08 - DODDER CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT STUDY.

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Abstract

The Dodder Catchment Flood Risk Assessment and Management Study (CFRAMS) had amongst its objectives:-

- Identify and map existing and potential future flood hazard risk.
- Identify viable structural and non-structural measures and options for managing flood risk.
- Build a strategic information database to make informed decisions to manage flood risk.
- Develop an environmentally, socially and economically appropriate long term strategy to manage the flood risk and help ensure safety and sustainability of communities.
- Carry out a Strategic Environmental Assessment (SEA) and Appropriate Assessment (AA) to ensure environmental issues and opportunities for enhancement are included in all decisions.
- Comply with the requirements of EU Directive 2007/60/EC "Floods Directive".
- Comply with all environmental and other legislation relevant to the study and plan.

This study was managed by Dublin City Council on behalf of the OPW and the three local authorities.

This Study included preparation of the following documents:

- Hydrological Analysis Report
- Hydraulic Analysis Report
- Preliminary Options Screening Report
- Option Multi Criteria Analysis
- Urban Drainage Accommodation Report
- Maintenance Plan
- Habitats Directive Assessment (Natura Impact Statement)
- Strategic Environmental Assessment (SEA) Report

Throughout the CFRAMS process there was significant consultation to ensure that knowledge, experience and views of stakeholders and the public were evaluated.

1. INTRODUCTION

1.1 Recent Major Floods

Severe Dodder fluvial floods occurred on 25 August 1986 (Hurricane Charlie) and on 24th October 2011 while on the first of February 2002 the most severe tidal flood took place. 369,

335 and 621 dwellings respectively were reported flooded in the Catchment as a result of these events.

1.2 Study Approach

The Dodder CFRAMS has been to a level of detail appropriate for the development of a Catchment Flood Risk Management Plan (CFRMP). It included the compilation and analysis of survey, meteorological, hydrological and tidal data. This data has been used to develop a suite of hydraulic computer models of the Dodder, its tributaries and Dublin Bay. Flood maps are the way in which the model results are communicated. The key types of mapping developed are flood extent, depth, velocity and hazard. These allow identification of likely locations within the catchment that are at flood risk.

Potential flood impacts were considered under three main categories:

- Economic: loss or damage to buildings or infrastructure
- Social: loss or damage to human life, health, community and social amenity
- Environmental and Heritage: sensitivity of the river environment, habitats, species, plus cultural and historical heritage.

The SEA process assessed the impacts of flooding on environment and heritage, at a strategic level.

Where flood risks are significant, the study has identified a range of potential flood risk options to manage these at four spatial scales:

- Catchment;
- Sub catchment or analysis unit (AU);
- Areas of potential significant risk (APSR) or flood cell;
- Individual risk receptor (IRR)

Fifteen objectives were applied under four different categories: economic; social; environmental and heritage; technical and other. The assessment process involved preliminary evaluation of a long list of measures for each AU and APSR to filter out inappropriate measures. It culminated in a detailed multi-criteria analysis (MCA) to determine the preferred option(s) for each assessment ensuring that options are evidence-based, transparent, inclusive of stakeholder and public views.

1.3 Flood risk management plan

The CFRMP does not provide solutions to all of the flooding problems. It does identify viable structural and non-structural cost beneficial options, with a positive MCA score, for managing the flood risks within the catchment as a whole and for localised high-risk areas.

- At catchment level, tidal and/or fluvial flood forecasting systems in conjunction with public awareness and flood warning programmes, maintenance, monitoring and policy measures such as spatial and flood planning.
- At Analysis Unit level, one option consisting of earth embankment flood defences.
- Within four APSR's/flood cells, proposals for flood defences and river works.

An indicative programme for implementation of the Dodder CFRMP was prepared.
The CFRAM Plan and many of the supporting documents can be viewed in more detail at www.dublincity.ie/Pages/DodderFloodStudy.apsx.

2. THE DODDER CATCHMENT

The Dodder Catchment area is of 121km^2 (47 sq. miles)-, flowing from the Dublin Mountains in South Dublin, to the middle portion around Chruchtown and Dundrum in Dun Laoghaire Rathdown County Council, to the lower portion including a two kilometre tidal stretch, in the Dartry, Clonskeagh, Donnybrook, Ballsbridge and Ringsend areas of Dublin City Council. The river is very steep with a gradient of 1:115.

The 121km^2 became 125km^2 during a 1% Annual Exceedance Probability (AEP) event (or 100 year event) due to floodwater contributions from neighbouring catchments. The lower part of the tidal zone up to London Bridge has predominately a tidal only influence and flood levels were designed from a previous study called the Dublin Coastal Flood Risk Assessment Study (2005) following the most severe tidal flooding of Dublin City on 1st February 2002 where over 1250 buildings were damaged. The Dodder CFRAMS linked into and confirmed the results of this earlier study in the tidal region.

The results of all other previous flood studies and records of flood defence works were analysed and incorporated into the Dodder CFRAMS.

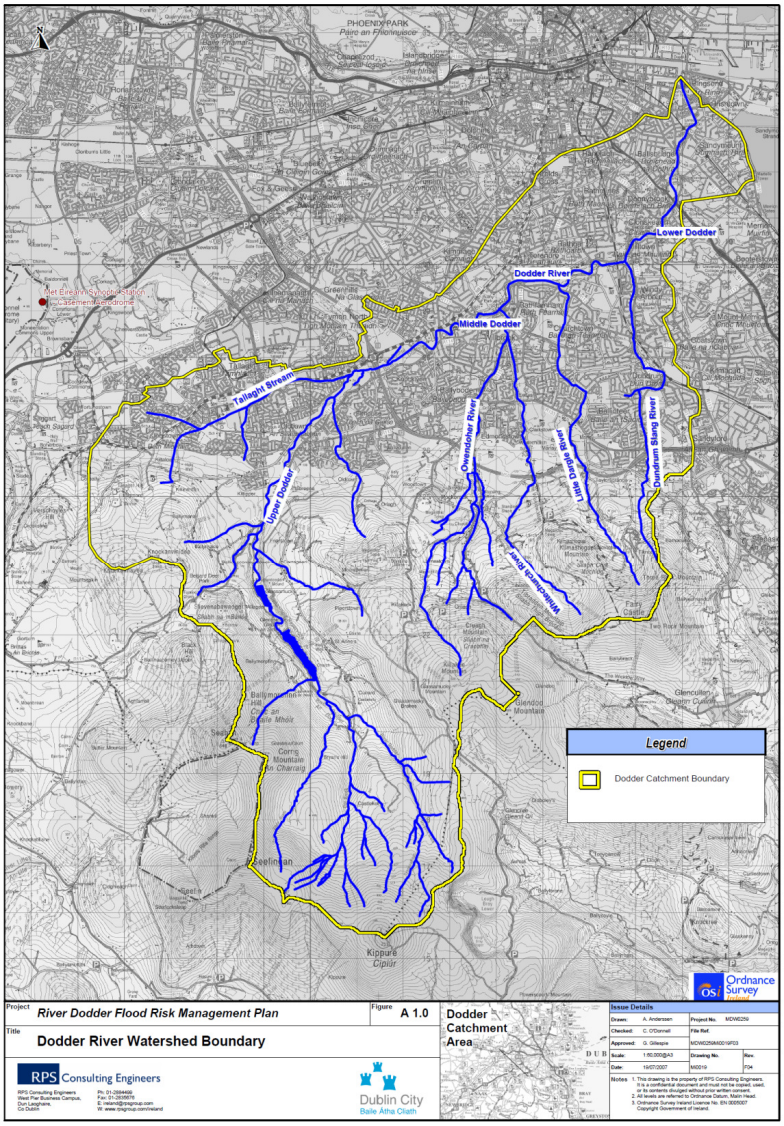

Figure 1: *Dodder river and five main tributaries.*

The river catchment is in three Local Authority areas namely Dublin City Council, South Dublin County Council and Dun Laoghaire Rathdown County Council. The main channel is only 19km long downstream of two storage reservoirs and the tributaries are the Tallaght stream which is 5km long, the Owendoher stream is 10km long, the Whitechurch stream is 8km long, the Little Dargle is 8km long, the Dundrum Slang is 8km long and the tidal region is 2km long.

The figure below shows the normal extent of the Dodder Catchment, very steep at the top in the Dublin Mountains, some farmland and development areas (in orange) below this and heavily developed urban area below this to the Liffey estuary. Some floodplains are shown in the lower catchment which extend outside of the catchment area.

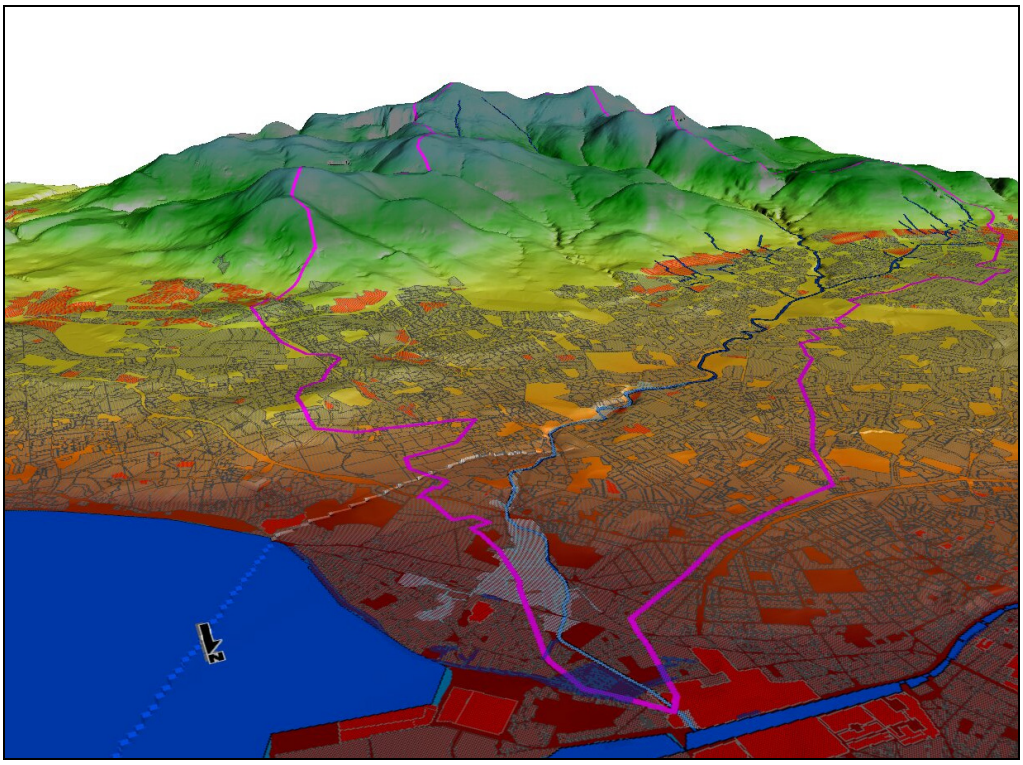

Figure 2: *Dodder Catchment Topographical, Development and floodplains.*

For the purpose assessing future flood flows, it was assumed that no significant development would occur above the 180m Malin Head level which is approximately the foot of the mountains. It was assumed that all of the designated development land will be built upon. A climate change scenario was considered with rainfall assumed to increase by 25% and tide levels assumed to rise by 600mm, these are slightly changed in the National CFRAMS programme following the latest outputs from the International Panel on Climate Change, (IPCC).

It should also be noted that the five major tributaries, in total contribute almost 50% of the catchment and thus normally 50% of the flows. Most go through heavily urbanised areas similar to the main Dodder river and are very steeply inclined.

Two storage reservoirs in Bohernabreena on the main river Dodder have a capacity of 1.6 and 0.73 million cubic metres respectively. They are located upstream of Tallaght, (see Fig 1 above). The larger of the two is upstream and used to supply drinking water to County Dublin while the lower one is used to maintain a minimum flow in the river for flora and fauna. The

lower reservoir water level is reduced before forecast heavy rainfall but it has a negligible effect on flooding downstream.

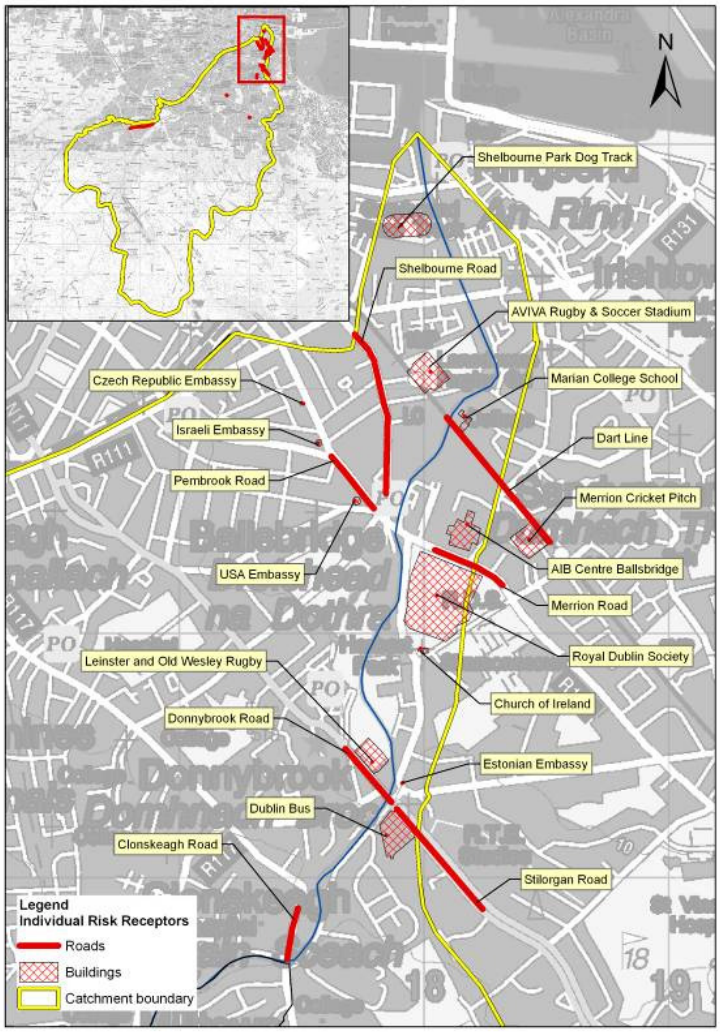

Figure 3: *Individual Risk Receptors*

3. SURVEYS AND MODELS

The Dodder CFRAMS required many detailed surveys. These included:- Historic, Centreline, Cross-sections, Lidar, Structural, Existing flowmeter and raingauge records, Planning zones, Land usage and Floor levels of buildings which had been flooded in the past. Cross-sections were taken every 100m, at every bridge and at every change in direction. These cross-sections were carried out to the anticipated extent of the 100 year floodplain from historical records. Every inlet of 300mm or larger was surveyed. The centreline of the river and tributaries was surveyed every 30m, upstream and downstream of each weir (of which there are many). All of this was carried out on the main Dodder from the Liffey estuary up to the Lower Bohernabreena Reservoir. On the tributaries it was carried out until the tributary disappeared into the local piped drainage network or until it left the urbanised area.

Visual structural surveys were carried out of all existing flood defences and recommendations made on their standard of repair. Three river gauges were used on the main Dodder upstream of Waldron's Bridge, on the Owendoher near the Tuning Fork and on the Slang at Frankfort

Court, all of which had significant historical data. These were combined with eight raingauges to produce design flow estimates for the 2, 5, 10, 25, 50, 100, 200 and 1,000 year flood events.

Individual Risk Receptors were identified. These were buildings or critical infrastructure, the loss of which, even for a short period of time, will have a significant effect on the local population. They included main roads (some National Primary), electricity supply stations and substations, embassies, schools, banks, sports grounds, shopping complexes, strategic Government Buildings, etc. Some of these are outlined in Figure 3 above.

Nine interlinked computer models were built to represent the five tributaries, the three fluvial sections of the main Dodder and the tidal region. The Mike suite of computer model software was applied, mainly Mike 11 for the 1D flows in the river channel and Mike 12 for 2D flows in the floodplains. The August 1986 Hurricane Charlie event with certain modifications was used to verify the 100 year computer modelled event and the 1st February 2002 tidal flood event was used to verify flooding in the tidal region. A joint probability analysis was carried out to determine the design fluvial and tidal event which gave the highest water level and therefore caused the most damage in the tidal region. Seven different scenarios were modelled and the 100 year fluvial event combined with a five year high tide gave the highest flood water levels in this region.

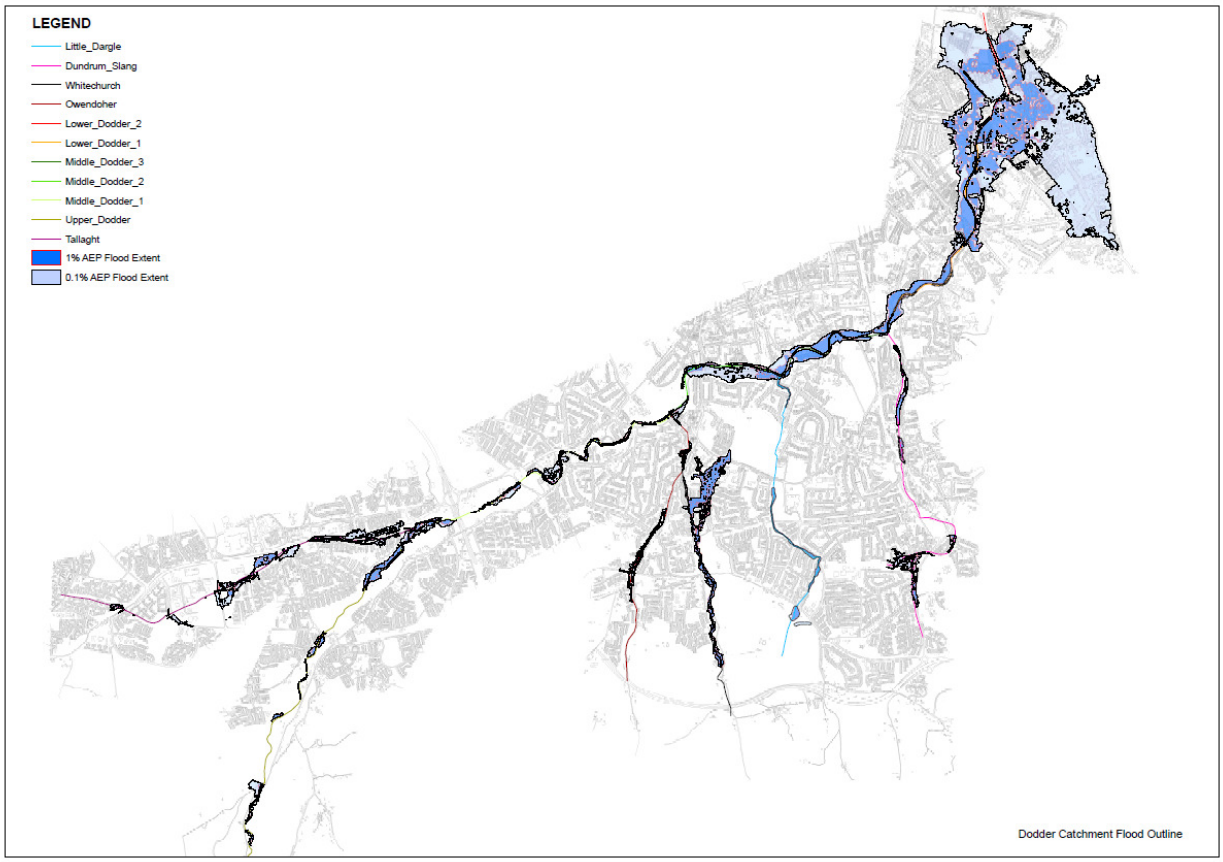

Figure 4: *Dodder Catchment Fluvial Flood Extent Map.*

Once the computer models, with minor adjustments, were verified for the test events they were run for the estimated 1,000 year flood event down to the two year event. Damages in each of these events were calculated. The 100 year and 1,000 year flood extent map for the catchment is shown above.

Many of the flooded areas shown occur in existing parkland and over the years these have proved a valuable flood alleviation resource. Minor environmental damage temporarily occurs, but floodwaters have normally disappeared back into the watercourse within the next 24 hours and the environment recovers quickly.

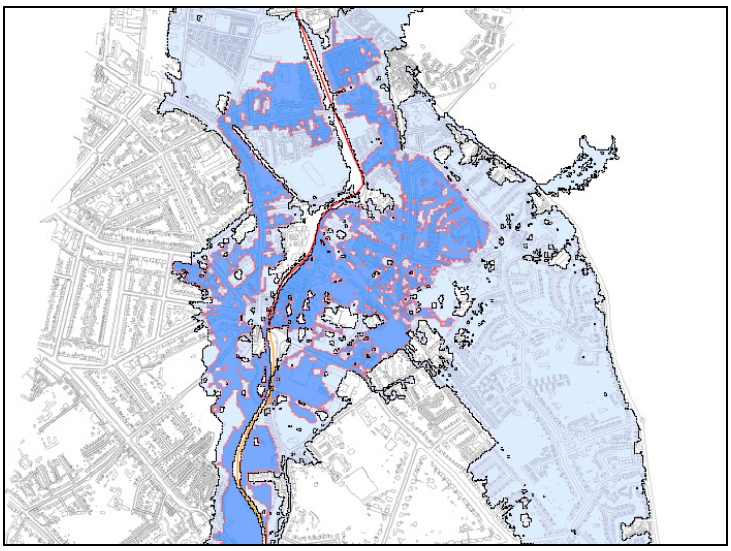

Figure 5: *Modelled Flood Extent for 100 and 1,000 year events on Lower Dodder.*

However other areas at risk of flooding in the 100 year flood event are in highly developed urban areas as shown in Figure 5. These areas require significant flood protection if it can be justified. Many of these areas are already protected to cater for a 20 to 30 year flood event following previous flooding and this leads to difficulties in some cases in identifying a cost beneficial flood alleviation scheme.

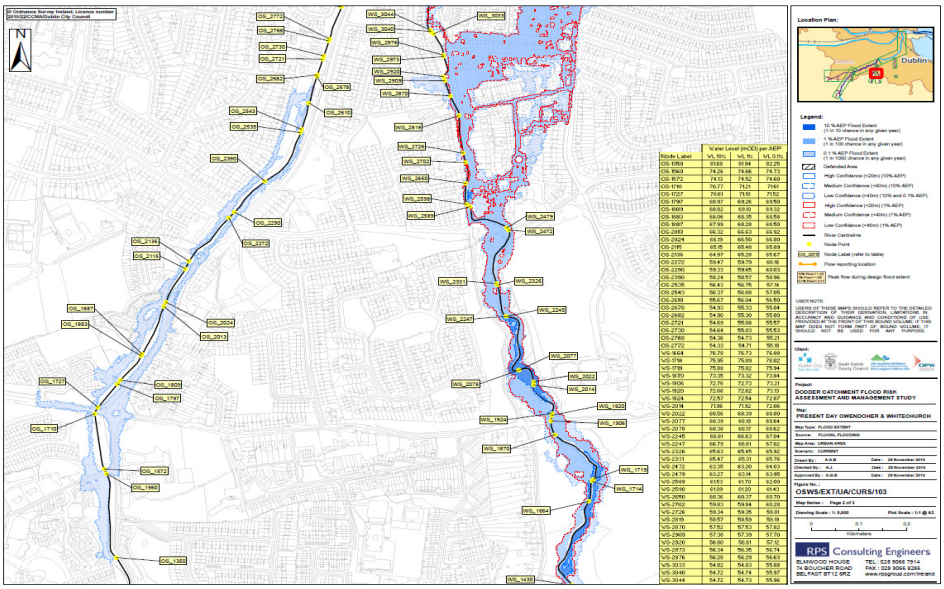

Figure 6: *Modelled Flood Levels for 10 year, 100 year and 1,000 year events.*

Many different flood maps are now available from the study. Above is a flood extent and water level map, but velocity, depth and hazard maps were also produced.

A study of the social activities on the river was also carried out. These included fishing for brown trout and mullet as well as walking, running and cycling on the various paths and parklands beside the river. Many people deliberately walk along a portion of the river on the way to or from work. Access to wildlife includes swans, ducks, kingfishers, foxes, other birds, fish, etc. and also viewing the many trees and other fauna beside the river. The taking pictures of wildlife, bridges, weirs, waterfalls, the environment, etc. as well as sitting beside the river and getting away from the noisy city.

An urban accommodation report was also prepared. This analysed the influence of the main river in flood on the local stormwater piped network. It identified critical manholes in the network which would be under pressure following a significant rainfall event. It also identified the likely duration of surcharge on the underground drainage network.

A Strategic Environmental Assessment (SEA) of all of the known environmental gems and more common environmental assets of the Dodder River and tributaries was also carried out. It highlighted bats, birds, fish, plants, geological features of particular interest as well as the general large value of an open river in an urban area.

An Appropriate Assessment (AA) and Natura Impact Study (NIS) identified all of the SPC, SPA, pNHA and other Natura 2000 sites existing or proposed in the catchment, so that all flood alleviation scenarios and options could be evaluated against these to ensure that there would be no significant impact.

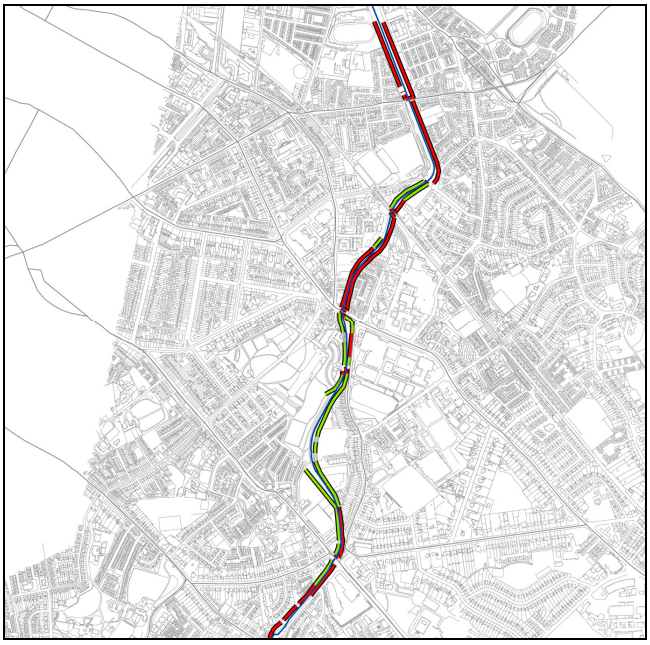

Figure 7: *Lower Dodder Flood Cell, proposed defences. Red indicates flood walls & green embankments.*

4. SCENARIOS

Scenarios considered included: Do nothing (as a baseline for comparison), Flood Forecasting & Flood Warning Systems, Sustainable urban Drainage Systems (SuDS), Proactive and Reactive Maintenance, Public Awareness Campaign, Rehabilitation of existing defences, Upstream Storage, Tidal Barrage, Increasing channel conveyance, Relocation of buildings,

Embankments, Flood walls, Culverting, Diversion of watercourses, Overland floodways, Deculverting, Altering bridges, Individual property protection and Flood proofing. These scenarios were considered both on their own and in combination with each other.

Following initial screening, all of the above remaining scenarios were evaluated on a cost basis, with regard to the benefits of each. One absolute criterion of the CFRAMS process is that the cost of any project has to be less than the benefits when evaluated over a 50 year time frame. Therefore all short-listed options went through this process and some were discarded as being too expensive.

Once a scenario is cost beneficial it is further evaluated using a Multi-Criteria Analysis. For the Dodder, +/- 30% of the marks went for economic viability, environmental viability and social viability. A further +/- 10% went for adaptability (mainly regarding global warming), buildability (mainly Health and Safety Aspects) and making sure that the proposal will not disimprove the situation upstream or downstream. A scenario must score above zero overall to progress to the next stage as a viable option.

Multi Criteria Analysis

Core Criteria	Objective	
Economic (±30%)	a	Ensure flood risk management expenditure is risk based Benefit Cost Ratio, 10.0=+30%, 1.0=0%, 0.1=-30%.
Social (±30%)	a	Human Life. Minimise health and safety risk of flood risk management options
	b	Protect key infrastructure
	c	Protect existing, and where possible create new waterside access and recreational and community facilities
	d	Maintain, and where possible increase, existing waterside access for fishing
Environmental & Heritage (±30%)	a	Safeguard and promote sustainable land use in keeping with WFD
	b	Support the achievement of good ecological status/good ecological potential (GES/GEP) under the WFD. Particularly morphology as a supporting element to ecological status
	c	Protect the flora and fauna of the catchment and, where possible, enhance biodiversity, Remove Alien Species
	d	Protect, and where possible enhance, fisheries within the catchment
	e	Protect, and where possible enhance, landscape character and visual amenity
	f	Protect and where possible enhance known features of cultural heritage importance and their settings
Technical (±10%)	a	Ensure flood risk management options are operationally viable and to minimise maintenance required.
	b	Ensure flood risk management options are technically and logistically viable
	c	Ensure flood risk managed effectively into the future
Other	a	No increase in flood risk to other areas

- Overall scenario must score positive to become viable option
- Benefit Cost Ratio ≥ 1

Figure 8: *Multi Criteria Analysis.*

The short listed scenarios were evaluated at a total catchment level, at river and at tributary level. At the catchment level, public awareness, proactive and reactive maintenance were evaluated and ultimately recommended as viable and overall positive options under the multicriteria analysis. At tributary level construction works on the Whitechurch stream and small works on the Little Dargle were recommended. Individual flood cells were evaluated next and various flood cells in the Lower and Middle Dodder were found to be cost beneficial and gave a positive outcome from the MCA.

In general, construction scenarios which proved to be cost beneficial had a slightly positive score on economic evaluation, a significantly positive score on social evaluation and normally a slightly negative score on environmental evaluation. The highest negative environmental score was normally on the change to the visibility of the river or tributary due to increased height of flood defences. This negative value will be mitigated as far as possible

during the more detailed construction proposals. Where possible replanting of trees and shrubs temporarily lost during the construction process is part of the plan.

The technical and other criteria are to ensure that the proposed option does not cause new problems elsewhere, that it is reasonably easy to construct and maintain now and in the future.

5. RECOMMENDATIONS:

Overall the main recommended options were:-

- Develop public awareness,
- Carry out proactive maintenance
- Carry out reactive maintenance
- Construction works on Whitechurch Stream to protect over 200 dwellings from fluvial flooding in the 100 year event.
- Construction works on the Little Dargle to protect two buildings from flooding in the 100 year fluvial event.
- Construction works on the Middle and Lower Dodder to protect over 1500 dwellings and other buildings from flooding in the 100 year fluvial or 200 year tidal event.
- Mitigating measures to reduce environmental impact to construction areas and to negate any impacts to SPA, SPC, pNHA and other areas significant scientific interest. Measures to make any environmental damage temporary in nature where possible. Measures proposed to enhance any environmental aspects which have historical damage. Measures to remove invasive species particularly Himalayan Balsam and Japanese Knotweed.

6. PUBLIC CONSULTATION:

Public Information Days were held in July 2010 and the Draft CFRAMP, SEA and NIS went to public consultation between March and June 2012 in all three Local Authority areas.
Forty-six submissions were received and are being processed. The submissions in general are in favour of the Draft Plan to protect dwellings and properties from flooding provided all legislative procedures are complied with, any environmental damage is minimised, existing floodplain designations are maintained and any reconstruction of existing heritage items are carried out to the national standard.

6.1 What's Next?

The Final Plan, SEA Statement and Natura Impact Statement will be going before the three Local Authorities for ratification later this year. If this is successful, planning permission for the different recommended projects can be sought with commencement of them in the near future.

7. ACKNOWLEDGEMENTS

This study was prepared by a large team comprising approximately 25 person years of work. I would like to acknowledge in particular the following:-

(1) The Office of Public Works, in particular Gerry Gallagher, John Martin, Mark Adamson and John Murphy for their help and guidance throughout the project to date. The sponsorship predominately by the OPW made this project and the construction works carried out to date possible.
(2) Michael Phillips, Dublin City Engineer and President of Engineers Ireland. Tom Leahy, Executive Manager, Victor Coe, Executive Engineer and Alan O'Regan, Administrator, Dublin City Council for their support in this and other related projects.
(3) Dermot Finch, Senior Engineer, Stephen Deegan & Gabrielle McGee both Senior Executive Engineers, South Dublin County Council.
(4) Frank Austin, Director of Service and Ger Looney, Senior Engineer, Dun Laoghaire Rathdown County Council.
(5) Alan Barr, Andrew Jackson, (Project Manager), Bjorn Elsaisser, Claire Shannon, Mark Wilson and Claire Coleman all RPS.

8. REFERENCES:

Dodder Draft CFRAMP, SEA, AA and supporting documents.

Lee CFRAMP viewed at www.opw.ie.