

Due to the raising of the revetment by nearly 1.5m, views from residential properties set back from the defences may be obstructed, though view from the footpath would be obstructed unless some land raising was undertaken along the length of the footpath. However, the distance from the revetment and limited extent of the obstruction is anticipated to result in a minor adverse impact. However, further work regarding property levels would need to be undertaken to suitably quantify this potential impact.

Construction works could be kept to a minimal area of disturbance, affecting only the recreational asset of the grassy area and immediate area of the coastal defence line, though some potential traffic disruption may occur at times. Construction noise and disturbance (dust, visual amenity) would also be expected but not significant in scale or magnitude. However, if the works were carried out in winter there is a potential that associated works (noise, machinery, personnel) could disturb wintering wildfowl and waders within the Bull Island SPA. This could have a potentially significant adverse effect on the wildfowl interest of the designated site, resulting in a potential major adverse impact on the designated site and its context. However, timing the works outside the wintering period would almost certainly avoid this impact.

**Option 2 – New Rock Revetment and Flood Wall Landward of Existing Footpath**

This option is fairly similar to Option 1, however, there are some minor differences which are described below.

As the revetment is set back, there would be less or no incursion into the designated site area, consequently, no impact is anticipated on the designated site interest or habitat.

The footpath would not be protected, consequently, the same impact of the do nothing scenario would occur.
The height of the new revetment would be 0.25m lower than Option 1, consequently, that and the fact that views from the footpath would not be obstructed by the defence indicate that no impact is anticipated in respect of landscape and visual amenity.

**Option 3 – New Rock revetment with Flood Wall along Greenfield Road**

Due to the similarity with Option 2, the same impacts are anticipated.

**Option 4 – New Concrete Seawall and Re-pointing of Existing Wall**

This option would entail raising of the sea wall along a distance of around 400m. This would not result in encroachment into the designated site, or may entail the placement of rock below the existing level of sand that could therefore be reinstated. Consequently, no impact is anticipated on the designated site or its nature conservation interest.

Due to the large increase in height above the existing ground level (greater than 1.5m in places) localised raising would be undertaken to maintain pedestrian views. However, a large number of properties set back from the road would experience an obstruction to views from ground floor levels. Overall, this is anticipated to result in a minor to moderate adverse impact on visual amenity.

Construction works would be extensive and would result in the loss of width of the road and also recreational parking area, consequently, there would be traffic and access disruption during the works. Construction noise and disturbance (dust, visual amenity) would also be expected and could be locally significant in magnitude, however, this could be mitigated to some extent. The works would entail disturbance to the immediate shoreline adjacent to the sea wall, and if the works were carried out in winter there is a potential that associated works (noise, machinery, personnel) could potentially disturb wintering wildfowl and waders within the Bull Island SPA. These could have a potentially significant adverse effect on the wildfowl interest of the designated site, resulting in a potential moderate adverse impact on the designated site and its context. However, timing the works outside the wintering period would almost certainly reduce this impact, whilst the disturbance of beach during construction would cease as soon as works were completed.

**Option 5 – Repaired/New Seawall with Set Back Flood Wall**

Although this option predominantly entails the construction of a set back flood wall, there is a stretch where the sea wall would need to be built sea ward of the existing wall, consequently extending into the designated site. Because there is no detailed information of wildfowl and wader usage of the area, or other details relating to designated site interest, it is assumed that this would result in a potential moderate adverse impact.

This option would result in the creation of a 6m wide promenade, which would provide safe and enhanced informal recreational amenity and improved views across Bull Island and Dublin Bay. Overall, this is considered to result in a minor beneficial impact on recreational amenity, due to the relatively low level of use of the area for informal recreation.
Due to the localised and limited extent of works (predominantly raising the revetment height and only limited incursion into the sea), no noticeable change is anticipated to the shoreline or the hydrodynamic regime in the area, consequently, no impact is expected.

Due to the wall being set back, the wall height would only increase by a maximum of around 1m. This would result in a reduction in the scale of obstruction from residential properties set back from the road, however, not sufficiently to reduce any potential impact. Therefore, a minor adverse impact is expected to remain as identified for Option 4.

Similar impacts during construction would be expected to those identified for Option 4.

### 6.8 Summary of Potential Impacts

Table 6.4 and Table 6.5 present a visual summary of the potential impacts and key issues associated with each of the options across the study area, with regard to the Dublin Coastal Flood Protection Project.

The tables summarise the impacts described in Section 6. These impacts are based on general study area information (and knowledge of the area held by project personnel). Where possible the impacts have been quantified using a qualitative method as opposed to a quantitative method, therefore, much of the assessment presented in this document is based on assumptions regarding the proposed works and the potential impacts. Detailed information and assessment could alter the key impacts likely to be associated with each option, as well as the scale of the impact. Consequently, it should be borne in mind that this ‘assessment’ presents an indication of the key issues.

One aspect of determining the significance of an impact and the effects of an option are determining whether it is likely that a formal Environmental Impact Assessment would be required to carry out each specific option. As legal advice cannot be given by ourselves, we have indicated in Section 6 which options may be likely to require an EIA and which may not. In order to formally determine this requirement a screening opinion should be sent to the appropriate authority (e.g. the planning departments of Fingal County Council or Dublin City Council). However, in the summary tables the likelihood of an EIA being required is most likely when a moderate adverse impact is expected as a result of an option in its operational phase, or if there is a potential impact upon designated nature conservation sites (e.g. NHA, cSAC and SPA). Construction phase impacts are not likely to influence this requirement, except where a designated site may be effected, and whereby this effect cannot be avoided for example by undertaking works outside of the winter period.

### 6.9 Conclusions

On the whole, most options identified as possible methods of protecting areas within Dublin and Fingal County from coastal flooding are generally acceptable in environmental terms, especially when balanced against the social (and economic) costs of flooding and the extensive disruption it can cause. There are impacts associated with the options, particularly landscape, which are likely to be affected by increased heights and scale of coastal defence options. However, mitigation measures can be identified
and expanded on at more detailed stages to minimise the scale of these impacts. Sensitive design having the most influence upon this!

Although many options appear to affect or potentially affect designated sites of national and international importance, this in itself does not indicate that these options are wholly unacceptable. As well as the necessity for flood protection some options are identified with health and safety aspects in mind, which can make such impacts on designated nature conservation sites acceptable. In addition, the assessment used to determine the effects on designated sites has been precautionary due to the lack of area specific information as well as information regarding changes to coastal processes, and could therefore reduce or be avoided through further assessment and identification of possible mitigation measures.
Table 6.4 - Summary of Potential Impacts on Fingal County Sites

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## Table 6.5 - Summary of Potential Impacts on Fingal County Sites

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7 PUBLIC INFORMATION CAMPAIGN

7.1 Format of Campaign

Being able to engage with the population of Dublin City Council and Fingal County Council in a positive and productive manner was an early objective of the Dublin Coastal Flooding Protection Project. The trauma suffered by members of the public during flood events such as February 2002, can only be overcome by a combined programme aimed at:

a) raising the awareness of the public to the risks posed by flooding;

b) promoting the options available to protect properties at risk;

c) raising awareness amongst the public of the responsibilities of the City and County Councils;

b) promoting dialogue among residents groups to hear their concerns and expectations; and

e) promoting the project.

The initial format proposed for the public information campaign consisted of a number of elements and included,

- Leaflet Survey
- Web-site
- Public Information Campaign

The construction of a web site was an early deliverable, as was the leaflet campaign, although delivery of the information leaflet and questionnaire was delayed until early 2004. Examples of the leaflet and questionnaire are included in Appendix F.

7.2 Leaflet Survey

A public information leaflet was prepared and delivered to members of the public via a leaflet drop during April 2004. The leaflet was accompanied by a questionnaire, the purpose of which was to gauge the public perception of the emergency response in relation to the February 2002 event, as well as to obtain additional confirmation of the details surrounding that event. Offering a prize draw encouraged public response. A copy of the leaflet and questionnaire is included in Appendix F.

7.3 Web-site

Although the content and format of the web site was substantially completed early on in the project, delays were experienced as a result of technical concerns raised by Ordnance Survey Ireland (OSi) on the use and integrity of maps and aerial photographs.

Access to the site itself is via the web address http://www.floods.eu.com. It is intended that the site will become part of a wider portal addressing flood mitigation initiatives undertaken by Dublin City Council and Fingal County Council.
7.4 Public Information Meetings

Wider consultation with members of the public will be considered once the development of options has reached the stage whereby comments can be invited in a constructive manner. The format of the meetings is currently under discussion, although an open forum or exhibition is considered to offer the most flexible approach. Meetings will be scheduled in the four main areas.

In addition to the proposed open exhibition format, meetings have been held with residents at Sandymount and Ringsend on 1st and 2nd June 2004 respectively. The meetings were arranged by Dublin City Council in response to the concerns raised in the completed questionnaires received by DCC. The meetings were well attended and have provided a valuable means of engaging the public in the consultation process.

7.5 Responses

Responses to the questionnaire were received by Dublin City Council over the months April and May. A total of approximately 1900 leaflets and questionnaires were delivered. From this a total of 292 questionnaires were received. This represents a return of 15%.

An analysis of the questionnaires has been undertaken by Dublin City Council. The results have been summarised and are included in Appendix F.
8 CONCLUSIONS & RECOMMENDATIONS

Conclusions

The following main conclusions can be drawn from the DCFPP:

1. Dublin City Council and Fingal County Council have commissioned the Dublin Coastal Flooding Protection Project (DCFPP) to Royal Haskoning. The work that has been carried out between May 2003 and April 2005 has resulted in this Final Report.

2. The DCFPP has been initiated in direct response to the extreme tide and flood event that was experienced across Dublin City and Fingal County during the 1st February 2002 and forms a major constituent of Dublin City’s work on the SAFER project as well as Dublin Flooding Initiative.

3. The primary sponsoring authority for the DCFPP is Dublin City Council. Furthermore Fingal County Council (FCC), the Department of Communications, Marine and Natural Resources (DCMNR) and the Office of Public Works (OPW).

4. The main objectives of the study were:
   - undertake a strategic examination of the risk to Dublin from coastal flooding;
   - identify appropriate strategies and policies to combat and manage risk;
   - identify short term urgent works on experience gained from the February 2002 event;
   - identify medium to long term options to reduce and / or manage risk;
   - learn from the past.

5. On 1st February 2002 an exceptionally high tide occurred in Dublin, which resulted in significant flooding throughout parts of the city and in Fingal County. It resulted in the highest water level ever recorded to date of + 2.95 m ODM. The main factors contributing to this event were a high spring tide as well as a significant surge. Rainfall and river flows were not significant contributing factors. A thorough analysis of the event was carried out.

6. An extensive data collection exercise was undertaken as part of the study and the data collected catalogued for future use. Data collection among others has been aimed at information on existing coastal defences, water levels, wave and meteorological data, topographical and bathymetrical surveys and historical reports of relevance. The data collection process continued throughout the project and is currently on going.

7. Regarding the existing coastal defences an asset condition survey was carried out collecting relevant data through site inspections, classifying the areas around the coastline in discrete defence units, entering and storage of recorded data into a database and preparation of a manual to facilitate use of the database. This database has been delivered to both DCC and FCC for their use.

8. To engage with the population of Dublin City and Fingal County in a positive and productive manner a public information campaign was carried out. The main elements included a leaflet survey, a web-site and a public information campaign at
various locations within the project area. With the completion of much of the project, significant steps in this respect can be further taken and a number of public information days are currently in planning. Furthermore workshops, stakeholder and focus group meetings were carried out.

9. A detailed analysis of mean sea level was carried out using actual historic data as well as a review of the latest international best practice. Based on this it was recommended that an annual average sea level rise in all designs of 4.15 mm/year be adopted to the end of this century. This includes an allowance of 0.3 mm/year for land subsidence.

10. To understand the significance of the February 2002 event and to provide a basis for preparing designs for flood defence, an analysis of tide records from Dublin Port has been carried out. Factors that were investigated were historical development of astronomical tide and of mean sea level, the occurrence of seiches and the main factors that result in surges. Part of the analyses focussed on the joint probability of extreme tides and surges. Furthermore the effect of river discharges on water levels (and joint probability) has also been investigated.

It was concluded that the February 2002 event was an extreme event having a return period in excess of approximately 60 years.

It also concluded that an additional unpredictable parameter requiring further investigation is the mechanism of seiches, which are noted to be a regular feature in Dublin Bay.

11. The DCFPP considered the interaction between fluvial and tidal components to assess the level of flooding and to arrive at design conditions. For this purpose various numerical models have been developed. These models are:
- SWAN: modelling of wave conditions, representing wave propagation in time and space;
- FINEL2D: tidal model, reproducing tidal conditions in two dimension across the project area;
- ZWENDL: river model, 1D hydraulic model for river calculations;
- AMAZON: overtopping model, 1D model which calculates overtopping discharges and volumes.

Furthermore use is made of the UK Met Office Forecast Models for the Irish Sea. This model provides 36 hour forecasts of water levels twice a day (at 2 am and at 2 pm) and provides the main boundary condition on the sea side. The other models have been converted to simplified models (matrices), which transfer these offshore conditions to nearshore conditions and eventually to conditions along the coastline.

12. A major deliverable of DCFPP is the tidal flooding forecasting system which will allow advance warning of potential flooding. The system comprises several elements, each of which contributes to the final forecast along the coastline. These are:
- Input from the UK Met Office Shelf Seas and Storm Surge models;
- Wave transformation matrices;
- Overtopping matrices;
- Water level prediction matrices;
- Tidal water levels from Alexander Pier Lighthouse tide gauge.

The output is given at 27 warning points along the coastline.
13. Within the flood forecast system, it is proposed to have a four-tier warning approach, with each tier getting progressively more serious: flood watch, Flood Warning A, Flood Warning B and Severe Flood Warning. Each of these levels is triggered using criteria for water levels and overtopping (rates and volumes). Initially default values will be used for all warning points. Through on site experience during future events and through detailed analysis these values will then be fine tuned.

14. The Flood Forecasting System will be installed on a server at the offices of Met Éireann. A second server will be provided at Dublin City Council to also allow access to the warning system by DCC. Apart from providing a user’s manual, the staff of Met Éireann and DCC involved with the early warning system will be trained to work with it.

15. The flood hazard along the coastline has been investigated within the DCFPP. This included an assessment of a 200 year event and an indication of the standard of protection offered by the existing defences. In follow on to this, indicative extents of flooded areas for an event with a return period of 200 years in the present day as well as in 2051 were also determined. These calculations have been carried out to provide basic estimates of flood damage for economic assessment and to justify risk reduction works proposed. Further elaboration of this aspect of flood risk will take place within the SAFER project. The flood risk assessment concluded that much of the Dublin and Fingal coastline falls below an acceptable level of protection which the project has concluded should be a 200 year event or greater. Should an event of this order of magnitude occur today significant areas of Dublin and Fingal would be at risk and considerable economic damage would result.

16. An overview of relevant policies applicable to Dublin has been provided. This overview has been given, benchmarking these against international practices. The various aspects of flood management policy have been categorised:
- Category 0: where there is no defined policy or documentation;
- Category 1: where there is some form of policy, but not documented as such;
- Category 2: where there is some form of documented policy;
- Category 3: where there is comprehensive policy that is fully documented.
Based on this, subsequently recommendations have been given regarding the various policy items (e.g. on climate change, flood warning systems, flood defence measures, operation and maintenance), indicating the advised scope, the advised “owner” and the advised “vehicle” for progressing matters.

17. Based on the current standard of protection, the current condition of the defences (visual inspection only), the flood hazard analysis and the design conditions (i.e. event with a 200 year return period), design options were given for the various stretches along the coastline and tidal reaches of the three rivers. The designs have furthermore been based on a design life up to 2031. A distinction has been made between urgent works as well as works for the medium to long term. For all options cost estimates have been given. The total cost of works to bring the defences up to an acceptable 200 year standard is estimated at €12m for FCC and €50m for DCC, or a total of €62m (low scenario). The maximum scenario is €93m. Furthermore the total costs of implementing a full Early Warning System is estimated at €2m. These costs do not include the cost of design fee, further site
investigation, structural inspection or environmental works, land acquisition, way leaves, but does include VAT.

18. An environmental review has been undertaken within the DCFPP. The review provides a summary of the baseline environment for all relevant areas and describes the potential issues and impacts associated with the various flood defence options. Furthermore recommendations have been made whether or not an EIA will be required. It is anticipated that overall the proposed options will have minor adverse impacts, however some options are likely to require a full EIA.

19. In Table 19.1 an overview is given of the project area, the current standards of protection, the current condition of the defences, the potential benefits that may be derived from implementing flood defence options, the options themselves, the costs involved, the main environmental impacts and a recommended priority for implementing the options.

20. Regarding the options, the following can be concluded:
- the options proposed for Fingal can generally be characterised as having a medium rated priority for undertaking the proposed works; the main consideration behind these are the reasonable height and condition of the existing defences as well as the limited benefits that can be achieved from implementing the works;
- the options for Dublin City Council can, with the exception of a few sections, generally be characterised as having a high priority; the main considerations behind these are the high benefits that can be derived from implementing the works as well as the beneficial benefit – cost ratios;
- Conspicuous sections in this respect are: Merion Gates (high risk, extremely beneficial benefit – cost ratio), Clontarf (high risk / major road, beneficial benefit – cost ratio) and the River Dodder and mid and lower sections of the River Liffey (relatively high risk, reasonably beneficial benefit – cost ratio).

Recommendations

The DCFPP has resulted in the following main recommendations:

1. Regarding the models used:
- Investigation into the mechanics of seiches should be carried out, to improve prediction of seiche effects.
- The accuracy of the surge prediction of the UK Met Office Shelf Seas model with respect to mean sea level should be investigated further.
- River modelling was undertaken only for the lower reaches of the Tolka, Liffey and Dodder. Furthermore calibration was difficult for extreme fluvial events and initial findings suggest that significant risk could exist on both the Dodder and the Liffey for such extreme events. It is therefore recommended to model the complete systems (Liffey and Dodder in particular) in order to obtain a better understanding of the influence of the rivers on (fluvial) flood situations.

2. Regarding the Flood Forecasting System:
- The forecasting system initially will be installed with default values for the triggers used to issue warnings. It is recommended that these are fine-tuned
over a period of approximately 1 year to allow appropriate actions as a result of the forecasts.

- The flood forecasting system currently focuses on coastal flooding. An integrated approach is suggested, combining fluvial as well as tidal forecasting and warning. In order to optimize the development of such an integrated warning system, a separate proposal has been made to provide (i) a framework for a fluvial warning system (main elements, criteria related to accuracy and reliability), (ii) required steps for the development of such a system and (iii) a pilot case study.

- Furthermore integration of contingency planning and the forecasting system is required, such that it is clear who is responsible, what phases can be distinguished, which actions need to be taken and when, and how can these actions be monitored effectively, thus providing a full Early Warning and Response System.

3. Regarding the design options for the various flood defences:

- The options have been detailed to a preliminary design level. Further detailing is required in order to allow for design optimisation. It is however important to support this with additional site investigations, these include: geotechnical, structural and environmental investigations.

- The designs proposed are generally straightforward. Although attention has been given to aesthetics, it is suggested to give considerable attention to this. Not only with respect to the individual stretches, but also to the combined plans that will be undertaken.

- Design life to 2031 in terms of flood defence has been considered. As a consequence economic justification has also been considered to this time scale. It has been seen that significant additional economic benefit is available if the design life were extended to say 2051. This should be considered against the minimal extra capital costs which would be required to bring the defence up to this design life.

4. Regarding Flood Risk

Whilst every effort has been made to obtain reliable level and flood path information for the flood risk assessment process, a number of locations require further data collection and assessment due to access restrictions and other issues. The areas include:

- Small stream at northern end of Baldoyle Estuary flowing under Portmarnock Bridge presents a potential flood path. Level information relevant to this stream was not available and further investigation is required to substantiate the risk and options proposed for this area.

- North Howth defences contain and depend on the existing dune system along that frontage. The flood risk has been evaluated based on the current level and extent of the dunes. It does not attempt to investigate or quantify the geomorphological aspects of the frontage and the effect of the potential reduction or loss of these dunes to flood protection, except to indicate that it would be of significant importance. It is therefore recommended that a detailed coastal evolution and geomorphologic study be undertaken to evaluate these issues and recommend appropriate long term coastal protection and hence flood defence options.

- ESB Poolbeg Power Station defence should be confirmed. Access restrictions at the time of the survey prevented detailed level information being obtained
along the Liffey Frontage. The levels should therefore be checked and the flood risk reviewed. Furthermore issues with respect to the water cooling system and its potential restriction during extreme events could result in the need to shut down the power station. This should be investigated further.

- Access restrictions on the left bank of the River Dodder prevented detailed defence levels being obtained in places upstream of New Bridge. These levels should be confirmed.
- Access restriction on the left and right banks of the River Liffey upstream of Sean Hueston Bridge prevent detailed defence levels being obtained in some locations. These should be checked.

5. Regarding the Liffey and Dodder
The River Dodder and to a lesser extent the River Liffey require substantial measures to deal with coastal dominated flooding. Fluvial flooding however is expected to be a major consideration. In defining measures it is therefore suggested to have an integrated approach, addressing coastal as well as fluvial flood risks. Furthermore it is suggested to investigate all measures dealing with flood alleviation in a phased approach: from a spatial planning point of view (what are the most important restrictions, what are opportunities), from an operational point of view (which operational measures can (or could) alleviate the situation) and finally from an engineering point of view (types of defences).

Regarding the first step: a tool that may prove valuable in this phase is the so-called water-opportunity-mapping, an approach developed in the Netherlands that has been successfully used internationally.

6. Regarding North Howth
Whilst North Howth along Burrow Road is not significantly at risk from flooding at present, this is mainly due to the presence of the existing dunes. These dunes are however showing signs of considerable erosion, particularly after storms. It is therefore recommended that a detailed coastal evolution and geomorphological study be undertaken to evaluate the coastal erosion issues in this area and consideration given to appropriate long term coast protection and flood defence options. In the short term a programme of sand dune management works should be implemented and managed over a period of a number of years to minimise current erosion impacts. These measures, through monitoring and management, would help justify or not the need for a more detailed investigation depending on the benefit they bring to the area.

7. Coastal database
DCC currently has the DCFPP Coastal Database. It is strongly recommended the most vulnerable locations are inspected and that the database be used on a regular basis. Not only will this allow timely taking of measures, but only through monitoring in time will thorough insight be obtained in the condition of the coastal defences.

8. Tide and River Guages
It is recommended that new tide and river gauges are installed around the coastline and within the rivers to aid future modelling and analysis work and for the benefit of future EWS developments.

9. Remaining activities of the DCFPP
With the completion of this report most of the work has been completed and delivered to DCC. The remaining activities concern holding public information sessions, final upgrade of the website and carry out the study tour.
REFERENCES

References are grouped by Chapter to facilitate ease of location.

Chapter 1

Chapter 2


Chapter 8


11.0  **Structural Engineering Appraisal of BJ Marine Buildings (see Volume 2, Section 4.8.2)**
PROJECT: BJ MARINE HOUSE

PROJECT NO. 07.237

DOCUMENT TITLE: STRUCTURAL ENGINEERING APPRAISAL OF BJ MARINE HOUSE

DOCUMENT NO: 07.237-RP-01

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STRUCTURAL ENGINEERING APPRAISAL OF BJ MARINE HOUSE
C O N T E N T S

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1.0 INTRODUCTION

1.1 General

Barrett Mahony Consulting Engineers (BMCE) were commissioned by the Dublin Docklands Development Authority (DDDA) to carry out a structural appraisal of the two redbrick buildings on Sir John Rogerson’s Quay.

These two buildings are the only two buildings located directly on this campshire beside the River Liffey. For convenience, the larger of the two is referred to as Building A, and the smaller one as Building B in this report.

‘The narrow gauge rails still evident outside the building are indicative of use by the Hibernian Gas Company (later the Dublin Gas Company) to offload and store imported coal for use in production of town gas at the nearby works in the late 1800’s. For the previous 30 years, the building was in occupation by a boat sale and repair company, who conducted their business there up to May 2006. It has remained vacant since then.’

The buildings may well date from the 1880s as this section of the quay was rebuilt between 1881 and 1884. Moreover, the granite quoins of the buildings are said to have come from Carlisle Bridge (now O’Connell Bridge) to which widening works were undertaken from 1879 – 1881.

Appendix A contains plans and elevations of the two buildings. These drawings indicate the cracking patterns of the walls and floors, and the locations of verticality surveys and moisture meter readings.

Appendix B contains photographs illustrating both generic and particular defects of the buildings (Appendix F contains the digital photograph files on CD).

The remaining appendices contain copies of the original construction drawings of the quay wall, a borehole log from a neighbouring site investigation, and Dublin City Council’s drainage plan for the area.

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2 Cross Sections of River Quay Walls, dwg ref. no. K.1205, Appendix C
2.0 OBSERVATIONS

2.1 Building A

2.1.1 General Description

This brick rectilinear building is approximately 76m long by 7.85m wide, and has a slated duo-pitched roof. There are two modern mezzanines on the inside, one to the east and one to the west.

The mezzanine to the east was used as office space by BJ Marine. It has 100mm deep concrete ground floor slab poured directly over the original cobbles. The walls of the office space are of blockwork at ground floor level, while studwork with ceiling joists over is used at the mezzanine level. Two steel beams span north-south over blockwork walls/piers with timber joists spanning east-west on top of them.

At the western end there are 4no. steel UBs spanning north-south with timber joists spanning east-west over them.

2.1.2 Roof

Description:
The roof is duo-pitched with a number of slate repairs having been carried out in the past. All the slates seem to be in place, although some of these are coming loose at the western end near the ridge tile.

The gutter on the southern elevation collects rainwater and discharges it via 6 rectangular downpipes that recess into the brickwork, giving an overall flush appearance to the wall. At the gable ends there is a parapet wall only 2 courses of brick high. Grass and moss are growing out of the western parapet, and the eastern parapet also has some vegetative growth present. The two courses of headers that comprise the parapet walls are constructed of purplish brick to match the brick quoins of the building.

Inspection of the north elevation of the roof was not available although it was noted that some sections of guttering are missing (the westernmost end and in-between the two doors to the north elevation), elsewhere the gutters appear to be full of grass and vegetation. Some slates at eaves level may be coming loose.

64no. timber trusses span north-south. Rafters are 230mm deep by 79mm wide with a 180mm deep tie beam of the same width. Lapping pieces connect the tie beam to the rafters with a simple timber bracket giving bearing support to the tie beam. The timbers appear to be of pitch pine. Every second truss has a 35mm diameter early steel tie rod which runs through the wallplate. A 50mm by 8mm hanger suspended from the top of the southern rafter supports the tie rod in the middle. All the tie bars are present in this building, though most are slightly bent. Boarding is 180mm wide and laid across rafters.
In general, the timber looks in bad repair primarily because its original whitewash paintwork is peeling off and is covered with soot. The paint is somewhat lumpy and powdery, and generally flaking off.

*Moisture Meter Readings:*

Moisture meter readings were taken at a number of locations where damp ingress was most likely e.g. at wall-plate/eaves level. Table 1 presents the results.

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**Table 1** Moisture Meter Readings (%H₂O) to roof of Building A

(refer to Appendix A for location plan)

Additional Moisture Meter readings are as follows:-

- Between B and M: Ridge beam 12.5 to 15; boarding 16; top of rafter 11; bottom of rafter 12, tie beam 13.5.
- Location I: Touch of woodworm on the wall-plate, lots of pigeon guano on top of walling over arch.
- Location E: Rafter bearing onto wrought iron beam 20.
- North east corner – bottom of rafter 30, wall-plate 20
- South east corner – bottom of rafter 22, wall-plate 15

From the results it can be seen that most of the readings are under 20%, which would indicate that there is little risk of dry or wet rot. The readings for the tops of rafters at eaves level are the exception, where the readings are predominantly in the low twenties. The timbers proved difficult to drill with a standard ¾" spade bit, and are thought to be in generally good condition.

Note that the moisture meter reading of 30% in the north east corner at eaves level can be explained by a leak in this corner of the roof. Though some timber replacement may well be needed in this area upon opening up, the moisture reading could be reduced by local repairs to the external slating and guttering.
2.1.3 Walls

General

The walls are predominantly in brickwork with quoins having rounded corners. The first five quoins from ground level are of granite, with the remaining quoins in five courses of purple coloured brick (note that the granite quoins are only four courses of brick high). The rest of the masonry is constructed of red brick in English garden wall bond with 3 courses of stretchers.

The red bricks are 230mm long and 70mm deep. It was possible to remove one brick from the interior, revealing a solid, wire-cut, production-line brick. Bedding joints are typically 15mm with vertical joints ranging from 10 – 15mm.

In contrast, the purple bricks are 230mm long by 75mm deep, meaning that the bedding joints for the quoins are typically 10mm deep. Closer inspection with a cherry picker inside the building, revealed that these denser purple bricks, which were no doubt fired for longer giving them their darker colour, have five holes through them – perhaps roughly equivalent to a modern engineering brick. Externally at eaves level, these purple bricks step out three times, jutting out by half a brick in all.

Quoins to the door jambs of the arched openings behind the sliding double doors are also of this purple brick, and have rounded corners too. The exception is the fourth quoin which is of granite (this granite stone houses the door locking mechanism from the inside). The depth of the arches spanning over the doors is 2 bricks thick. At the top of the arch the wall steps in by ¾ of a brick internally. Piers either side of arched openings are 530mm thick by 820mm long (2 and a half bricks thick by 3 and a half brick long). Elsewhere the walls are one and a half bricks thick full height.

At eaves level, there are two rows of bolts at 818mm centres, staggered top and bottom. These are presumably to tie in the sliding door rails. The top row has big square washers while the bottom row, running through the wall plate has circular plates.

All of the walls are white-washed internally, with the exception of the office spaces which have generally been painted. The windows are metal framed.
a) Northern Flank Wall

**Exterior:**
Access unavailable.

**Interior:**
This wall has 3 doors. D8 is crowned with a brick arch, while Doors D7 and D9 are larger openings with wrought iron girders bearing onto granite padstones over. Padstones are 570mm long by 530mm wide and 250mm deep. Girders consist of 10mm top and bottom plates with two side plates all joined together with four equal angles by rivets at 120mm centres. Angles are 75 x 75. There are also bolts through the side plates, staggered top and bottom at approximately 940mm centres, and acting like pipe spacers to prevent the side plates from buckling. These were confirmed to run through in the girder over D7 with a boroscope. The boroscope also confirmed that the ends of the girder had been infilled with brickwork in line with the pier jamb.

There are 14 courses of modern blockwork infill to Door D7. This is only across the western half of the opening. The eastern half seems to be covered in timber that may be associated with an original sliding door. At the right hand bearing of the girder of the Door D7 the brickwork seems to have lifted up by approximately 3.5mm, probably due to some corrosion of the wrought iron girder lifting the masonry up. Left hand pier above padstone: half a brick form the left there is a vertical crack. This could indicate the end of the wrought iron beam with some corrosion pushing the brickwork back.

There are two courses of brick infill above wall-plate and between the rafters.

The north east corner has significant damp ingress with black mildew growing on the white-wash. Paintwork pealing off as well as some brick facing flaking off. White efflorescence was noted on this brickwork where this flaked off.

To the right hand side of Door D8 there is severe rising damp / frost attack damage to the first 8 courses of brickwork.

Arched opening of Door D8 has a little mechanical abrasion visible, and some of the brickwork in the bottom left hand corner of its pier the facing has corroded away. One brick is missing at high level from this pier. At eaves level of Door D8 there are a number of bricks missing.

2 panels of modern blockwork fill Door D9 (again, 14 courses high). On closer inspection with the cherry picker, this wrought iron girder is not galvanised but seems to have a grey coloured primer that is flaking off. Over the primer is perhaps the same whitewash that is on the walls. The whitewash has completely flaked off. It is apparent at the granite padstone on the left hand side that corrosion is lifting brickwork. There is a crack running down the middle of the padstone.
As noted before, the four steel beams supporting the mezzanine at the western end have been cut into the northern wall by half a brick and bear directly on the masonry without a padstone.

**Verticality:**
A plumb line was used to evaluate the verticality of the wall, and the results are as shown in Table 2.

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**Table 2 Verticality Survey of North Wall, Building A (mm) (leaning inwards –ve; leaning outwards +ve)**

In general this wall is leaning slightly inwards at eaves level, save the central portion of the panel between doors D7 and D8, which is bowing outwards. None of the eccentricities are extreme for a 350mm thick solid brick wall.

**Cracks:**
Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). Vertical hairline cracks are present at regular intervals. These are presumably behind the rainwater downpipes to the exterior which act to reduce the wall thickness locally by half a brick. The likely cause of these tension cracks is due to thermal expansion in the absence of expansion joints or a more flexible lime mortar (note that the mortar appears to have ‘Roman’ cement, which does not tolerate expansion as well as traditional lime mortar).

There are also horizontal and vertical cracks beneath and to the side of the granite padstones due to the point loads from the wrought iron girders. Some of these cracks may also be due to rusting iron expanding and pushing the brick apart.
b) **East Gable End Wall**

**Exterior:**
Window W15 is a false window. There is a large steel container located in front of this gable wall making the inspection difficult, however it appears that there is only one small crack 0.5mm thick in the bottom left hand corner (see Appendix A).

**Interior:**
There is damp ingress in the north eastern and south east corners at eaves level. Also some paint and brickwork flaking off particularly at joints within the middle of the wall (in the corners where the damp ingress is most significant).

**Verticality:**
Due to access constraints, a verticality survey was not carried out on this wall.

**Cracks:**
Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). The two small cracks observed on this wall seem to be old, and do not appear to effect the overall structural stability.

c) **Southern Flank Wall**

**Exterior:**
6no. rectangular downpipes are recessed into this wall by approximately 120mm. There are 5 full height sliding double doors, each with two high level windows either side. The first, say, 12 courses of brickwork show a lot of mechanical abrasion. This abrasion is not a structural defect, but rather an aesthetic one.

Moving from left to right: Window W2 has a crack from its top right hand corner runs diagonally upwards and to the right; the cill of Window W3 has some spalling brickwork;

In between Doors D3 and D4 there are three decayed bricks at pavement level, second course up (the brick missing could have been an underfired brick as its facing seems to have crumbled away).

In the panel of masonry between Doors D4 and D5, frost damage and some efflorescence in first three or four courses is visible. To the left of the rainwater downpipe, there is some mechanical abrasion quite high up, just beneath the cill level of Winnow W9. To the left of window W10 there is a large metal bracket with fixings bolted through the masonry.

There is a rainwater downpipe between Doors D5 and D6. Two half bricks are missing to the right hand side of this where a new vent has been put in for a toilet. Window W12 has slight crack running diagonally downwards to the
right from the bottom right hand corner. There is a vertical crack running between Window W14 and W13, which appears to widen as it goes upwards.

*Interior:*
There is a vertical crack increasing in width as it goes upwards between windows W1 and W2. This is located directly behind a rainwater downpipe.

Doorway D1 is infilled with blockwork with a high level window and the double doors blocking the light from the outside. The middle two steel beams that support the mezzanine floor bear on to this blockwork wall. The left hand beam cuts in through the springing of the brick arch over the doorway. The beam at the extreme western end bears onto the window cill of Window W2, while the extreme eastern beam of this mezzanine floor bears onto window cill of Window W3. The mezzanine beams have also been cut into the northern wall.

Between Windows W3 and W4 behind the rainwater downpipe there is another crack that increases in width as it goes up the wall.

Arch over Door D2 has some mechanical damage visible to the arch’s soffit and also to the pier in the brickwork beneath the granite quoin.

There is slight vertical cracking between windows W5 and W6 behind rainwater downpipe.

The arch over Door D3 has more mechanical abrasion to the soffit visible. At Location K the wall panel steps out 48mm from underside of the wall-plate. On top of the wall-plate this step is only 16mm. It seems that the panel of masonry has been pushed out and that the tie bars are pulling the wall-plate back in. Tie bars run through the centre of the wall-plate

Between Windows W7 and W8 there is another vertical crack behind the rainwater downpipe.

At Door D4 on the right hand side of the springing of the arch there is a crack in a bedding joint (suspect some corroding metal).

A panel of masonry between Doors D4 and D5, first 3 courses exhibit frost and rising damp damage with the face of some bricks crumbling away and white-wash paint peeling off (more so over the joints). A vertical crack between Windows W9 and W10 is present, again behind the rainwater downpipe.

The arch over Door D5 has mechanical abrasion to its brickwork soffit.

Some damp ingress through the interior at eaves level in the south east corner.

*Verticality:*
A plumb line was used to evaluate the verticality of the wall, and the results are as shown in Table 3.
Table 3 Verticality Survey of South Wall, Building A (mm) (leaning inwards –ve; leaning outwards +ve)

This wall is leaning slightly outwards at eaves level. None of the eccentricities are extreme for a 350mm thick solid brick wall.

**Cracks:**
Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). Again, tension cracks are observed behind the external rainwater pipes. Windows seem to be a source of minor cracks, with the exception of the extreme eastern end of the wall which has a crack widening as it propagates vertically upwards – this may be due to some previous settlement of the gable-end wall and/or to thermal expansion of the wall itself.

d) **West Gable End Wall**

**Exterior:**
Brickwork on this elevation is generally in good condition with the exception of a crack in the bottom left hand corner. This crack narrows as it goes up the wall. There is a crack to the top right hand corner of the fourth granite quoin from the ground.

Some frost damage is visible in this wall, both at lower level and high up. A modern steel door has been fitted in the centre of this wall.

**Interior:**
This wall has a wall-plate bolted to it at window cill level to carry the joists for the mezzanine of this end of the building.

**Verticality:**
Due to access constraints, a verticality survey was not carried out on this wall.

**Cracks:**
Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). A minor crack in the bottom right hand corner may indicate some previous local settlement of this gable-end wall.
2.1.4 Floor

*Description:* 
The floor of Building A is generally cobbled. Limestone cobbles are approximately 110mm square. The floor slopes from the south down towards the Liffey to the north, presumably originally for drainage. A few cobbles are missing just to the left of Door D7.

The office space floor to the east is a 100mm dp concrete slab poured directly onto the cobbles.

The mezzanine floors at each end consist of 175x45 timber joists at 400mm centres bearing onto 254x102UBs at regular intervals. The western mezzanine has chipboard on the floor joists.

*Cracks:* 
It was noted that a 7mm wide crack runs between Doors D8 and D7, with other minor cracks as noted on the attached plans (Appendix A). These may be associated with the settlement of backfill behind the quay wall.

2.1.5 Foundations

No opening up to the foundations was carried out to determine the precise foundation configuration.

Appendix C contains construction details of the Quay wall.

Appendix D contains a borehole log from the nearby site on John Rogerson’s Quay.

The north wall would appear to be founded on the Quay wall construction. This Quay wall construction extends to 37 ft 10" (11.53m) below the Campshire level. The borehole information would suggest that a dense grey gravel or black boulder clay was founded upon. It is likely that the southern wall is founded on timber piles or the like. From the out-of-plumb readings taken in the verticality survey, there is an indication of some rotation of the building southwards. The north wall leans southwards by up to 27mm and the south wall leans in the same direction by up to 54mm.

This rotation would suggest some history of settlement of the piles or whatever is the foundation configuration under the southern wall. It is not possible to determine if this is recent / active movement or historic settlement.

Interestingly, the location of the 54mm out-of-plumb corresponds to an anomaly on the northern wall i.e. at that location the northern wall leans northwards. This is indicative of roof spread at that location, which may be a result of inadequate horizontal tie bar connection or the like.
There is also cracking evident on the eastern gable. This could be settlement of the gable wall, but may also be due to thermal movement, given the length of the building. In reality, it is probably due to the combination of both.

2.1.6 Services

Given the location of the building and the extent of new development in the locality, it is likely that all services e.g. gas, ESB, NTL etc. are reasonably adjacent. In relation to foul discharge, DCC records are included in Appendix E.
2.2 **Building B**

2.2.1 **General Description**

This brick rectilinear building is approximately 43m long by 6.73m wide, and has a slated duo-pitched roof. The inside is vacant, though the floor is covered with some rubble.

2.2.2 **Roof**

*Description:*

The roof of Building B is duo-pitched with 6mm thick natural slate (440mm wide slates). 36no. pairs of rafters span north-south. Most of the lime plaster backing to the slates has come away in-between the horizontal battens. The battens (50x70 @ 255 c/c) bear on to rafters (225x75 @ 1210 c/c), which in turn, sit on a timber wall-plate (145 dp) with half-lap joints to accommodate the length of the building. The wallplate is notched to receive the rafters. The pitch pine timbers appear to be in bad condition due to the white paint flaking off, which, from ground level, may be misinterpreted as fungal growth; but the timbers generally prove relatively difficult to drill in areas where damp ingress would be expected (eaves and corners).

20mm early steel bars penetrate the wallplate and tie the eaves together at every second rafter. An 8mm dia hanger provides mid-span support to the tie rod, being hung off the rafter immediately north of the 300x25 ridgebeam.

Left to right: rafters 14 and 16 (location C, appendix A) are missing tie bars and hangers, 22 is missing a tie bar, 26 is broken and bent. Most of the tie-rods and hangers are distorted and slightly bent.

From the outside (southern elevation) the ridge of the roof is relatively level, with only the ridge tiles stepping up a fraction at either end. All the slates appear to be in place with a couple of lead clips where slates have previously slipped. The gutter runs full length with three downpipes and there are two areas of vegetation growing within the gutter (ferns and grass).

There is a similar gutter to the north elevation and presumably this also has 3 downpipes, however access was not available to inspect this. The gutter at this side has a lot more plant growth in it with some buddleia. More slates on this elevation appear to be coming loose.

Beam over Door D4: From the inside this beam measures 320mm deep, and at its right hand bearing the wall-plate is recessed in to it. Some worm attack and rot is present at the end of the beam. The beam has a bearing of 450mm upon purplish brick, each brick with 5 holes through its top face. The top inside corner of the beam has been chamfered full length, and the rafters are notched into the beam here.

In general, the timber looks in bad repair primarily because its original whitewash paintwork is peeling off and is covered with soot. The paint is somewhat lumpy and powdery, and generally flaking off.
Moisture Meter Readings:
Moisture meter readings were taken at a number of locations where damp ingress was most likely e.g. at wall-plate/eaves level. These are typically between 16 and 20 for wall-plates. Where rafters bear onto the wall-plate, moisture meter readings range between 20 and 23 approximately. Elsewhere the rafters and battens typically range between 18 and 20. Moisture meter readings at ridge beam level, battens and rafters are between 19 and 22. (Moisture meter readings taken firstly at Location C, and then elsewhere, and appeared to be consistent; pitch pine proved generally not easy to drill).

Door 3, left hand side: moisture reading taking for rafter bearing over beam was 35. Moisture reading for the beam in general is between 16 and 22, where damp ingress is more likely. Wall-plate moisture reading is approximately 23 where joins the beam. There is a slight whitish mildew here, but the timber is difficult to drill.

Door D3, right hand side: Moisture content of beam ranges between 14 and 18 generally. Bearing of rafter over this is approximately 23-24, increasing up to 45 where the rafter meets the brickwork.

North east corner: Wall-plate 16; rafter at bearing 19; battens 13

From the results it can be seen that most of the readings are under 20%, which would indicate that there is little risk of dry or wet rot. The readings for the rafters notched into beams over doors at eaves level are the exception, where the readings are predominantly in the low twenties. The timbers proved difficult to drill with a standard ¾” spade bit, and are thought to be in generally good condition.

2.2.3 Walls

General

Masonry of this structure is English garden wall bond with 3 courses of stretchers followed by a course of headers. The corners of the building are rounded with 5 or 6no. granite quoins at the base (each stone being four courses of brickwork high), and the rest in brick. The walls are generally a brick and half thick up to about 3m high, where the walls steps in half a brick internally to become one brick thick.

The mortar has a lot of grit in it and seems very hard. It may contain Roman Cement. Bricks are generally yellow coloured with some red brick repairs. Rainwater downpipes are located on the side walls, and are rectangular in section and sunk into the face of the wall to give a flush appearance.

All walls within the building have been white-washed. Large timber beams support the rafters over the top of the sliding double doors (D1 to D4), and there are two further courses of brickwork in-between the rafters on top of the wall-plate.
There are two rows of bolts through the top of the side walls, presumably to tie the top of the sliding double doors in. The upper level of bolts have 110mm square washers and go through the first course of brick above the wall-plate. These bolts are at approximately 800mm centres. The lower level of bolts have 125mm dia circular plates and run through the wallplate.

All windows are metal framed with flat arch lintels over. The windows have 8 glass panels. The wall-plate bears directly onto the flat arches, and there are 2 courses of brickwork above this.

The following notes should be read in conjunction with the drawings in Appendix A:-

a) **Northern Flank Wall**

**Exterior:**
Towards the eastern end a large panel of brickwork has been, otherwise close access to this wall was unavailable.

**Interior:**
The two sliding double doors, D3 and D4, have been infilled with 20 courses of blockwork. The large timber beams that span over these door openings are still in place. These timber beams have bolts through them at equidistant centres.

Rising damp to the first 6 courses was noted along this wall where the white-wash has flaked off.

**Verticality:**
A plumb line was used to evaluate the verticality of the northern wall, and the results are as shown in Table 4. Note that the measurements were taken from within the building where piers either side of the door openings were vertical full height, whereas the wall panels in between the piers stepped in by half a brick.
<table>
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<th>D</th>
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Max out of plumb*

-18  4  -30  -70  -102  -127

*max out of plumb readings have made allowance of the half brick step mid-height in the wall i.e. subtract 112mm to get overall out of plumb of wall.

This wall is generally leaning inwards, with the eastern corner leaning in slightly excessively. Note that a portion of the wall at this end has previously been rebuilt, and that the eastern gable-end exhibits much cracking (see section 2.2.3 b)).

**Cracks:**
Along with cracks emanating from Windows W11, W13 and W14 as illustrated in Appendix A, there is generally cracking around the newer panel of brickwork towards the eastern end.

Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). Again, vertical tension cracks are present, presumably behind the recessed rainwater pipes where the solid brick wall looses a half a brick in its thickness. Cracks around windows may also be due to thermal expansion finding the path of least resistance, and/or may be due to corrosion of metal window frames. The newer brickwork to the eastern end of this wall also has cracks around it, highlighting it as a period of later rebuilding.

b) **Eastern Gable End Wall**

**Exterior:**
The eastern gable end wall has two high level windows and a number of cracks in it. Both Windows W7 and W8 have cracks extending from their top right hand corners vertically upwards. In between and below these two windows, there is a crack running approximately vertically downwards and this has been patched up in the past with some brick replacements and cement re-pointing.
There is also a crack from the bottom right hand corner of Window W8 extending towards the corner and then vertically downwards. This crack runs through the top granite quoin and then seems to disappear at the base of the wall at its right hand corner. It has been patched up with a cement repair and crack pattern is difficult to discern.

At the top of the third granite quoin a horizontal crack within the bedding joint runs nearly full width of this elevation. There is a heavily corroded metal strip located within this bedding joint and it appears to be pushing downwards on the panel of masonry below, to create a gap of approximately 6mm.

*Interior*:
The pattern of cracks is as illustrated above, with the exception that two bed joint gaps are visible. The upper one, which is the one also visible from the outside, allows daylight through it. Past attempts have been made to fill these cracks and gaps with a cement based mortar, but the cracks have opened up again to approximately 1mm.

A panel of brick in the centre of the wall above the upper bed joint crack steps out eastward from the general wall face by approximately 8mm. In the bottom left hand corner there is a large cement repair and there is a large crack between the north wall and the east gable end wall of approximately 7mm.

There is also a crack from the bottom right hand corner of Window W7 running down and to the right.

*Verticality*:
A plumb line was used to evaluate the verticality of this wall, and the results are as shown in Table 5.

Though there is an outward lean, it is not excessive.

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<td>Max out of plumb</td>
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Table 5 Verticality Survey of East Wall, Building B (mm)

Cracks:
Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). The larger bed joint crack appears to be largely due to a rusting metal flat exerting expansion forces on the brickwork. The rest of the crack pattern may be indicative of previous local settlement of the gable end wall.

c) Southern Flank Wall

Exterior:
The first ten or so courses up from ground level have been badly damaged by frost, and efflorescence of salts has spalled the brick facing off in places. Pointing has receded to approximately 25mm and this wall may need re-pointing in its lower level. It appears that some re-pointing may already have been attempted however this has started to come loose. The brickwork has a lot of mechanical abrasion evident; however this is purely aesthetic.

There is a crack which is approximately vertical at the eastern end, widening towards eaves level. Another vertical crack runs from the ground up between Windows W5 and W6. Windows are covered in a flat arched lintel of brick and where these arched lintels are bearing mortar has come away. Around these windows some spalling of brick is present, generally on the cill which has been covered in a cement based render.

Doors D1 and D2 are large full height sliding timber double doors. Door D2 has a crack running through its right hand pier and then up towards Window W1.

A rainwater pipe is located between Window W20 and Door D2 - at the top of this, brickwork is coming loose and bulging out (suspect corroded metal pushing brickwork out).

In the panel of masonry between Doors D1 and D2 the bottom nine courses have suffered frost attack and spalling of the brick facing due to efflorescence i.e. salts leaching out through the face of the brickwork.

Spalling of brickwork is more apparent on Window W17 where the bricks have cracked in half along their length. The same defect is also apparent on the cills of Windows W18 and W19.

At the western end of this side wall, cracking is evident at the top of rainwater pipe.

Interior:
To the right hand side of Door D2 there is a large vertical crack directly behind the rainwater pipe that widens towards the top.
The left hand pier to the Door D2 has a crack that runs at approximately 30° upwards from the bed joint, and then continues through the one brick thick panel to the bottom right hand corner of Window W1.

Between Windows W3 and W4 there is again a vertical crack. Again, this coincides with the rainwater pipe to the outside and gets larger towards the top of the wall where daylight can be seen through the crack, approximately 10mm thick.

At the extreme eastern end of this wall there is a section of rounded brick, like a quarter column, directly above the one and a half brick thick panel and standing proud of the one brick thick panel.

**Vertically:**
A plumb line was used to evaluate the verticality of this wall, and the results are as shown in Table 6.

Though there is an outward lean, it is not excessive.

<table>
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<th>K</th>
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**Table 6 Verticality Survey of South Wall, Building B (mm)**

**Cracks:**
Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). Thermal expansion has again caused tension cracks behind rainwater downpipes. There are also numerous cracks at window corners. The widening crack at the extreme eastern end may also be due to thermal expansion.

d) **Western Gable End Wall**

**Exterior:**
This gable wall is constructed from an assortment of bricks. There is a large infilled opening in the centre of the wall with a 320mm deep reinforced concrete lintel over. Concrete has spalled off the lintel exposing a round, smooth steel bar. The opening has been infilled with yellow brickwork and contains a door within it.

Window W15 has cracks extending diagonally upwards to the left from the top left hand corner, straight down from its bottom left hand corner and diagonally upwards to the right from its top right hand corner.

Window W16 has two cracks, both running diagonally to the right: one upwards from the top right hand corner and one downwards from the bottom right hand corner.

On either side of the infilled opening the two lowermost granite quoins have dropped leaving a 7mm approx gap (suspect settlement at the central portion of this wall).

**Interior:**
The crack pattern on the interior is similar to that on the outside. The reinforced concrete lintel spans between brick piers, 760mm wide by 450mm thick, and the infill panel with stretcher bond appears to be half a brick thick.

Either side of the piers, the wall step back half a brick such that the main panel is a brick and half thick. From the beam level up the wall thickness reduces to one brick thick with the step on the inside.

A plumb line was used to evaluate the verticality of this wall, and the results are as shown in Table 7. Though there is an outward lean, it is not excessive.

<p>| | |</p>
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**Max out of plumb**

75

**Table 7 Verticality Survey of West Wall, Building B (mm)**

**Cracks:**
Refer to Appendix A for elevations marked up with crack patterns (internal cracks shown dashed, and external cracks shown solid). The crack pattern of this gable-end wall is indicative of local settlement between the flank walls.

2.2.4 Floors

The floor has been concreted throughout in this building. Constructed and Induced Joints are as indicated on the floor plan in Appendix A.

2.2.5 Foundations

Given the Quay wall construction and the available site investigation records, the foundation configuration is likely to be similar to Building A (see section 2.1.5).

The verticality survey to the south and the north wall of this building appears to suggest tilt / movement southwards, similar to the phenomenon exhibited in Building A. The southern wall leans southwards by up to 69mm and the northern wall leans southwards by between 80-127mm. It is difficult to see that the movement could be due to movement in the Quay wall given its foundation at the low level indicated in the attached drawings.

The rotation movement is more pronounced at the gables and this is maybe due to the settlement situation being somewhat aggravated by the additional weight of the gable, together with the presence of the gable which tends to manifest their movement as structural cracks.
3.0 ASSESSMENT

3.1 General

The nature of the general construction in Building A is substantially superior to that evident in Building B, however the defects recorded in both buildings are effectively generic, although more pronounced in the Building B structure. The assessment is carried out for both buildings together on that basis.

3.2 Roof

Roof timbers are reasonably intact, but the slate covering is in need of renewal. Natural slate generally has a life expectancy of between 100 and 130 years and we suspect the slate is the original roof covering. The moisture levels at the top of the rafters suggest a continuing moisture ingress, although rafters generally have not been ill-affected due to their being open and in a readily ventilated space.

The roof structure is in need of refurbishment, tie bars, etc. in places need to be replaced or renewed.

There is an absence of lateral bracing in the roof, although this is not considered a contributory fact to the building tilt, but may, if bracing were present, prohibit the out-of-plumb movement in the gable walls. In any substantial refurbishment the absence of such roof bracing should be addressed.

3.3 Walls and Foundations

Cracking to the walls can be repaired by a stitching and replacement techniques. The cause of the cracking, however, needs to be addressed. The gables are showing signs of settlement and rotating southwards. In addition, the gables are leaning outwards due to an absence of internal bracing. Essentially, underpinning by piles or the like to both the southern wall and the east and west gables is the most sure-fired solution. Prior to this decision being finally made, some geotechnical investigation needs to be carried out to determine the nature of the overburden over the underlying boulder clay and rock, together with the precise foundation configuration that exists under these walls.
3.4 **Floors**

In Building A the floors are limestone cobbles with a concrete slab (more recent addition) present at the eastern end. Taking into consideration the potential use for the building the requirement would be to generally provide a better quality of ground floor finish. The cobbles were laid at a fall to facilitate drainage within the building and it is difficult to see what usage could be put to without at least a level floor finish. If a new slab is to be provided, it will need to be a suspended slab because of the depth of fill underneath the floor slab. This suspended slab will need to be founded on piles at circa 4-6m centres internally within the building.

The ground floor slab to Building B is a more modern concrete slab. It is difficult to ascertain its precise condition due to the light within the building and the presence of dust and debris, etc. Given that this slab essentially is poured on what could be up to 10m of fill it is likely that for any future use the integrity of such a slab will come into question. The likelihood in substantial refurbishment is that this slab will need to be removed and a pile suspended slab be included in its place.
4.0 RECOMMENDATIONS

The historic fabric (both timber and brickwork) of Building A is in generally good condition. The two mezzanine levels may be removed with relative ease. Care must be taken to repair brickwork before removing modern blockwork panels beneath arched openings – particularly where a steel beam has cut into the springing of the arch to Door D1.

Building B, though a smaller structure, needs more work, and perhaps some rebuilding of masonry in the north east corner where the leaning of the ‘rebuilt’ northern wall is excessive, and there is numerous cracking to the eastern gable end wall.

Otherwise the general repairs/good maintenance procedures listed below can be applied to both buildings to conserve them.

4.1 Roofs

- Remove plant growth from guttering and parapets
- Remove slates carefully and store for reuse
- Clean timber of dirt and flaking paint
- Treat and replace timbers if necessary (minor areas of rot and worm)
- Straighten out tie bars and hangers, replacing where missing or necessary
- Remove rust to tie bars and hangers and apply anti-rust paint
- Re slate, using existing slates (new holes must be pre-drilled in each slate to ensure adequate fixing) and slates to match allowing for breakages
- Bracing of roof structure should be addressed
- Insulation etc. to architect’s detail

4.2 Walls

- Underpin southern flank wall, and gable end walls.
- Remove corroded metal from wall fabric (e.g. metal strip in East Wall of Building B) where possible. Where removal is too damaging, clean rust off and apply anti-rust paint.
- Replace individual defective bricks e.g. where efflorescence, frost attack and/or rising damp has caused the brick to crumble (bricks with mechanical abrasion need not be replaced)
- Stitch cracks with stainless steel bedjoint reinforcement (downpipes need careful attention – want to avoid tension cracks occurring elsewhere in the wall)
- Repoint cracks, and replace bricks where necessary
- Some lower courses of wall need repointing
- Replace spalling brickwork to window cills
- Some sections of brickwork need rebuilding (see brickwork at eaves level between doors D1 and D2, and panel east of door D3 in Building B for example)
- Remove modern block and brick infill where necessary taking care to repair superstructure before hand (e.g. repair springing of arch in Door D1 of Building A before taking down block infill)
4.3 **Floors**

- Remove mezzanine floors and repair masonry with brickwork to match
- Remove cobbles in Building A after removal of concrete slab to east on new bedding, and store for possible reuse.
- Floor of Building B – suspect that concrete slab is underlain by original cobbles. Client decision on what finish is required.
- Construct new suspended slab founded on piles at circa 4-6m centres internally within the building.
APPENDIX A

Plans and Elevations indicating crack patterns, Door and Window numbering, and locations for verticality surveys and moisture meter readings
MARINE HOUSE - BUILDING A (76.12m x 7.85m)

LOWER LEVEL PLAN

MEZZANINE UPPER LEVEL PLAN

64 no. TIMBER TRUSSES OVER, EVERY SECOND WITH A STEEL TIE BAR.

FRONT ELEVATION
MARINE HOUSE - BUILDING A (76.12m x 7.85m)

LEGEND
- External Crack
- Internal Crack
- Harline Crack
- Increasing Crack Width
- 0.3mm Measured Crack Width

South / Front Elevation

North / Rear Elevation

West Side Elevation

East Side Elevation

Section AA

Section B-H

Section C-C
APPENDIX B

Photographs with location plans / elevations
APPENDIX C

Construction drawing of the Old Quay Wall
APPENDIX D

Borehole log from neighbouring site investigation
17 - 19 Sir John Rogerson's Quay

MANHOLE 1

MANHOLE 2

BH2

TP2

BH1

TP1

TP4

Job No. DM80/10
Page No. 1
Made by LEO
Date 9/3/00

N.T.S Schematic only
## GEOTECHNICAL BORING RECORD

**Report Number:** 12018

**Contract:** Sir John Rogerson's Quay

**Borehole No.** BH1

**Coordination:**

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<th>Field Test Results</th>
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### WATER STRIKE DETAILS

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### GROUNDWATER DETAILS

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### INSTALLATION DETAILS

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<th>Type</th>
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### REMARKS

---

This geological boring record provides detailed information about the soil conditions at the site, including descriptions of different layers, water strike details, and installation notes. The data is crucial for understanding the subsurface geology and planning construction projects.
# Geotechnical Boring Record

**Contract:** Sir John Rogerson's Quay  
**Borehole No.:** BH1  
**Date Started:** 28/08/2006  
**Date Completed:** 29/08/2006

**Client:**  
**Engineer:**

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## Groundwater Details

## Installation Details

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## Remarks
APPENDIX E

Dublin City Council Drainage drawing
12.0 Options for Demountable Defences (see Volume 2, Sections 3.2.1 and 4.8.2.6)
the convenient truth

based on, among others, the integrated panels

www.dutchdam.nl
Because of this, the panels are also coupled to the foundations over their entire length. Nuts and bolts are totally unnecessary in building the Dutchdam.

The deployment of demountable flood defences mostly takes place in cold, bad weather. Simple and quick deployment is therefore a priority and the technology used in the Dutchdam removes a number of risks. If a panel is leaning against the stanchion, a connection is then formed by pushing a bar through an opening in the stanchion into the adjacent panel. All the components are connected to each other in this way and are at the same time locked in position.

The various Dutchdam types have different functions and so the panels are also available in several weight classes.

It is the various risk factors such as possible collisions, wave pressure and burden of traffic on the cover plate, which determine the wall thickness and/or panel height and length, and therefore the weight also.

The construction of the Dutchdam relies on the tilting of the panels in an opposing profile to the panel beneath or the ground rail.

One of the special characteristics of the Dutchdam is the way the panels are coupled together to each other. This produces a strong connection, both horizontally and vertically.

In the traffic-bearing duct the panels are vertically placed and partly connected into a column which ensures that the cover plate can withstand loads of up to 100(+65)kN per 30 x 30cm.

The partitions are connected both horizontally and vertically, with the result that in a collision with the top of e.g. the stanchion, the energy is absorbed through the entire wall.

In deployed position the partitions are safely locked.

The storage capacity required for the Dutchdam is limited by the compact construction of the panels and the stanchions which are only 50mm thick. The set-up on the right involves sea-container transport.
The Dutchdam flood barriers can be positioned in various ways and the components can be stored in different manners. Below are several examples where all the demountable parts are stored in their own foundation duct. This offers a number of practical advantages, saves many man-hours, logistical organization and storage depots. If the system has to be able to withstand traffic, there are several lockable cover plates to choose from.

The Dutchdam-Bold is an exhaustively tested model with various defence wall heights up to approx. 225cm. The demountable part of the Dutchdam-Cento reaches to a defence wall height of 100cm.

The somewhat complex infrastructure along rivers, canals and harbours requires tailor-made solutions. An important aspect of Dutchdam technology is that it has multiple applications, whilst maintaining its characteristics – fast deployability with limited man-hours. The short time required to erect it allows decisions to be taken at a later time, with the result that unnecessary deployment (with all the problems involved) can be limited.
Storage in its own foundation duct is not always the most ideal solution. Accessibility, limitations in depth, installation direction, rails for public transport, and a lack of any possible drainage all can form an impediment. A slowly sinking water level in the duct also demands a different solution.

Storage in cabins close to the site can also contribute to a speedy erection time and a quick reopening of the road network.

**Storage elsewhere.**

Both, the Dutchdam-Bold and the Dutchdam-Cento can be positioned at ground level or on top of a retaining wall or quay with storage of the parts elsewhere.

Dutchdam has developed very compact components which consequently can be stored and secured in a small space. The Dutchdam components have a storage volume of only 40% of that of traditional systems.

If storage at some distance is essential, then the limited volume of the components of the Dutchdam is of added value. The panels can for example be put in a rack on a trailer. If the flood defence needs to be erected, then any vehicle with a tow-bar is capable of transporting the necessary materials. The Dutchdam panels can be tilted into the required position directly from the trailer. However it is also possible to store the panels in cabins which are hung up in the direct vicinity of the site or attached to the ceiling of a parking-garage.

Loading and unloading using heavy equipment such as fork-lift trucks or cranes is not necessary, and therefore logistical organisation remains limited.

An emergency flood barrier in many cases is associated with complex decision-making. The landscape, the local climate, the speed of rising of the water table, the place of the current and the defence wall height required for the emergency flood barrier all determine the choices to be made.

For more information see: www.dutchdam.nl

Patented matters, additional patents applied for, design: Corné Rijlaarsdam, all rights reserved, copyright 2000 - 2008.
Three leading Dutch hydraulic organizations have been involved during the development of the Dutchdam. The Innovation Test Centre of the Ministry of Transportation and Water Management (RWS), GeoDelft and WL_Delft Hydraulics (WL),(since January 2008 merged with others to form the national institute DELTARES) are convinced of the special qualities of the Dutchdam and made the following statement:

As its conclusion to the validation report on Dutchdam, the RWS states:

on the basis of the results in phases 1 and 2 we conclude that the Dutchdam:

1. can be employed as a temporary flood defence and fulfils all the requirements and conditions set out by the Ministry.
2. demonstrates its superiority by the way in which it can be speedily deployed and installed; its appearance is also in keeping with the local architectural ambiance.
3. is stronger, more reliable and more cost-effective than panel barriers.

The Dutchdam requires a greater initial outlay, but is more economical to manage and maintain.

GeoDelft reports in its analysis:

The choice is:

a: to raise/adapt the entire local infrastructure or
b: to install the Dutchdam

a: raising the height of a levee:

Advantages: no limits to how this is implemented - can be used to compensate for large deficiencies - unlimited durability.
Disadvantages: services need to be laid - Roads have to be renewed - Approach and slip roads have to be made - Social restrictions are affected - Extra height required for : Houses have to be demolished - Cables and mounting - Damage caused by mounting.

b: using the Dutchdam:

Advantages: No houses need to be demolished - Existing dike road remains intact - Cables and services are not disturbed - Approach and slip roads do not change - The view and accessibility stay the same - Social restrictions are complied with - No mounting structure to be built.
Disadvantages: A deployment procedure is necessary - Only applicable for height deficiency - Restricted durability.

Result: Heightened security with positive effects on the environment and costs incurred.
The Dutchdam is a broadly applicable hydraulic technique which has strongly divergent uses.

The Dutchdam-Duplo, with a defence wall height of 80cm is employed at 8 places along the River Liffey in the centre of Dublin, Ireland. The Duplo is particularly suitable for areas with pedestrians, but is only of limited use for traffic conditions. The flat construction of the complete flood defence, only 14cm deep, makes this model suitable for an environment with a complex substratum such as on old quays, above existing foundations and above services such as gas and water mains, cables and pipes. The system is locked internally.

The Dutchdam-Bold is employable as a second line of defence for coastal overtopping.

The Dutchdam-Guard (a rail-version) is employable as a second line of defence for coastal overtopping. The Dutchdam can also be integrated into a (hand-)rail or crash barrier on quays, roads, bridges or terraces alongside river-banks, canals and lakes. The (hand)rail is adapted to become a stanchion construction, which can be fitted with a box at its foot in which the panels can be stored.
Slot-In Flood Barriers

Modular design, interlocking components and custom manufacturing, combine to make this system the most versatile and advanced slot-in flood-board system currently available.

Versatile Flood Protection
...robust and unobtrusive

With a host of design features (see facing page) and the ability to protect openings of up to 6 metres wide against flood depths of up to 2.4 metres, this system is ideal for protecting doorways, loading bays, pedestrian walkways, shop fronts, in fact, virtually any opening that requires dependable defence against flooding.

The modular components, simplicity of design & aluminium beams with ergonomically positioned carrying handles, enable the system to be easily and quickly erected by one person - without the need for special skills or training.
Introduced in 1994, thousands of slot-in barriers are currently installed in the UK and throughout Europe, and with a policy of continuous development and improvement the systems remain at the forefront of flood defence design......

**Designed for APPLICATION**

- Can be installed on any flat watertight surface
- Heights 300mm to 2400mm (in 300mm increments)
- Opening width any size up to 6500mm in a single span
- Can be extended using removable intermediate supports
- Reveal, Face or Corner mounted support channels
- Custom stand-offs (up to 350mm) to clear weatherboards etc.
- Can also be installed behind doors (e.g. for Emergency Exits)
- Vandal resistant covers & security clamps to lock systems
- Can be finished in RAL colour to match décor
- Fully removable options for listed buildings
- Stainless steel options for salt water environments
- Can be left semi-permanently installed

**Designed for CONVENIENCE**

- Can be installed by any competent builder or DIYer
- Aluminium beams weigh less than 8kg per linear metre
- Ergonomically positioned carrying handles
- Quickly and easily erected by one person
- Modular design requires no specific skills or training to erect
- Storage brackets available for beams & components

**Designed for DURABILITY**

- Construction grade steel & aluminium components
- Steel fabrications hot-dip galvanised
- Patented seal design stops silt clogging
- All seals made with EPDM for weather and UV resistance
- Seals fixed in preformed channels and easily replaceable
- Twinned seals for extreme flood/impact conditions
- Suitable for constant daily use

**Designed to STANDARDS**

- Manufactured & tested to exceed DIN19569-4
- Steel sections manufactured to EN10027
- Fabrications hot-dip galvanised to ISO 1461:1999
- Heat treated aluminium extrusions to BS1474
- Stainless steel sections manufactured to EN10088
- Seals all Ethylene Propylene Diene Monomer (EPDM)
- All fixings Load Rated Hilti™ or Fischer™
Hinged Gates

Our NEW GENERATION aluminium flood gates are approximately 70% lighter than equivalent steel gates and, thanks to our unique 'raise-swing-lower' mechanism, do not require recessed ground channels, raised ground beams or ramps, making them ideal for vehicle entrances and especially suitable for forklift or wheelchair access.

Even the widest gates can be operated by one person using the smooth winding lift action and the single point locking mechanism. And of even more importance the aluminium construction provides a far higher level of Operator Safety than heavy steel gates.

Available as single or double leaf gates, these systems are suitable for use in unmanned locations, are fully lockable and come complete with anti-theft and vandal resistant features.

For locations where a stepped entrance is acceptable, we also offer the same high standard aluminium gates with precision non-lifting swing hinges.

Our gates are designed for extreme weather durability to give a lifetime of service and with EPDM seals that reform even after prolonged periods of compression, the gates can, if required, be left closed indefinitely.
Our new generation aluminium flood gates set new standards in the field of watertight gate design……

Designed for APPLICATION
- Can be installed on any flat watertight surface
- Heights 600mm to 2100mm (in 300mm increments)
- Single Gate width any size up to 4000mm in a single span
- Double Gates any size up to 8000mm
- Inward and outward 180° opening gates available
- Lifting mechanism raises gate by up to 200mm to clear pavements
- Vandal resistant covers & security clamps to lock systems
- Can be finished in RAL colour to match décor
- Can be left semi-permanently installed

Designed for CONVENIENCE
- Smooth winding lift mechanism
- Single point locking.
- One person operation.
- Easy installation – no heavy lifting gear
- Requires less massive supporting structure

Designed for DURABILITY
- Stainless steel & aluminium components
- Life-time lubricated bearings
- Patented seal design stops silt clogging
- All seals made with EPDM for weather and UV resistance
- Seals fixed in preformed channels and easily replaceable
- Suitable for constant daily use

Designed to STANDARDS
- Load/stress calculated to maximum storage capacity
- Heat treated aluminium extrusions to BS1474
- Stainless steel sections manufactured to EN10088
- Seals all Ethylene Propylene Diene Monomer (EPDM)
- All fixings Load Rated Hilti™ or Fischer™

NB. We can also supply both hinged & sliding heavy duty steel watertight gates for virtually any application.
WaterWall
The practical flood defence system
1. When the WaterWall System is installed the post holders, with protective caps, remain inconspicuous and allow full and uninterrupted access to any location or opening.

2. As soon as it becomes obvious that the WaterWall System will be required, removal of the protective caps begins the process of erecting the banner.

3. Insertion of the post into the post holder is done in a matter of seconds and a quick twist holds it in place.

The WaterWall System has been developed to help alleviate some of the problems faced by many businesses and households throughout the country, caused by flooding.

The WaterWall design allows quick and easy assembly and dismantling.

www.carofds.co.uk
Caro WaterWall System is an affordable concept that allows for easy and quick deployment in the event of a flood warning.

4 In this same manner, a long run of posts can be installed in next to no time, with the minimum of effort or stress.

5 Once this process has been completed, the sealing plates can be inserted into the runners between the posts.

6 Each plate is able to slide down, allowing for the seals in the posts and on the undersides of the plates to become watertight.

www.carofds.co.uk

WaterWall Practical

Aluminium and steel manufacture, practical, light and resilient.
The WaterWall Barrier can protect those areas that would otherwise be at risk from rising floodwater and can easily be dismantled when the danger has passed.

Within a matter of minutes large areas can be made to hold back water, as the flood height increases.

Finally, to ensure the seals are at their maximum compression, top locks are rotated and tightened.

Within an extremely short period of time the WaterWall System has gone from unobtrusive caps in the ground, to a full height flood protection system.

www.carofds.co.uk

WaterWall

Versatile

Suitable for both residential and commercial protection.
WaterWall can be manufactured completely bespoke or supplied in standard sizes – up to 120cm panel widths with 100cm post heights.

The components are produced to the very highest standards using cast and extruded aluminium with steel tubes and stainless steel fittings.

WaterWall uses a Patented system (Patent No. 2371068) to ensure an extremely quick and robust assembly of the defence barrier and an equally quick and easy removal back into storage.

The Caro Group of Companies

The first of the Caro Group companies commenced trading in 1985 and over the years the name has become trusted throughout the Building/Construction industry for the supply of Construction components.

Expansion over the recent years has meant that the Group has grown to now incorporate a Die, Sand and Investment Casting Foundry, a full Wet and Powder Commercial Coatings division, Non Destructive Testing facilities that are approved by virtually all Aerospace and Military production companies and in 2001, the addition of Caro Flood Defence Systems.

visit www.carofds.co.uk
email enquiries
info@caro.co.uk
Caro Flood Defence Systems have taken the WaterWall concept of quick and easy use and developed WaterDoor.

WaterDoor makes use of two vertical channels fitted at either side of the door entry, that allow the lightweight individual panels to be dropped into position.

Again, as with WaterWall, each panel has its own rubber seal that, when compressed by the WaterDoor fixing sequence, forms a completely water tight barrier.

The use of these small lightweight panels allows for the very quick setting up of the barrier and once finished it can be easily dismantled and stored away inconspicuously.

Available in widths up to 120cm and heights up to 100cm, WaterDoor is available as a complete kit, subject to confirmation of dimensions required.

It should be fitted externally between two opposing, solid, vertical structures.

A full installation kit, with instructions will be supplied.

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**WaterDoor**

Protecting your property

---

**Caro Flood Defence Systems Limited**

Edge Barn

T1 Market Hill

Royston

Hertfordshire, SG8 9JN

United Kingdom

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Caro Flood Defence Systems Limited maintains a policy of continual product development and improvement and, as such, retains the right to alter designs shown within this brochure. All reasonable care has been taken in preparing this information, but Caro Flood Defence Systems Limited is unable to guarantee against working practices that are outside of their control.
K-System

1. System Description

General

K-system is an abbreviation for catastrophe protection system (german: Katastrophe = catastrophe). This system does not require any preparatory construction measures on asphalt up to a flood height of 1.30 m and can therefore be applied flexibly in different locations.

The special feature of the K-system is that the water pressure applied by the flood water makes a positive contribution to the system’s stabilisation.
Flexibility

The protective wall only consists of the following 4 components; there is no mix up during assembly.

1. K-trestle
2. Dam beam
3. Pressing tool
4. Ground seal

Due to its modular design, the system can be extended in any directions depending on the requirements and also optimally adapted to the topographic conditions. The system is capable of compensating ground unevenness of up to 15 mm, curves in the terrain with radiuses larger than 20 m and height differences of up to 190 mm. Please note that selective that exceed these dimensions can easily be sealed with sand bags and foils. Experienced flood fighters are aware of and familiar with this type of flood combating, which provides almost limitless room for improvisations.

Wall connections and corner solutions are standardised or specially adapted to local conditions.

Wall connections

Materials

K-trestles, dam beams and pressing tools consist of robust and durable materials like aluminium (AlMgSi) and stainless steel (V2A; 1.4301). All sealing joints are sealed with proven and advanced seals made of PVC foam and EPDM. Due to the high-quality materials, which have been used in flood protection for many years, almost any service life can be achieved with proper storage. This way, the system can be applied any number of times without requiring replacement purchases.

Assembly and Disassembly

The setup and dismantling of the system requires only limited personnel and time expenditure. Depending on the flood height, 4 to 8 persons can erect 100 m of protective wall in one hour. Due to the fact that the protective wall consists only of 4 components, which cannot be mixed up during assembly, the quality of the protective wall is independent of the deployed personnel. Installation in adverse conditions like limited sight, darkness, rain and wind is also possible without any efforts.

2. System Variants

K-Systems for Flood Heights of up to 1300 mm

We carry the following 3 standard systems variants for which we have obtained a static type test from LGA Bayreuth:

<table>
<thead>
<tr>
<th>Flood Height</th>
<th>Number of dam beams</th>
<th>Dam beam dimensions</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>550 mm</td>
<td>3</td>
<td>50 x 226</td>
<td>IBS-K50-550</td>
</tr>
<tr>
<td>900 mm</td>
<td>5</td>
<td>50 x 226</td>
<td>IBS-K50-900</td>
</tr>
<tr>
<td>1300 mm</td>
<td>7</td>
<td>50 x 226</td>
<td>IBS-K50-1300</td>
</tr>
</tbody>
</table>

Intermediate flood heights of 1100, 740, 370 and 190 can be realised by inserting less dam beams into the standardised K-trestles of the above system variants.

When using a nail plate on bitumen cover layers and roads, the three system do not require additional anchoring. This configuration was subjected to a principle check at LGA Nuremberg. The prerequisite is that the surface is capable of bearing surface pressures of 100, 200 or 400 kN/m².
We do recommend anchoring the system when using it on rough concrete surfaces and pavement to prevent slipping.

3. Storage

We provide an advanced storage technology for our system. This ensures contact-free storage of the dam beams and K-trestles through spacer blocks made of water-proof bonded wood. The system is stored in hot-galvanised steel palettes equipped with fork tracks, stackable palette feet and tension belts. Due to the contact-free storage of the individual parts on the steel palettes, these can be simply rinsed off with a water hose after use.

If the system cannot be stored in a suitable location, it can also be delivered and stored in containers. Depending on the flood height, protective walls with a maximum length from 130 to 280 m can be stored in a 12' container.
Mobile Walls as Flood Protection Systems

1. System Description

General

A mobile protection system enables the elevation of flood protection systems while leaving the townscape, the sight and the traffic conditions to and across the river largely unchanged. It therefore preserves the identity and appeal of the city as well as the attractiveness and quality of life of the real estate properties close to the river. In order to achieve this added flood protection while leaving the everyday situation largely unchanged under observation of today's safety standards, the construction and operation of a mobile flood protection system has to meet the highest demands.

The principle of mobile flood protection walls made of dam beam systems

In principle, the mobile elements of the IBS systems consist of two components. The center support posts, which are mounted at regular distances in case of a flood, and the dam beams that are stacked between the center support posts.

Two additional components are required for activating the protection function: screw fittings and pressing tools. The centre support posts are screwed together with the stationary reinforced concrete construction via tapped bushes. In order to activate the system's high degree of impermeability, the dam beams must be pressed in vertical direction with the pressing tools. This seals the dam beams and ensures that the bottom dam beam is clamped on the installation surface. This system consisting of centre support post, dam beams, screws and pressing tools enables the construction of mobile walls with a height in excess of 4.0 m with just 4 system components.

Flexibility

Radiuses larger than 20 m (with a support post distance of 2.0 m) or larger than 30 m (with a support post distance of 3.0 m) can be formed with standard support posts.
Angle supports are used for hinge points. Inclines of up to 5% with surface unevenness of up to 15 mm can be compensated. Height protrusions (steps) are overcome with flood height transitions. Depending on the post interspaces, it is possible to construct free-standing support post constructions in excess of 2.0 m. Rear support posts are used in case of larger stress on the construction.

Materials

- Dam beams made of aluminium extruded sections (AlMgSi)
- Support posts as full-aluminium constructions (AlMgSi) or combinations of aluminium extruded sections (AlMgSi) with hot-galvanised steel foot (S235)
- End profile made of aluminium extruded sections (AlMgSi)
- Pressing tools made of Gk-AlSi12 / V2a (W-no. 1.4301)
- Anchor plates made of stainless steel (V2A, 1.4301 / V4a, 1.4571) with black steel anchoring
- Seals made of EPDM, PE / PUR

Due to the applied high-quality materials, which have been used in flood protection for many years, we guarantee long durability under proper storage conditions. The system is designed in such a way that planned replacement purchases are not required during the material service life.

Assembly and Disassembly Times

The time period required for the assembly of the mobile flood protection system consists of:
- the alarm time - The time from the issue of the alarm and the readiness of the assembly personnel
- the loading time - Time for loading the transport vehicles
- the transport time - driving time from the storage location to the deployment location
- the securing time / unloading time – time to secure the traffic along the flood defence route, unload the vehicles and distribute the storage and transport containers along the defence line
- assembly time – the time for preparing the defence line, placing and screwing down the support posts and inserting/bracing the dam beams

Only the setup time is significantly influenced by the support system. However, the local situation, e.g. the area behind the defence line, the placement of support posts level to the ground or on embankments, etc, also have an influence on the assembly time. The construction of a 100 m long, straight mobile flood protection wall with a support distance of 3.0 m and a protection height of 1.20 m requires 1 to 2 hours and 4 to 8 instructed workers on average with a high-quality system configuration. Twice the time has to be calculated for disassembly, removal to the storage containers and cleaning.

Required Tools, Lifting Equipment and Transport Vehicles

The mobile elements (e.g. dam beams, support rods) are stored in transport containers with a maximum weight of approx. 850 kg each. Any lifting equipment (e.g. tractor, fork lift, front loader, etc.) with transport fork or any type of crane (dewing pillar crane, hall crane, truck crane, etc.) are suited for this purpose. All vehicles/trailers with a loading area of at least 2m x 3m can be used for transport. The assembly of the system only requires simple tools (ratchet wrench with the corresponding hexagon sockets).

2. System Variants

The following product types are available:
- IBS BSH-I 50 with 50 mm wide and 166 mm or 300 mm high dam beams for application of walls with a maximum height of 1.50 m
- IBS BSH-I 100 light with 100 mm wide and 150 mm high dam beams for application of walls with a maximum height of 3.0m
- IBS BSH-I 100 (heavy duty) with 100 mm wide and 150 mm or 250 mm high dam beams for application of walls with a maximum height of 5.0m
- IBS BSH-I 100 (Köln) (heavy duty) with 100 mm wide and 150 mm or 250 mm high dam beams for application of walls with a maximum height of 5.0m

These product types provide technical variation options that allow custom-tailored solutions for just about any project situation.

3. Storage
We provide an **advanced storage technology** for our system. This technology allows the contact-free storage of the dam beams and support posts. The system is stored in hot-galvanised steel palettes equipped with fork tracks, crane stop positions, stackable palette feet and tension belts. Due to the contact-free storage of the individual parts on the steel palettes, these can be simply rinsed off with a water hose after use.
Attention: Mr. Michael Hughes,
Moylan Consulting Engineers,
Wilson House,
Fenian Street,
DUBLIN 2.

24 Nov 08

re: LIFFEY QUAY WALLS / SOUTH CAMPSHIRE.

Dear Michael,

We refer to your e-mail of the 18th inst. We understand that you require flood protection to the walls of the two existing buildings. We understand that these are protected structures with walls of random rubble construction. We recommend the following specification for tanking of these walls externally.

1. Remove any existing wall plaster and limewash.

2. Apply a preparatory scud and float coat of sand/cement incorporating 30% HEY'DI Bonding Agent in the mix, to leave a reasonably smooth surface.

3. Apply three coats HEY'DI K.11 tanking incorporating 50% HEY'DI Bonding Agent.

4. Apply a scud and float coat of sand/cement incorporating 30% HEY'DI Bonding Agent.

5. We recommend that the above works be carried out down to foundation level. Ideally, the HEY'DI K.11 application should turn out horizontally at the base of the foundation for a distance of approximately 500mm. At the junction between the horizontal and vertical, a fillet of HEY'DI Barrier mortar should be installed prior to the HEY'DI K.11 application.

Please find enclosed technical data sheets on the above-mentioned materials.

We thank you and assure you of our close attention at all times.

Yours faithfully,
QUIGLEY PRESERVATION LIMITED.

[Signature]
Brian Quigley,
Managing Director.
Spray Application:
Use air operated spray equipment capable of spraying cementitious materials. Use a 3.2 cm nozzle. On concrete surfaces, K11 Slurry Grey is to be sprayed in two coats. On concrete masonry surfaces, apply a first coat. Before initial set, back brush the surface with a mason's brush or broom to fill voids and ensure uniform coverage. Allow the first coat to cure for 24 hours. Doppen the surface and spray on a second coat (same thickness as the first coat) in the same manner as the first coat. Back brushing the second coat is not required.

K11 Slurry Grey is also available in white. K11 Slurry White is used to enhance the aesthetic appearance of the waterproofing system and is used as topcoat for K11 Slurry Grey.

Combined applications:
Very safely waterproofing with bituminous construction materials. Apply K11 Slurry Grey directly to all joint and flawless masonry if it is followed by second layer of bituminous coating (HEYDI K100, HEYDI Thick Coat brushable, HEYDI Biflex, HEYDI Thick Coat 1K and HEYDI Thick Coat 2K). Allow K11 Slurry Grey to dry for at least 48 hours before applying the bituminous waterproofing. The application of K11 Slurry Grey as a primer layer reduces the risk of blistering of bituminous construction materials of porous substrates and excludes the risk of backflow on problematic wall/floor junction.

Consumption:
- against moisture: min. 1.5 kg/m² (2 coats)
- against non-pressurised water: min. 2 kg/m² (2 coats)
- against pressurised water: min. 2.5 kg/m² (2-3 coats)
- combined with bituminous construction materials: min. 2 kg/m² (2 coats)

Clean-up instructions:
Clean mixing and application equipment with water immediately after use. Clean splatter or spills with water before material sets. K11 Slurry Grey is a cementitious product containing a polymer bonding additive, and it allowed to dry on the surface, removal becomes extremely difficult.

Cautions:
Do not retemper K11 Slurry Grey. Do not apply to frozen or frost filled surfaces or when the temperature is below of expected to fall below 5°C within 48 hours. Do not try to speed up the drying process or any similar equipment, this will reduce the sealing quality. Do not apply K11 Slurry Grey at temperatures above 35°C, unless the surfaces has been fully saturated with water at the time the application begins. K11 Slurry Grey is not designed as a wearing surface. Apply a protective topcoat before subjecting it to traffic. Do not fill open cisterns, tanks, pools, etc. with water for at least 7 days. Ensure that adequate ventilation is available during the application and the curing period when using K11 Slurry Grey containing SB Bonding Agent in enclosed tanks or reservoirs. Load minimum 7 days drying time before backfilling unless protection board is used. Allow 7 days cure at 20°C before covering or before the application of waterbased decorative coatings. Do not apply time contained paints over K11 Slurry Grey. Allow minimum 7 days cure before exposing K11 Slurry Grey to water pressure, or any contact with water. When K11 Slurry Grey is used in areas exposed to chemicals or high sulfite containing soils, consult technical service for specific recommendations. Apply a test patch to evaluate performance and appearance on concrete or block substrates which have been subjected to contamination, efflorescence or chemical attack.

Packaging:
25 kg bag (Part No. 51 - 127741)

Storage:
K11 Slurry Grey can be used for a period of at least 12 months when stored in a dry and cool place sealed in the original bags.

Safety precautions:
K11 Slurry Grey contains portland cement which is alkaline on contact with water. Do not breathe dust. Irritating to eyes and skin. Avoid splashing into eyes or contact with skin. In case of eye contact, flood eyes repeatedly with potable water and call a physiciian. DO NOT RUB EYES. Wash skin thoroughly after handling and before smoking or eating. Use adequate ventilation. KEEP AWAY FROM CHILDREN AND ANIMALS. Consult Material Safety Data Sheet for further information.

Test Certificates:

Official test certificate, Institute for Hygiene, Gelsenkirchen – Container coatings, following the recommendation of the study group "Trinkwassersicherung" (drinking water interests) of the commission on synthetics of the Federal Health Office.

Test certificate of the MPA Clastural according to ibh-regulations.

With our technical application recommendations, oral or written, we wish to advise the purchaser/user according to the best of our knowledge based on our tests and practical experience; however, they can only serve as general information without any promise regarding properties as we have no influence on the work site conditions and the performance of the work. Advice and the supply of information neither establish a legal relationship nor constitute any ancillary obligation from the purchase contract. For industrial production, we recommend always performing sufficient tests. We guarantee the proper, consistent quality of our products. In other matters, our sales and delivery conditions apply.
K11 Slurry Grey
CEMENT BASED, CRISTALLINE WATERPROOFING SYSTEM

Field of application: K11 Slurry Grey is applied to below or above grade surfaces (interior or exterior) to protect against moisture and hydrostatic water pressure. Typical applications include foundations, basements, masonry or cementitious plaster in damp rooms, bathrooms, shower rooms, tunnels, dams, water reservoirs, manholes and many other underground structures. K11 Slurry Grey effectively waterproofs concrete, medium/heavy weight concrete block, brick and shotcrete. Horizontal surfaces treated with K11 Slurry Grey and subject to traffic must be covered with a protective topping. K11 Slurry Grey must be allowed to cure before applying a finishing floor system.

Product description: K11 Slurry Grey is a breathable, on-part cement based system for waterproofing concrete and masonry. K11 Slurry Grey has a texture and consistency similar to concrete and may be brush or spray applied. K11 Slurry Grey becomes an integral part of the wall and waterproofs through a crystallization process.

K11 Slurry Grey is a multiple active formulation of cements and chemical additives designed to penetrate deep in the capillaries of the substrate and form a crystalline structure. It contain no added chloride or sodium. It is inorganic, non toxic and resist chemical attack in a similar way to portland cement.

The addition of SB Bonding Agent improves better adhesion, higher flexibility and permeability resistance to K11 Slurry Grey.

Technical Data:
- Colour: grey
- Impermeable to water pressure: over 7.5 bar
- Compressive strength: approx. 35 N/mm²
- Pot life: approx. 3 h
- Flexural strength: approx. 7.0 N/mm²
- Load test (foot traffic): approx. after 2 days
- Tensile strength: approx. 2.0 N/mm²
- Load: approx. after 2 weeks
- Adhesion to concrete: 2.6 N/mm²

Values are typical and not necessarily referenced to create specifications.

Surface preparation: The surface must be structurally sound, clean and free of dirt, oil and other contaminants including curing compounds, from release agents, old coatings, paint and efflorescence. New concrete and masonry must be cured a minimum of 7 days. All concrete laitance must also be removed. Provide an absorptive surface on all substrates including precast and for optimum crystalline growth. Remove form marks and other protrusions. Concrete honeycombs, cavities, joints, cracks, voids, tie holes and other defects must be opened and routed to sound material. For the use on the negative side: no active water leaks should be present at the time of application of K11 Slurry Grey. Use the HEYDI POWDER X SYSTEM to seal active leaks.

Mixing instructions: For positive side waterproofing, blend a 1:5 ratio of SB Bonding Agent with potable water to make the „mixing liquid“. For negative side waterproofing, blend a 1:2 ratio of SB Bonding Agent with potable water to make the „mixing liquid“. Slowly pour small of mixing liquid into the K11 Slurry Grey (not the other way around) in order to obtain a plastic consistency (approx. 9 for one 25 kg bag K11 Slurry Grey). Make sure that the mixture is blended thoroughly so that an optimum homogeneity is achieved.

Slurry application: Dampen the surface with potable water prior to application. There should be no running or standing water present. A minimum of two coats of K11 Slurry Grey is applied to a surface to effective waterproofing. Each following coat should be applied when the previous one has not yet completely dried (or by no means later than on the following day). Brush Application: Surface must be damp at the time of application. Load bristles of a cement masons brush with K11 Slurry Grey. Work the slurry into the surface to fill pores and voids. The final brush strokes should be in one direction to produce an even texture and finish. Apply the second coat in the same manner as the first coat except that the finish brush strokes should be at right angles to those of the first coat.
**Bonding-Agent**

External waterproofing (Positive pressure conditions)

**Product Description**

*Bonding-Agent is ideally suitable for application in all those areas where above-average bonding strength, abrasion resistance and impact strength is required. Thus, in combination with other HEY®DI products and additives, the emulsion forms a bonding bridge, a bonding mortar, a salt barrier or even a modifier for mortar, screeds and similar. *Bonding-Agent is absolutely compatible with cement, provides excellent alkali resistance, improves flexibility, restrains evaporation and shrinkage, it is frostproof and resistant to de-icing salt and it contains no solvents.

**Bonding-Agent Product Information**

Strict adherence to the instructions is essential in order to ensure the superb durability of our products.

**Areas of Application**

*Bonding-Agent is frequently utilized:

- a) as a bonding bridge and thus safe connection between the substrates and plaster, screed or similar;
- b) as a bonding mortar for repair and patching jobs and for levelling screeds that need to taper off to 0;
- c) as a salt barrier (in connection with *K11-Sturry);
- d) as a modifier for slurry and mortar. Further and above this, you can also use *Bonding-Agent for preparing lime coatings that are weatherproof and resistant to wiping, mortar joints that are tight and not at risk of cracking, as well as facing mortar and exterior plaster. Furthermore, the emulsion is suitable as a bonding agent for brittle and/or porous substrates made of mortar, plaster and screed, plus for glueing gravel bottomings onto flat roofs.

**Combined Applications**

Depending on the application you will require different additives:

- a) Bonding bridge: water, cement, sand
- b) Bonding mortar: water, cement, sand
- d) Modifier: water, *K11-Sturry, mortar

**Directions for Use**

Prior to Application: The product can be applied by one person starting at +5 degrees Celsius. Tools, etc.: Pail, mixing tin, mixer. Also: gloves. Depending on the application you will require additionally:

- a) Bonding bridge: Brush, shovel
- b) Bonding mortar: Paste brush, trowel, smoother, shovel
- c) Salt barrier: Paste brush, brush, applicator board, shovel, smoother
- d) Modifier: Brush or spray gun, trowel. Usage: depends on the individual application. Prepare surface: The surface must be sound, supportive, free of debris and for the most part level. Remove separation layers such as forming oil, grease, paints or similar (e. g. by grinding off or brushing off).
Working Steps

a) Bonding Bridge
Here, you need approx. 150 g of *Bonding-Agent per m²:
1. Combine dry ingredients, that is sand and cement, using a mixing ratio of 1 part (sand) to 1 part (cement).
2. Next, prepare the mixing liquor consisting of *Bonding Emulsion and water using a mixing ratio of 1 part (*Bonding-Agent) to 2 parts (water).
3. Add only as much of this mixing liquor to the dry compound until a mush is obtained.
4. Brush this mush onto the surface.
5. Once the bonding bridge has been brushed on, allow for at least 24 hours of settling time. Next, you can apply plaster and screed fresh on fresh.

b) Bonding Mortar
For preparation of the mortar you will require approx. 0.08 - 0.15 kg *Bonding-Agent per m².
1. First, prime the surface with a mix of 1 part of *Bonding-Agent to 2 parts of water.
2. Next, combine the dry ingredients, that is sand and cement, using a mixing ratio of 3 parts (sand) to 1 part (cement).
3. Then prepare a mixing liquor consisting of *Bonding-Agent and water, using a mixing ratio of 1 part (bonding emulsion) to 2 parts (water).
4. Add only as much of this mixing liquor to the dry ingredients until a workable mortar is obtained.
5. The mortar must be applied to the priming before it has dried.

c) Salt barrier
The surface must be de-salted prior to application of the actual salt barrier:
1. First, knock off plasters and screeds that have been attacked by salt or that are decayed. Then remove loose joint mortar and brush the surface dry.
2. If the brickwork is severely attacked by salt, then it needs to be treated with *Antisulphate twice. In the first working step, combine 1 Antisulphate with water using a mixing ratio of 1 part to 1 part, and apply liberally. 24 hours later, apply unthinned *Antisulphate (if the salt attack is not so severe, then the first working step will suffice).
Now you can apply the actual salt barrier:
1. Pre-wet the surface with a mixture of 1 part *Bonding-Agent to 10 parts of water.
2. Next, mix *K11-Mortar to a mushy consistency, using a mixing recipe of 2 parts of bonding emulsion to 7 parts of water for the mixing liquor; this quantity is enough to make a 25 kg batch of slurry.
3. Apply ready-mixed, stiff plastic slurry with a brush. You will need approx. 1 kg of slurry per m².
4. Allow the coating to evaporate for approx. 2 hours and then apply a second coating.
5. 24 hours later, rough-cast the second coating with *Dash-Coat so that 70 - 80 % of the coated surface is covered. You can then complete the job by applying *Renoting Rinder.
6. Floors should be finished off with a screed.
d) Modifying
For *K11-Slurry: Add 10 - 30 % of *Bonding-Agent to the mixing water. For mortar: Depending on the thickness of the coating, add 5 - 10 % of *Bonding-Agent to the mixing water. The thinner the coating, the more bonding emulsion you should add.

By adding *Bonding-Agent, you can also prepare lime coatings that are weather-proof and resistant to wiping, mortar joints that are tight and not at risk of cracking, as well as facing mortar and exterior plaster.

Furthermore, the bonding emulsion is suitable as a bonding agent for brittle and/or porous surfaces made of mortar, plaster or cement. The portion of *Bonding-Agent ranges between 5 and 50 %. The actual amount depends on the individual conditions of the substrate resp. on the extent to which the mortar is stressed (specific information on request).

After Application
Cleaning: Clean tools and dirty areas immediately with water. You can clean hardened residues with *Epoxan-Cleaner.

Packaging, Storage and Disposal
Packaging: 5 kg and 10 kg plastic canister (PE)
Colour: beige (dried)
Shelf life: *Bonding-Agent can be stored in its original container for a period of one year after delivery without any loss in quality (see date of delivery on packing slip).
The sealed containers must be stored in a dry area. Thaw frozen material in sealed containers at room temperature.
Delivery: Ex works or via our outside warehouses.
Disposal: Packaging and hardened material may be disposed of via domestic garbage.

Any more Questions?
Please direct these to our sales staff in Offenbach
++49 - 69 - 89 00 17 62

All of the information provided has been compiled to the best of our knowledge. We recommend that the suitability of our products be ascertained prior to application by means of matching the treatment to the individual conditions and testing the product if necessary. Liabilities cannot be derived from this technical information. Our general sales, delivery and payment conditions are valid.
Barrier Mortar / Barrier Mortar Fine

Waterproofing of buildings from the **positive side**

**Product Profile**

**Application**
Barrier mortar is a universally applicable repair mortar for restoring concrete, forming channels, etc. and is resistant to seawater. An additional application possibility is pointing the joints of masonry and filling superficial cracks.

**Composition**
Polymer-modified, water-repelling repair mortar.

**Properties**
Good bonding strength and low shrinkage.

**Application Data**

**Hardening**
Potlife: approx. 2 hours, Completely hardened: approx. 5 hours

**Application Method**
Apply with a suitable trowel

**Application Thickness**
Max. 5 cm per application step

**Post-Treatment**
Protect from excessive sunlight

**Product Alternatives**
Swelling mortar

**Substrate Treatment**
Wet the substrate until evenly damp, possibly with the addition of bonding emulsion concentrate

**Substrate Properties**
The substrate must be free of gypsum, structurally sound and free of any separating layers

**Processing**
Temperature + 5 °C and above

**Consumption**
Per litre of cavity, approx. 1.8 kg; for channels with 5 cm edge length, approx. 2.0 kg per m

**Tool Cleaning**
Wash off with water; if hardened, with lime remover or mechanically

**Important Instructions**
Pre-soak the substrate first, protect from excessive sunlight

**Biological / Chemical / Physical Data**

**Base**
Polymer-modified, water-repelling repair mortar

**Ready for Walking**
After 1 day

**Ready for Loads**
After 1 day, for additional layers after 4 hours
Flexural Strength
After 28 days approx. 7 N/mm²

Compressive Strength
After 28 days approx. 60 N/mm²

Frost and Thawing Salt Resistance
Present

Grain Size
Barrier Mortar 0 – 2 mm grains,
Barrier Mortar Fine 0 – 1 mm grains

Mixing Ratio
3 litres mixing water per 25 kg of dry mortar

Shrinkage
≤ 0.3 mm/m

Ready for Coating
After 4 hours

Additives
Bonding emulsion concentrate (for increasing the elasticity, bonding strength and water blocking of the mortar) or water used as primer (consumption approx. 500 g/m², processing temperature not below +5 °C). At lower temperatures, it must be ensured that the substrate is free of ice before application of the primer.

Purchase / Order / Information

Packaging
25 kg paper bag

Storage
Cool and dry. Keeps approx. 12 months in original packaging.
13.0 DCC Parking Survey (see Volume 2, Sections 4.1.6.3 and 4.8.1)
Moylan Summary of DCC raw survey data

Parking Survey
Survey carried out on Wednesday 24th November 2010 between 7am and 6:30pm providing 24 half hour periods.
Each space was surveyed every half hour and its occupancy recorded. Also recorded was type of occupant i.e. Residential, ticket etc.

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<th>Windmill Lane</th>
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<th>Lime Street East Side</th>
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<th>Creighton Street East Side</th>
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**Note:**

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  - Time: 09:00
  - From: Parking
  - To: Parking

**Observer:**

- Signature

**Officer:**

- Signature

**Inspectors:**

- Signature

**Witness:**

- Signature
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**SHEET NO:** 1

**BAR CODE SPACES:**

**SHEET 20**
14.0 Grand Canal Harbour Area Flood Risk Assessment (see Volume 2, Sections 1.0, 1.7.4 and 3.0)
South Campshire Flood Protection Project

Grand Canal Harbour Area Flood Risk Assessment

22/03/11
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1. Introduction ......................................................................................................................................... 1
2. Background Information .................................................................................................................... 2
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4. Summary and Conclusion .................................................................................................................. 3
APPENDIX A – South Inner City Flood Cell ......................................................................................... 6
APPENDIX B - Forbes Street Flood Extent ........................................................................................... 7
1. Introduction

Dublin City Council (DCC) has carried out extensive flood studies of the areas contiguous with the River Liffey following flood events, principally in 2002. These studies have identified areas of the City, south of Georges Quay and Sir John Rogerson’s Quay, which are at significant risk of flooding. In order to protect this flood cell DCC, in conjunction with the Office of Public Works (OPW) and Dublin Docklands Development Authority (DDDA), are proposing to construct a flood defence system (South Campshire Flood Protection Project).

Flood predictions undertaken in 2005 estimated if a flood event, of a level representing a 1 in 200 year risk, occurred the south side of the River Liffey along the South Campshires from Sir John Rogerson’s Quay to Butt Bridge would flood. The current flood protection proposal is to build a flood wall along the south quay wall from Butt Bridge to approximately 50m east of the Samuel Beckett Bridge, as shown Figure 1 below. The wall would then cross from the quay wall to the Riverside One building (McCann FitzGerald) on Sir John Rogerson’s Quay with the use of demountable barriers.

This report has been undertaken by DCC to assess the flood risk to areas further east, in the Forbes St. and Grand Canal Harbour Area, following concerns raised by residents, given that this area is outside the extent for the proposed flood protection.

Figure 1 Extent of Proposed Flood Scheme
2. Background Information

Flood Cell Extent
The SAFER project (Strategies & Actions for Flood Emergency Risk management), was undertaken by DCC in 2005 and identified flood areas for the 1:200 year return period. This is the level of risk which is specified for protection in coastal areas under National policy. This flood information was produced into flood maps for the Dublin coastline. A flood cell was identified on the South Campshires from George’s Quay to Sir John Rogerson’s Quay. The flood cell in this area extends from the quays as far south as Lower Grand Canal Street and has an approximate area of 0.5 km². The flood cell is shown in Appendix A.

The depth of the flood waters during the 1:200 event is predicted to vary from 0.25mm up to a possible 1.5m within the flood cell. The depth of the flood cell increases as the land falls away from the quays, with the deepest points in the area of Macken Street and Clarence Place Great.

Grand Canal Harbour Area
The Grand Canal Harbour area is located at the east edge of the 1:200 flood cell and is only partially impacted by flood waters. The flood predictions from the 2005 report estimated that the 1:200 flood would be approximately 3.13m (OD Malin Head). Appendix B shows the predicted 1:200 flood cell for the Grand Canal Harbour area and it illustrates that Forbes Street is the only area affected by this flood event in this area. Forbes Street would be impacted for a short length on the north end of the street and would have a maximum flood depth of 250mm (10 Inches).

3. Flood Risk Assessment

When the flood extent for the Forbes Street area is compared to the rest of the flood cell it is clear that there is significantly less flood impact. The other streets within the flood cell are fully impacted by the flood waters and experience a greater depth of floodwaters. This reduced level of impact on Forbes Street is primarily due to the street level and topography. Assessing the road levels on Forbes Street, based on a survey undertaken by Apex Surveys in August 2008, the street naturally rises above the 1:200 flood level within 14m from the north end of the street. The street has a level of 2.767m OD at the north rising to 3.41m OD 25m from the quays. The 3.41m OD level is road kerb level and an additional 150mm can be added to this level to allow for footpaths. This means that Forbes Street has a 3.56m OD level of protection within the first 25m from the quays.
In addition to the topography of Forbes Street reducing the level of flood impact, the design of the existing building also helps to reduce flood risk. Photo 1 below shows the view from the quay south down Forbes Street. It can be seen that the road itself has a notable upward slope and the buildings on both sides of the road have the ground floor levels higher than the road level. The buildings on the right hand side of the street also have steps into them which would help prevent flood waters affecting in these premises.

![Photo 1: Forbes Street view south from quays.](image)

Photo 1 also shows a speed ramp located at the mouth of the north end of the street near the quays. This would act as a mini flood barrier during a flood event and give additional flood protection.

4. Summary and Conclusion

DCC have carried out extensive flood studies of the River Liffey following recent flood events. These studies have identified areas of the City, south of Georges Quay and Sir John Rogerson’s Quay, which are at risk of flooding. DCC are proposing to build a flood wall along the south quay wall from Butt Bridge to approximately 50m east of the Samuel Beckett Bridge to help prevent flooding in the area of the south inner city most at risk.

This report was undertaken to assess the flood risk in the Grand Canal Area and on Forbes Street. The flood mapping shows Grand Canal Area having a low risk from flooding with only
a short length of Forbes Street prone to flooding in the 1:200 year return period and then only to a maximum depth of 250mm (10”). A site survey and photos were used to assess level of flood risk. It was found that the elevation of Forbes Street increases above 3.5m OD within 25m from the quays. This rise in elevation in addition to the design of the street, with speed ramps, and the high ground floor level of the buildings reduces the flood risk in this area.

Forbes Street has a significantly lower level of flood risk than that experienced by the other streets in the flood cell. This low risk was taken into account when the location for the proposed flood protection scheme was being considered.

It is recognised that the proposed flood defence wall, which is being built to a level of 3.7m, will give a higher level of protection than required for a 1 in 200 year event and a higher level of protection than that provided to the area to the east of its termination point. That is because, when constructing a permanent flood defence, it is Government and OPW policy to include additional protection from future sea level rise and wave action as it is more efficient to construct such defences in this way. However, given the above analysis, it is considered reasonable that the permanent flood defences would terminate at the current proposed location. Notwithstanding this position, and in recognition of the concerns raised, I am prepared to give an undertaking that further and more detailed analysis will be carried out of the exact street levels, floor levels etc. in the Forbes St. area and that options such as temporary demountable defences will be considered if the predicted event is likely to exceed those levels and result in property flooding. Furthermore this detailed analysis and proposals arising there from (if any) will be included in the Environmental Impact Statement prior to its submission to an Bord Pleanala.

___________________
Adrian P. Conway
Senior Engineer
APPENDIX
APPENDIX B - Forbes Street Flood Extent

[Map of Forbes Street Flood Extent with legend showing flood depth within unprotected 200yr Area: 0.00m - 0.25m, 0.25m - 0.50m, 0.50m - 1.00m, > 1.00m]
15.0 Photos from Dublin City Council’s Flood Resilient City Office, Showing Indicative 3.5m and 3.7m OD Flood Levels (see Volume 2, Section 3.3.1.2)
Hanover & Creighton Streets:

Legend:
- Flood Prone at 3.7m OD HT
- Flood Prone at 3.5m OD HT
Pearse Street Area (nb most have basements):

Legend:
- Green: Flood Prone at 3.7m OD HT
- Yellow: Flood Prone at 3.5m OD HT

14 – Library @Road Level = 2.40 OD
15 – Byrne Lane @Road Level = 1.80 / 1.4 OD
16 – Brunswick Lane @Road Level = 1.80 / 2.20 OD
17 – Macken Street @Road Level = 2.00 OD
18 – School @Road Level = 2.00 OD
19 – Pearse Square @Road Level = 2.00 OD
16.0 **Novation Agreement between Dublin Docklands Development Authority and Dublin City Council** (see Volume 2, Section 1.1)
Seamus Lyons
Assistant City Manager
Environment and Engineering Dept.
Block 1 Floor 6
Civic Offices
Fishamble Street
Dublin 8

16th September 2009

Re: South Campshires Flood Protection

Dear Mr Lyons,

I refer to your letter to Gerry Kelly, dated 5th August 2009, in relation to the South Campshires Flood Protection Project.

We confirm our agreement with the arrangement that Dublin City Council (DCC) will assume the role of lead authority.

Your letter states that "Design costs will continue to be shared as per our current agreements."

To clarify this point, DDDA wish to state that Moylan's appointment included two phases of work. Phase 1 was for the quay wall cleaning and maintenance and was fully funded by the Authority. This project is now complete.

Phase 2 was to include the design, project management and PSDP services relating to the flood protection requirements. This is to be fully funded by DCC/OPW.

We note that any incidental landscaping works required as a result of the introduction of the flood barrier will be funded by DCC/OPW.

Please note that as the Authority is also the landowner, we require that all designs are presented to us for our sign-off and approval at each stage.

Yours sincerely,

John McLaughlin
Director of Architecture and Urban Design

Cc: Mr Gerry Kelly, Dublin Docklands Development Authority
    Mr Tom Leahy, Executive Manager (Engineering), Dublin City Council
Dublin City Council
ORDER OF THE ASSISTANT CITY MANAGER
ENVIRONMENT AND ENGINEERING DEPARTMENT

South Campshires Flood Protection Project - Novation Agreement
Transfer of DDDA Contract with Moylan's Consulting Engineers to Dublin City Council

The above Project was set up in 2008 to deliver the required level of flood protection to the South City Quays and the area of the city immediately to the south - this area being one of the most vulnerable to Coastal Flooding as identified in the SAFER Flood Atlas.

Order of the Assistant City Manager ENG 341/2008 approved the following:

1. Dublin City Council partnering with the Dublin Docklands Development Authority (DDDA) to develop the flood defences on the South City Quays.

2. Dublin City Council writing to the DDDA to confirm this and the recommendation of the interview board that Moylan's Consulting Engineers be appointed by the DDDA as Service Provider.

3. Dublin City Council to pay the costs of the Flood Defence Design element (currently estimated at circa €110,000) of the appointment.

4. The costs of the Flood Design process to be Grant Assisted by the OPW (See OPW Letter, John Kelly, Engineering Services dated 18th December 2007) and the Dublin City Council Development Levy Fund.

By letter dated 27th November 2009, the DDDA indicated that it had decided to withdraw from financial involvement in the Project as the Project was now entirely focused on the flood protection element and proposed that the DDDA's contract with Moylan's be novated to Dublin City Council. Moylan's have indicated their agreement to this proposal.

I have examined the proposed Novation Agreement as has Dublin City Council's Law Department and am satisfied that it is acceptable. Dublin City Council's budget remains at €150,000 exclusive of VAT.

I therefore recommend that approval be given to the novation of the existing contract between DDDA and Moylan's Consulting Engineers in relation to the above project to Dublin City Council and to the sealing of said Agreement.

Dated: 19th January 2010

Adrian P. Conway
Senior Engineer

ORDER: Approval granted to the signing and sealing of the Novation Agreement transferring the existing contract between DDDA and Moylan's Consulting Engineers in relation to the South City Campshires Flood Protection Project to Dublin City Council, as set out in the above report of the Senior Engineer, Project Management Office.

Dublin City Council's budget to remain at €150,000 exclusive of VAT

Dated: 23rd January 2010

Assistant City Manager

To whom the appropriate powers have been delegated by Order of the Dublin City Manager dated 11th January 2010.
(1) DUBLIN DOCKLANDS DEVELOPMENT AUTHORITY
(2) MOYLAN CONSULTING ENGINEERS LIMITED
(3) DUBLIN CITY COUNCIL

CONSULTANCY AGREEMENT
RIVER LIFFEY QUAY WALLS AND CAMPSHIRES

NOVATION AGREEMENT

McCann FitzGerald
Solicitors
Riverside One
Sir John Rogerson's Quay
Dublin 1
THIS AGREEMENT made day of February 2010 between

(1) DUBLIN DOCKLANDS DEVELOPMENT AUTHORITY of 52-55 Sir John Rodgerson’s Quay, Dublin 2 ("the Authority");

(2) MOYLAN CONSULTING ENGINEERS LIMITED of Wilson House, Fenian Street, Dublin 2 ("the Consultant") and

(3) DUBLIN CITY COUNCIL of Civic Offices, Wood Quay, Dublin 8 ("the Council").

RECITING

A. By an Agreement dated 3 July 2008 ("the Agreement") made between the Authority and the Consultant, the Consultant agreed to provide engineering and other services in relation to River Liffey Quay Wall and Campshires, Dublin ("the Services").

B. The Authority wishes to be released and discharged from the Agreement and the Consultant has agreed to release and discharge the Authority upon the terms of the Council undertaking to perform the Agreement and to be bound by the terms of the Agreement in place of the Authority.

NOW IT IS HEREBY AGREED AS FOLLOWS:

1. The Council undertakes to perform the Agreement and to be bound by the terms of the Agreement in every way as if the Council was a party to the Agreement in lieu of the Authority.

2. The Consultant releases and discharges the Authority from all claims and demands whatsoever in respect of the Agreement and accepts the liability of the Council under the Agreement in lieu of the liability of the Authority and agrees to be bound by the terms of the Agreement in every way as if the Council was named in the Agreement as a party in place of the Authority.

3. The Consultant shall be entitled in any action or proceedings by the Council to rely on any limitation or exclusion in the Agreement and to raise the equivalent rights in defence of liability as it would have against the Authority under the Agreement.

IN WITNESS WHEREOF the parties have executed this Agreement the day and date first hereinbefore written.

PRESENT when the Seal of DUBLIN DOCKLANDS DEVELOPMENT AUTHORITY

was affixed hereto:

[Signature]
Authorised Signatory

[Signature]
Authorised Signatory
PRESENT when the common seal of MOYLAN CONSULTING ENGINEERS LIMITED was affixed to this deed and this deed was delivered:  

[Signature]
Director

[Signature]
Director/Secretary

PRESENT when the Seal of DUBLIN CITY COUNCIL was affixed hereto:

[Signature]
Cathaoirleach/Nominated Member

[Signature]
Authorised Signatory

CIVIC OFFICES
DUBLIN
CITY COUNCIL OFFICIAL

[Signature]
CITY MANAGER
17.0 Records of Correspondence with Consultees and South Campshire Stakeholders (see Volume 2, Sections 1.7.4, 4.1 and 4.8.2)
Adrian,

I refer to your letter dated 9th December 2010 relating to the South Campshire Flood Defense Project ESB Substation.

I have reviewed drawing No. P174 and ESB Networks are satisfied with your proposal to fully protect the ESB Substation with the proposed flood defense works.

Should you wish ESB Networks to attend when the enabling and construction works in the vicinity of this substation are commencing please feel free to contact me,

Thanks,

Brian Tapley,  
Design & Construction Manager,  
Dublin Central,  
ESB Customer Services,  
South Lotts Road,  
Dublin 4.

Tel: +353 1 6042615 Mobile: 087 6308758 Fax: +353 1 6388155  
E-mail: brian.tapley@esb.ie
Mr. Adrian Conway
Dublin City Council,
Project Management Office, Block 1, Floor 4,
Civic Offices
Woodquay
Dublin 8

20th April 2011

Dear Sir/Madam,

Re: Flood Defense Project

The Authority hereby consents to Dublin City Council making an application to An Bord Pleanala for flood defense works on lands along the southern campshire within the Authority’s ownership (as per drawings contained within volume 3 of 4 of the Environmental Impact Statement P101, 102, 103, 104, 105, 106 received by the Authority on 2nd Dec. 2010). However, the Authority reserves the right to re-evaluate the development, if it is amended by An Bord Pleanala.

The Authority is aware that Dublin City Council is in consultation with the local community regarding the management of anti-social behaviour along the campshires at the location of the proposed works. The Authority requests this consultation continues to its conclusion during the pre-application process.

Notwithstanding this letter of consent to make the application to An Bord Pleanala, the Authority wishes to advise Dublin City Council that it reserves its right to make comments to An Bord Pleanala in relation to the issues raised by the local community (anti-social behaviour) and the impact of the proposed development on same during the public consultation process.

Yours sincerely,

Gerald A. Kelly
Chief Executive Officer
Mr. Ciaran Callan,
Dublin Port Company,
Port Centre,
Alexandra Road,
Dublin 1.
callan@dublinport.ie

11th March 2011

Re: EIS – South Campshires Flood Defence Project.

Dear Mr. Callan,

I refer to previous discussions with you and your colleagues in relation to the above Project.

The design was presented at a public meeting on the 3rd March 2011 to residents in the locality and concerns were raised regarding potentially antisocial behaviour occurring behind the wall, despite the fact that the wall is of the order of 900mm high. The Residents expressed the view that they wanted the wall to be built alongside the river.

You will recall that at a workshop on 13th. August 2009 that you attended, it was stated that, due to the requirements of ship berthing along this stretch of the river, the wall would have to be a minimum distance back from the quay wall.

Dublin City Council is about to submit the proposal in the form of an EIS to an Bord Pleanala. In the light of the views expressed by the residents as outlined above, it is essential that we have a clear statement of the position of Dublin Port Company in this regard. Accordingly, I would appreciate if you could confirm, in writing as soon as possible, the position of Dublin Port Company in relation to the position of the proposed flood defence wall relative to the existing quay side, taking into account the requirements for occasional use for berthing purposes.

If you have any queries in relation to the above, do not hesitate to contact me directly.

Yours sincerely,

Adrian Conway,
Senior Engineer. (Tel 2222410)

c.c. Nick Smith, Moylans
Dear Yvonne,

With reference to your letter of 11/03/2011,

The requirement of Dublin Port Company is for the facilitation of ships moored alongside the Campshires, especially taking cognisance of the Tall Ships in August 2012.

Any design must allow for:
- Safe passage and working area for linesmen or seafarers whilst mooring vessels to the bollards.
- Safe access and egress by gangway onto the quays from the vessel.
- Working area and clearance for the vessel gangways over the full tidal range.

If necessary to clarify these requirements DPC can meet you on site tomorrow or next week.

Yours sincerely

Ciarán Callan

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Dublin Port Company
Port Centre, Alexandra Road, Dublin 1 (Registered Office)

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VAT No. IE686267G

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Visit our website: www.dublinport.ie

Please consider the Environment before printing this email.
**South Campshire Flood Protection Project**

**Minutes of Site Meeting**

**TIME & DATE:** 11:00, 01.04.2011

**LOCATION:** Sir John Rogerson’s Quay

**PRESENT:**
- Michael Roche, MR, Chief Technician, DCC
- Thomas Doyle, TD, Assistant Engineer, DCC
- Ciaran Callan, Maintenance & Services Manager, CC, Dublin Port
- Captain David Dignam, Harbour Master, DD, Dublin Port

**APOLOGIES:**

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<td>DCC met with CC and DD on site. They expressed concern regarding the section of flood wall running from the ESB substation to the east most BJ Marine building. In this area the wall is setback approximately 1.3m from the quay edge. This area is used for ships to dock occasionally. Approximately six ships a year would use this area for docking, but in addition to this there are occasions like the Tail Ships event when this quay would be used for docking.</td>
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<td>DD did state the area of river in front of the BJ Marine buildings is currently too shallow for large ships to dock but this could be alternated in the future by the dredging of the river. But Dublin Port would, ideally, like to keep this area available for docking in the future.</td>
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<td>Smaller ships can dock in this area. Small ship with gangway “ladders” would be able to dock with the proposed layout and larger ships with their own gangways that can rotate could also dock here. The main problem is from large ships that require Dublin Port to supply a gangway for them. When this situation occurs Dublin Port supply either an 8m or 12m long gangway. DD did state that the proposed wall location near the Matt Talbot Bridge (approximately 8m away from the quay edge) would give adequate room for ships to dock successfully.</td>
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**Distribution:** All present, all apologies and

**Signed by:**

Adrian P. Conway, Senior Engineer

**Name on behalf of**


**Date:**


**Enclosures:** [Insert]
Minutes of Meeting with City Quay Residents

On Wednesday, 2nd March 2011 at 7.15 p.m.

In Gloucester Street Sports Centre

In Attendance

Sean Moran, DCC.
Tony Gallagher, DCC.
Nora Monaghan, DCC.
Adrian Conway, DCC.
Deputy Kevin Humphreys.
Deputy Lucinda Creighton.
Councillor Maria Parodi.
Tom Armstrong, Dublin Docklands Development Authority.
Sinead O’Malley.
Pearse Street Community Policing Unit.
B Byrne, 46 City Quay.
Mary Stafford, City Quay.
Joan Hayden.
Dolores McCluskey, 4A Lombard Street East.
Linda O’Toole, 32A City Quay.
Esther Uzell, 8 Hanover Reach, Hanover Quay.
Brigid Walsh, 11N Hanover Reach, Forbes Street.
Irene Foley, 9 Hanover Reach.
Martina Brennan, 20 Hanover Dock, Hanover Quay.
Shay Keegan, 45A City Quay.
Marian Mitchell, 45A City Quay.
Linda O’Toole Byrne, 46A City Quay.
John Kennedy, 42 City Quay.
Michael Creighton.
Kathleen Rice, 36 City Quay.
Gerry O’Donoghue, 42A City Quay.
Maura O’Donoghue, 42A City Quay.
Danny Colgan, 29 City Quay.
Ann Leech, 34A City Quay.
Bernie Conway, 2A Lombard Street East.
Mary Barter, 12 Dowlings Court.
Kathleen Young, 13 Dowlings Court.

Apologies received from Councillor Catherine Noone and Sally Reddington, Dublin City Council.
1. South Campshire Flood Protection Project.

Adrian Conway gave a presentation on the South Campshire Flood Protection Project and circulated an Outline of the Proposal. A resident from Forbes Street was concerned that the street would not be protected against floods. Deputy Kevin Humphreys stated that the basin is controlled manually. Adrian Conway asked people to give Sean Moran specific locations in relation to where they have concerns about flooding. A resident from City Quay was concerned about the narrowing of cycle lanes and the removal of some car parking spaces for the new flood wall. Adrian Conway stated that the DDDA own the Campshires and that the ESB own the substation which the proposed wall will have to defend. The wall will be the responsibility of the DCC. A resident enquired about security at the Campshires. Tom Armstrong from the DDDA stated there was no security. The Campshire is for public use.

Adrian Conway indicated that Dublin Port can be invited to a future meeting to discuss the proposal. Adrian Conway stated that the next step is to apply for planning permission for this wall. He stated that a public consultation process would take place before planning permission was granted. Deputy Kevin Humphreys stated that residents can request an Oral Hearing. Residents requested that the wall be placed at the river edge. Residents said they are entitled to make decisions regarding the area they live in. Tom Armstrong stated that the Docklands take the residents opinions on board.

Adrian Conway stated that the wall cannot be built on the river edge because of shipping issues. Adrian said he will take back the views of the residents to his superiors. Deputy Kevin Humphreys stated that the risks of flooding was a serious issue and the wall was needed.

Residents said flyers should have been sent to everyone in relation to the meeting. Residents suggested that drawings could be made available in the Rent Assessment Section for circulation.

Adrian Conway stated that smaller meetings can be more productive and said he would be available to attend such meetings. Deputy Kevin Humphreys suggested that plans should be drawn up and that the residents should form a group of spokespeople to examine and make recommendations in relation to the plans. He suggested bringing someone like Community Technical Aid on board. Adrian Conway suggested that further representations should be made through Sean Moran.

2. Garda Issues

Gardai said cameras do not cover the full Quays. Private CCTV would not be under their control. There are two issues causing concern – (a) teenagers from the Northside and teenagers from the local area engaging in anti social behaviour by organising “fights among themselves” and (b) other issues including the use of drugs and people drinking on the streets, etc. The Gardai stated they had an open mind as to the issue of the proposed wall.


Issues – e.g. lack of parking at City Quay and poor lighting at Lombard Street were discussed.
Ms. Lucinda Creighton T.D.,
Minister of State for European Affairs,
Department of An Taoiseach,
Government Buildings,
Merrion St.,
Dublin 2

27th. April 2011

Re: South Campshires Flood Defence Project
Meeting with Local Residents.

Dear Minister,

I refer to the meeting with local residents which you attended on Wednesday 2nd March 2011, organised by the South East Area Office and to the subsequent e-mail from your office dated 27th. April 2011.

In relation to the two substantive issues raised by the residents at the meeting the situation is as follows:

1. Anti Social Behaviour

I have noted the views of the residents as expressed at the meeting that they wanted the wall located on the quay edge as they felt that any other location would exacerbate their ongoing difficulties with anti social behaviour on the campshires. At the meeting, I pointed out that there were a number of reasons why this option was not chosen, including the policy of Dublin City Council and Dublin Port Company to retain the use of the quayside for shipping and maritime events into the future. This policy is demonstrated by the decision to have all of the bridges east of the Memorial Road Bridge constructed as opening bridges.

The Project Steering Group met on 5th. April 2011 to consider the views expressed by the residents. At that meeting, Mr. Gerry Kelly, CEO of the DDDA said he shared the concerns of the residents in regard to these matters. However he accepted the importance of the project in terms of flood defence requirements.

The general consensus of the other members of the Steering Group was that the current design was the best possible compromise, taking all of the various and often conflicting viewpoints into account. The Group asked the Project team to further assess the design against best practice in this area, including policies under the general heading of "Designing out Crime" in use in the United Kingdom. The Project team was also asked to examine the use of particular pavement types in close proximity of the proposed wall to deter sitting or lying on the ground behind the proposed wall.

Mr. Kelly said would consult further with Dublin Port Company in relation to the shipping access issue. He said he would bring the matter to the next DDDA Board meeting later in April, following which the DDDA would write to the DCC Project team. He accepted that it was unlikely that any design would satisfy all of the concerns and he proposed that the DDDA
would write to DCC allowing, as landowner, the DCC project team lodge the EIS with an Bord Pleanala, but expressing their reservations in relation to the issues as outlined. The DDDA may also make certain observations on this issue directly to an Bord Pleanala. It is, therefore, the intention of the Project Team to assess the current design in the light of this issue as outlined above and then, following receipt of the DDDA letter as described above, proceed to submit the project EIS, as amended if necessary, to an Bord Pleanala, probably towards the end of May 2011.

As I explained at the meeting on 2nd March, this lodgement will coincide with the start of a formal public consultation phase, with the EIS going on public display in the area, as well as in the DCC Civic Offices. I will be confirming full details of this arrangement to the DCC Area Manager prior to that date and I am sure he will circulate that information to yourself and the other public representatives in the area at that time.

2. Flood Risk at Forbes St.

This issue was raised, in particular, by Ms. Brigid Walsh with whom I have corresponded directly as promised. I enclose a Report drawn up since the meeting and already forwarded to Ms. Walsh, which examines this issue in detail. You will note the following:

- DCC is satisfied that the level of flood risk at Forbes St. and to the east of Macken St. generally is significantly lower than the area being protected by the proposed works, due to the topography of this area.
- Notwithstanding the above, and the attached Report, DCC is engaging in further surveys in this area, the results of which will be incorporated into the final EIS in establishing why the proposed flood defences terminate where they do. If there is any residual risk to properties in this area during periods when extreme flood events are forecast, DCC will consider the use of temporary flood defences placed across these streets during such periods.

I trust this is satisfactory.

Yours sincerely,

Adrian Conway,
Senior Engineer.

Encl. Forbes St Flood Risk Report

cc. (letter only) Michael O’Neill, South East Area Manager.
Dear Deputy Humphreys,

I refer to meeting with local residents which you attended on Wednesday 2nd March 2011, organised by the South East Area Office. I attach, as requested, a CD with a copy of the presentation given at that meeting by this office for your information.

In relation to the two substantive issues raised by the residents at the meeting the situation is as follows:

1. Anti Social Behaviour

I have noted the views of the residents as expressed at the meeting that they wanted the wall located on the quay edge as they felt that any other location could exacerbate their ongoing difficulties with anti social behaviour on the campshires. At the meeting, I pointed out that there were a number of reasons why this option was not chosen, including the policy of Dublin City Council and Dublin Port Company to retain the use of the quayside for shipping and maritime events into the future. This policy is demonstrated by the decision to have all of the bridges east of the Memorial Road Bridge constructed as opening bridges.

The Project Steering Group met on 5th April 2011 to consider the views expressed by the residents. At that meeting, Mr. Gerry Kelly, CEO of the DDDA said he shared the concerns of the residents in regard to these matters. However he accepted the importance of the project in terms of flood defence requirements.

The general consensus of the other members of the Steering Group was that the current design was the best possible compromise, taking all of the various and often conflicting viewpoints into account. The Group asked the Project team to further assess the design against best practice in this area, including policies under the general heading of “Designing out Crime” in use in the United Kingdom. The Project team was also asked to examine the use of particular pavement types in close proximity of the proposed wall to deter sitting or lying on the ground behind the proposed wall.

Mr. Kelly said would consult further with Dublin Port Company in relation to the shipping access issue. He said he would bring the matter to the next DDDA Board meeting later in April, following which the DDDA would write to the DCC Project team. He accepted that it was
unlikely that any design would satisfy all of the concerns and he proposed that the DDDA would write to DCC allowing, as landowner, the DCC project team lodge the EIS with an Bord Pleanala, but expressing their reservations in relation to the issues as outlined. The DDDA may also make certain observations on this issue directly to an Bord Pleanala. It is, therefore, the intention of the Project Team to assess the current design in the light of this issue as outlined above and then, following receipt of the DDDA letter as described above, proceed to submit the project EIS, as amended if necessary, to an Bord Pleanala, probably towards the end of May 2011. As I explained at the meeting on 2nd March, this lodgement will coincide with the start of a formal public consultation phase, with the EIS going on public display in the area, as well as in the DCC Civic Offices. I will be confirming full details of this arrangement to the DCC Area Manager prior to that date and I am sure he will circulate that information to yourself and the other public representatives in the area at that time.

2. Flood Risk at Forbes St.

This issue was raised, in particular, by Ms. Brigid Walsh with whom I am corresponding directly as promised. I enclose a Report drawn up since the meeting which examines this issue in detail. You will note the following:

- DCC is satisfied that the level of flood risk at Forbes St. and to the east of Macken St. generally is significantly lower than the area being protected by the proposed works, due to the topography of this area.
- Notwithstanding the above, and the attached Report, DCC is engaging in further surveys in this area, the results of which will be incorporated into the final EIS in establishing why the proposed flood defences terminate where they do. If there is any residual risk to properties in this area during periods when extreme flood events are forecast, DCC will consider the use of temporary flood defences placed across these streets during such periods.

I trust this is satisfactory.

Yours sincerely,

Adrian Conway,
Senior Engineer.

Encl. CD., Forbes St Flood Risk Report

cc. Michael O’Neill, South East Area Manager.
Ms. Linda O’Toole Byrne,
46a City Quay,
Dublin 2.

8th April 2011

Re: South Campshires Flood Defence Project
Meeting with Local Residents.

Dear Ms. O’Toole Byrne,

I refer to meeting with local residents which you attended on Wednesday 2nd March 2011, organised by the South East Area Office.

I have noted the views of the residents as expressed at the meeting that they wanted the wall located on the quay edge as they felt that any other location could exacerbate their ongoing difficulties with anti social behaviour on the campshires. At the meeting, I pointed out that there were a number of reasons why this option was not chosen, including the policy of Dublin City Council and Dublin Port Company to retain the use of the quayside for shipping and maritime events into the future. This policy is demonstrated by the decision to have all of the bridges east of the Memorial Road Bridge constructed as opening bridges.

The Project Steering Group met on 5th April 2011 to consider the views expressed by the residents. At that meeting, Mr. Gerry Kelly, CEO of the DDDA said he shared the concerns of the residents in regard to these matters. However he accepted the importance of the project in terms of flood defence requirements.

The general consensus of the other members of the Steering Group was that the current design was the best possible compromise, taking all of the various and often conflicting viewpoints into account. The Group asked the Project team to further assess the design against best practice in this area, including policies under the general heading of “Designing out Crime” in use in the United Kingdom. The Project team was also asked to examine the use of particular pavement types in close proximity of the proposed wall to deter sitting or lying on the ground behind the proposed wall. He said he would bring the matter to the next DDDA Board meeting later in April, following which the DDDA would write to the DCC Project team. He accepted that it was unlikely that any design would satisfy all of the concerns and he proposed that the DDDA would write to DCC allowing, as landowner, the DCC project team lodge the EIS with an Bord Pleanala, but expressing their reservations in relation to the issues as outlined.
It is, therefore, the intention of the Project Team to assess the current design in the light of this issue as outlined above and then, following receipt of the DDDA letter as described above, proceed to submit the project EIS, as amended if necessary, to an Bord Pleanala, probably towards the end of May 2011.

As I explained at the meeting on 2nd March, this lodgement will coincide with the start of a formal public consultation phase, with the EIS going on public display in the area, as well as in the DCC Civic Offices. I will be confirming full details of this arrangement to the DCC Area Manager prior to that date and I can write to you directly at that time also.

Yours sincerely,

______________________________

Adrian Conway,
Senior Engineer.
Adrian Conway  
Engineering Department  
Dublin City Council  
Civic Offices  
Dublin 8

10th May 2011

Re City Quay Anti-Flood Cell

Dear Mr Conway,

We are writing regarding the proposed anti-flood works for the City Quay Cell.

We trust you take this as our formal response to be included as the stakeholder scoping, for inclusion as part of the planning process, and production of an Environmental Impact Study to be included as part of the application to An Board Pleanala.

We will of course also be sending our concerns to An Board Pleanala as part of the observation process of the planning process.

We acknowledge the need for the flood defence work to be undertaken and thank you for your presentation to our residents. As stated at the presentation meeting we have significant concerns that need to be addressed.

The proposed wall creates a new linear pathway one metre high close to our homes. As you are keenly aware from other developments, which are linear in nature, there are consequences to these developments. In particular we draw your attention to the Luas line e.g. Jervis Street and the Boardwalk along the Liffey. Broadly speaking both developments have fulfilled their brief, but both also have significant anti-social aspects. The Boardwalk in the summer attracts high levels of public drug misuse and antisocial behaviour, as well as problems with graffiti. The Luas Line has similar problems at key stops. The Luas
operator has been forced to hire security staff and install CCTV to reduce the anti-social behaviour at the stops.

As you are aware a dispensing drugs clinic is within 150 metres of the proposed wall. There is already some anti-social behaviour occurring on the Campshires beside our homes (see enclosed letter from the Gardaí). We believe from significant experiences that this will increase if a new one metre high wall is placed where it is proposed.

- Firstly it will be graffitied as all studies have shown that one metre high walls are ideal both visually and locationally ideal for graffiti.
- Secondly, a one metre high wall placed that far back from the river bank provides an ideal sitting out area for people, due to low height of the wall and the fact that there will be less wind blowing. If the wall is placed closer to the Great Wall then the climatic conditions make it less comfortable. This is the proposal we favour as it will reduce noise and anti-social behaviour.

We note in the Dublin City Development Plan 5.2.4.10 Noise pollution

_Dublin City Council is actively engaged in the strategic management of noise in compliance with requirements under the Environmental Noise Directive. Dublin City Council through the planning system can minimise the adverse impacts of noise pollution by controlling developments which are noise intensive away from more sensitive areas such as residential areas._

_S154 To reduce noise pollution by requiring all developments to be designed and operated in a manner that will minimise noise levels_

_S1085 To give careful consideration to the location of noise sensitive developments so as to ensure they are protected from major noise sources_

As these are the policies of Dublin City Council we note our proposal is in line with the City Plan and ask that you adhere to the policies and objectives set forth.

As part of the E.I.S. we wish to see our proposed scenario tested and to be included as a mitigation response to our concerns. In addition we wish to see a detailed design including a materials chart and design control to be used to
control anti-social behaviour and skateboarding. In addition we require assurances that the controls set down in the E.I.S. will be adhered to, even without a mandated condition from An Bord Pleanala.

We trust you will contact us to discuss this and look forward to seeing copies of the E.I.S. with our scenario incorporated.

Thanking you for your consideration in this matter.

Yours Faithfully

Kathleen Rice
36 City Quay
Dublin 2.
Kathleen Rice (Mrs)  
36. City Quay  
Dublin 2.

To whom it may concern,

I, the above named, register my objections in the strongest possible terms to the proposed construction of the Liffey Flood Barrier, on the City Quay site as presently designated.

I feel its construction will be an eyesore in the area, and will help conceal the illegal activities of undesirables in the district. Not to mention, a gathering point for all the other drug dealers and abusers from nearby areas.

In my opinion this proposal needs to go back to the drawing board.

 yours faithfully,

Kathleen Rice.
Ms. Brigid Walsh,
11N Hanover Reach,
Forbes Street,
Dublin 2.

8th April 2011

Dear Ms. Walsh,

I refer to meeting with local Residents regarding the South Campshires Flood Protection Project on 2nd March 2011 which you attended.

You raised a particular concern that the proposed wall was not protecting the Forbes Street area. As promised I have had this issue examined and I attach for your information report on the Flood Risk in the Forbes St. area.

It is proposed to have the EIS completed and submitted to An Bord Pleanala on or about end May 2011 at which time the full details of the Project will be put on display to allow public consultation.

As stated the final version of the EIS will take account of the concerns raised by you in relation to the Flood Risk issue.

If you have any further queries please feel free to ring this office.

Yours sincerely,

Adrian Conway,
Senior Engineer.

Ms. Anna Connaughton,
McCann Fitzgerald,
Riverside One,
Sir John Rogerson’s Quay,
Dublin 2.

20th May 2011

Re: South Campshires Flood Defence Project.

Dear Ms Connaughton,

I refer to previous correspondence in relation to the above matter and to our meeting on 5th April 2011 at McCann Fitzgerald Offices, where we outlined the proposals, in particular the proposal to have a terminal connection point for a demountable flood defence fixed to your building.

It was agreed at that meeting that we would forward more details of the proposal for your consideration, including details of the exact location of the proposed fixture, the material used etc.

I must apologise for the delay in forwarding these details which was due to some difficulty in obtaining the technical information from the manufacturers of the particular type of demountable defence proposed.

Please find attached Moylan drawing No. P107, which contains all of the relevant information. You should note that, following our meeting, we have moved the proposed location of the defence to “Location B” which is further east and allows the permanent fixing point to be fixed to the outer wall of the existing ramp rather than directly to the building – the new location also avoids any interference with access to your building at times when the defences are in place.

I would be obliged if you would consider this information, consult with all relevant interests and revert to me as soon as possible.

It is intended to submit the Environmental Impact Statement for the overall project to an Bord Pleanála shortly and it would be intended to include these proposals and reference to the consultations in the EIS, and, hopefully agreement, with McCann Fitzgerald, so an early response would be greatly appreciated.

Yours sincerely,

Adrian Conway,
Senior Engineer.

c.c. Nick Smith, Moylan
South Campshire Flood Protection Project

Minutes of Steering Group Meeting

TIME & DATE: 3.00pm 5th April 2011
LOCATION: Block 1, Floor 4, Conf. Room

PRESENT

<table>
<thead>
<tr>
<th>Name</th>
<th>Position/Department</th>
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<tbody>
<tr>
<td>Gerry Kelly (GK)</td>
<td>CEO, Dublin Docklands Development Authority</td>
</tr>
<tr>
<td>Patrick Opdebeeck (PO)</td>
<td>Moylans</td>
</tr>
<tr>
<td>Nick Smith (NS)</td>
<td>Moylans</td>
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<tr>
<td>Grainne Shaffrey (GS)</td>
<td>Shaffrey &amp; Assoc.</td>
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<tr>
<td>Tomas O Connor (TOC)</td>
<td>Shaffrey &amp; Assoc.</td>
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<tr>
<td>Owen O ‘Doherty (O’OD)</td>
<td>DCC City Architect’s Dept.</td>
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<tr>
<td>Rory Deegan (RD)</td>
<td>DCC Planning Dept.</td>
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<tr>
<td>Ruth Johnson (RJ)</td>
<td>Dublin City Archaeologist</td>
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<tr>
<td>Tony Maguire (TM)</td>
<td>DCC Flood Resilient Cities Project</td>
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<tr>
<td>A Conway (AC)</td>
<td>DCC PMO</td>
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<tr>
<td>Thomas Doyle (TD)</td>
<td>DCC PMO</td>
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<tr>
<td>Yvonne Patterson (YP)</td>
<td>DCC PMO</td>
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Item No. | Item Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Action |
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<td>1</td>
<td>AC asked to meet with the Steering Committee today to report to the group of the outcome of a recent Public Meeting (2nd March 2011) organised by the South East Area Office and to ask the Steering Group for a formal decision as to any actions that were required arising from that meeting.</td>
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<td>The main issue raised at the Public Meeting was the location of the wall. The residents wanted the wall located on the quay edge as they felt that any other location would exacerbate their ongoing difficulties with anti social behaviour on the campshires. AC pointed out at the meeting, that there were a number of reasons why this option was not chosen, including the policy of Dublin City Council and Dublin Port Company to retain the use of the quayside for shipping and maritime events into the future. The decision by DCC and DDDA to have all of the bridges east of the Memorial Road Bridge, most recently the Beckett Bridge, constructed as opening bridges to allow shops access this area has cost a considerable amount of money and placing the proposed wall directly on the quay side would be seen as undermining that position. He had also pointed out that the wall was a maximum of 900mm high. However, the residents were adamant that they would not accept the current proposed location. Gerry Kelly CEO of the DDDA said he shared the concerns of the residents in regard to these matters. However he accepted the importance of the project in terms of flood defence requirements. He felt that there may be too much weight given to the requirements for the very occasional uses for shipping access, as opposed to the ongoing concerns of the local residents.</td>
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<td>AC said that the Project Team had recently met with representatives from Dublin Port Company (Ciaran Callan and David Dignam) on site and that these representatives confirmed the previously stated position of the Port Company that the proposed wall should be located away from the quay side to ensure continued use of the quay side by shipping. Moreover, they were not happy that the current design included sections of the proposed wall close to the quay side in the area between the ESB sub station and the Beckett Bridge. GK said that he would consult further with the CEO of Dublin Port Company on this matter and may then revert to the Project Team on the outcome of this consultation.</td>
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<td>The general consensus of the other members of the Steering Group was that the current design was the best possible compromise, taking all of the various and often conflicting viewpoints into account. The Group asked the Project team to further assess the design against best practice in this area. OOD mentioned a UK report that could be useful “Designing out Crime”. The Project Team will look into this. The Project team was also asked to examine the use of particular pavement types in close proximity of the proposed wall to deter sitting or lying on the ground behind the proposed wall.</td>
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<td>GK accepted that it was unlikely that any design would satisfy all of the concerns. He accepted the importance of the flood protection for the area and he said the DDDA did not want to prevent the project from seeking approval from an Bord Pleanala who would have the task of weighing up all of the various viewpoints and making a decision on the matter.</td>
<td>GK</td>
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<td>He said he would bring the matter to the next DDDA Board meeting later in April. He would be proposing that the DDDA would then write to DCC as the landowner, allowing the DCC project team lodge the EIS with an Bord Pleanala, but expressing their reservations in relation to the issues as outlined. He also said the DDDA may wish to formally present their reservations in relation to the matters raised by the residents to an Bord Pleanala when the EIS was lodged.</td>
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<td>5</td>
<td>It was agreed that the overall concept of the current design would be retained, but that the design would be reviewed in the light of the issues raised above, and in the light of the UK policy documents mentioned. The Project Team would make any necessary amendments, including amending the EIS Report to include for the consultation with the residents and the issue of anti social behaviour. Following receipt of the DDDA letter as described above, the Project Team would proceed to submit the project EIS, as amended if necessary, to an Bord Pleanala, probably towards the end of May 2011. It was agreed that there was no requirement for a further meeting of the Steering Group in advance of this submission.</td>
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<td>6</td>
<td>The Steering Group Committee will be kept informed of progress as will the DCC South East Area Office. AC noted that Thomas Doyle was departing from the PMO Team shortly on a career break and thanked him for all of his work on the project.</td>
<td>PMO</td>
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**Distribution:** All present, Tom Leahy, DCC Executive Manager (Engineering); Michael O'Neill DCC SE Area Manager