Mixed Use Development (LRD), Santry Avenue, Dublin

Site Specific Flood Risk Assessment

230146-X-Z-X-XXX-RP-DBFL-CE-0002

INFRASTRUCTURE

February 2024

DBFL CONSULTING ENGINEERS

Project Title:	**Mixed Use Development (LRD), Santry Avenue, Dublin 9**		
Document Title:	**Site Specific Flood Risk Assessment**		
File Ref:	**230146-X-Z-X-XXX-RP-DBFL-CE-0002**		
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Rev.	Date	Description	Prepared	Reviewed	Approved
0	29/02/24	Issued for Planning	Ryan Parkes	Laura McLoughlin	Laura McLoughlin

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1 Introduction

1.1 Background

DBFL Consulting Engineers were commissioned by the Applicant to prepare a Site Specific Flood Risk Assessment (SSFRA). Dwyer Nolan Developments Ltd. wishes to apply for permission for a Large-Scale Residential Development (LRD) on this site, c. 1.5 hectares, located at the junction of Santry Avenue and Swords Road, Santry, Dublin 9. The development site is bounded to the north by Santry Avenue, to the east by Swords Road, to the west by Santry Avenue Industrial Estate, and to the south by the permitted Santry Place development (granted under Dublin City Council Ref.s. 2713/17 (as extended under Ref. 2713/17/X1), 2737/19 & 4549/22).

The proposed development provides for 321 no. apartments, comprised of 104 no. 1 bed, 198 no. 2 bed, & 19 no. 3 bed dwellings, in 4 no. seven to thirteen storey buildings, over basement level, with 3 no. retail units, a medical suite / GP Practice unit and community/arts & culture space (total c.1,460sq.m), all located at ground floor level, as well as a one storey residential amenity unit, facing onto Santry Avenue, located between Blocks A & D.

This SSFRA was prepared to comply with current planning legislation, in particular the recommendations of "The Planning System & Flood Risk Management - Guidelines for Planning Authorities".

Figure 3.1 – Site Location, Santry Avenue, Dublin 9 (Extract Google Maps)

2 Planning System and Flood Risk Management Guidelines

2.1 General

"The Planning System and Flood Risk Management Guidelines for Planning Authorities", November 2009 and its technical appendices outline the requirements for a Site Specific Flood Risk Assessment.

This type of development is classified as a "highly vulnerable development" according to Table 2.1 of the Guidelines (see below extract).

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).
*Uses not listed here should be considered on their own merits	

Table 3.1 Classification of vulnerability of different types of development

Table 2.1: Extract – The Planning System and Flood Risk Management Guidelines for Planning Authorities

Table 2.2 of the Guidelines indicates that this type of development is appropriate and compatible with Flood Zone C that is, outside the 1000 year flood extents (see below extract).

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Table 3.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

Table 2.2: Extract – The Planning System and Flood Risk Management Guidelines for Planning Authorities

2.2 Flood Risk Assessment Stages

This site-specific flood risk assessment will use existing flood risk information to determine the flood zone category of the site i.e. to check if the Guidelines Sequential Approach has been applied, see Table 2.3 below for details.

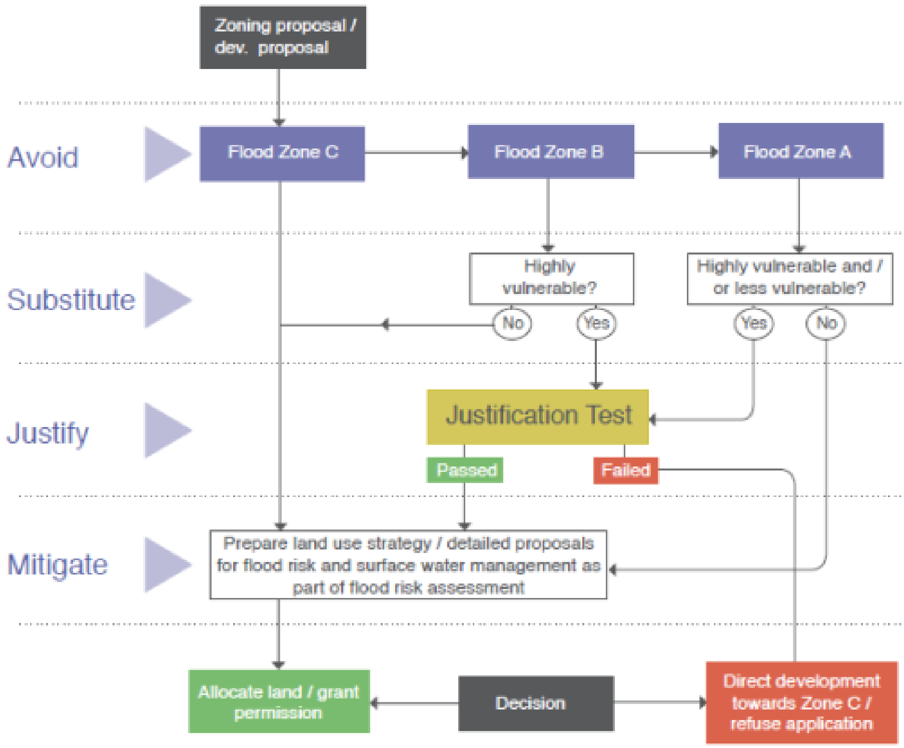

Table 2.3: Sequential Approach Mechanism in the Planning Process

Flood risk is normally assessed by a flood risk identification stage followed by an initial flood risk assessment. The Greater Dublin Strategic Drainage Study (GDSDS), states that if the risk of flooding is found to be low, there are no restrictions to development. However, if the risk is found to be medium or above, a more detailed flood impact assessment stage must be approved which includes an assessment of surface water management, flood risk and mitigation measures to be applied.

As stated in "*The Planning System and Flood Risk Management Guidelines for Planning Authorities*", the GDSDS is noted as the most comprehensive of local authority guidance documents developed to assist applicants in the preparation of their drainage design, including the drainage impact assessment and it is considered a key reference document.

3 Flood Risk Identification Stage

3.1 General

The initial flood risk identification stage uses existing information to identify and confirm whether there may be flooding or surface water management issues for the lands in question that warrant further investigation.

3.2 Information Sources Consulted

Information sources consulted for the identification exercise are outlined in Table 3.1 below.

Information	Source	Assessment
Predictive and historic flood maps, and benefiting lands maps, such as those available on http://www.floods.ie;	OPW www.floodmaps.ie and ECFRAMS website consulted.	The proposed development is located outside the extents of the 1 in 1000 year (0.1% AEP) of the Santry River (Fig 3.1). Flood events were recorded by DCC on the 24/04/1958 and 20/01/1965 approximately 300m to the south of the site on Swords Road (Fig 3.2). A Report produced by D.C.C. titled "Wad River catchment Study - Full Catchment Report Rev E " concludes the flooding was pluvial, originating from the mostly culverted River Wad. The proposed site is within the catchment of the River Wad. It is noted that a number of defence assets have since been put in place downstream of the site. We believe these works to be the 1967 diversion via a culvert along Ballymun Road to the River Tolka. Information on the River Wad is not available on the ECFRAMS website. Refer to Appendix A – River Tolka Flood Report and Appendix B – Wad River Catchment Study for further information. The site is located over 6.5km from the coast and outside tidal flooding extents.

Information	Source	Assessment
Management areas available on www.floodinfo.ie	OPW flood plans www.floodinfo.ie website consulted.	There were no OPW land commission schemes or benefitting land zones within the subject site's boundary.
Ground Investigation January 2019	Ground investigation conducted by GII on adjacent site in January 2019 as part of Planning Ref: 2713/17 & 2737/19 (directly south of the proposed development).	Perched water was encountered in one of the three boreholes conducted. The stratification is consistent with the groundwater vulnerability declared on the GSI mapping.
Topographical maps.	OSI Maps consulted, site topographic survey undertaken and analysed.	No evidence found of flooding within the proposed bounds of development. Historic maps (1888-1913) (Fig 3.3) were consulted. No evidence of previous water course or culvert in vicinity of site.
Information on existing public sewerage condition and performance;	GDSDS performance maps for existing sewerage in the vicinity of the subject site examined.	GDSDS flood mapping shows that the site is outside the Santry River catchment (Fig 3.4).
Alluvial deposit maps of the Geological Survey of Ireland. These maps, while not providing full coverage, can indicate areas that have flooded in the past.	GSI maps consulted.	The site consists primarily of till derived from limestones. Refer to Figure 3.6. Groundwater vulnerability is low. Refer to Figure 3.7. Subsoil permeability is low. Figure 3.8 Locally important aquifer-Bedrock which is moderately productive only in local zones. Refer to Figure 3.9.
Study on River Wad Catchment	River Wad Drainage Catchment Study Nicholas O'Dwyer Consulting Engineers.	The site was found to be within the catchment of the River Wad (Fig 3.5). The lower section of the Swords Road downstream of the site is also within the catchment of this River explaining the historical flooding event. D.C.C. has carried out a study on this river

Information	Source	Assessment
		catchment and the report can be found under heading 'Wad River catchment Study - Full Catchment Report Rev E ' on D.C.C's website.
Hydrogeological Impact Assessment	AWN Consulting.	A hydrogeological Impact Assessment was completed for the site by Awn consulting under a different cover on 18/06/2021. It was found that the proposed basement will have no long term impact on water levels in the overburden or underlying aquifer and no impact on the current water body status. The bedrock water table will not be affected by the excavation works.
Dublin City Council Development Plan 2022 - 2028	Dublin City Council Development Plan 2022 - 2028	The site which is located within the Wad catchment is addressed and is targeted within the life of the DCC development plan. The provisions are set out as below; Section 9.5.3 - Flood Management SI19 – Provision and Upgrading of Flood Alleviation Assets: To facilitate the provision of new, or the upgrading of existing, flood alleviation assets where necessary and in particular, the implementation of proposed flood alleviation schemes, on the Santry, Camac, Dodder, Wad, Naniken, Mayne, Tolka and Poddle rivers as well as Clontarf Promenade, Sandymount/ Promenade (northwards towards Irishtown Nature Park subject to the outcome of a flood/ environmental study), Liffey estuary and any other significant flood risk areas being progressed through the planning process to completion during the lifetime of the 2022-2028 Dublin City Development Plan, with due regard to the protection of natural heritage, built heritage and visual amenities, as well as potential climate change impacts SIO10 OPW Flood Relief Maintenance: To support and facilitate the OPW in its duty to maintain flood relief

Information	Source	Assessment
		schemes completed under the Arterial Drainage Acts, 1945-1995, including the schemes at River Dodder (Tidal), River Tolka, River Wad (Clanmoyle) South Campshires and Spencer Dock. It is not clear from the clear from the development plan as to whether the proposed site will benefit directly from these objectives. It can be assumed that the site will benefit indirectly from the development plans objectives.

Table 3.4 – Information Sources Consulted

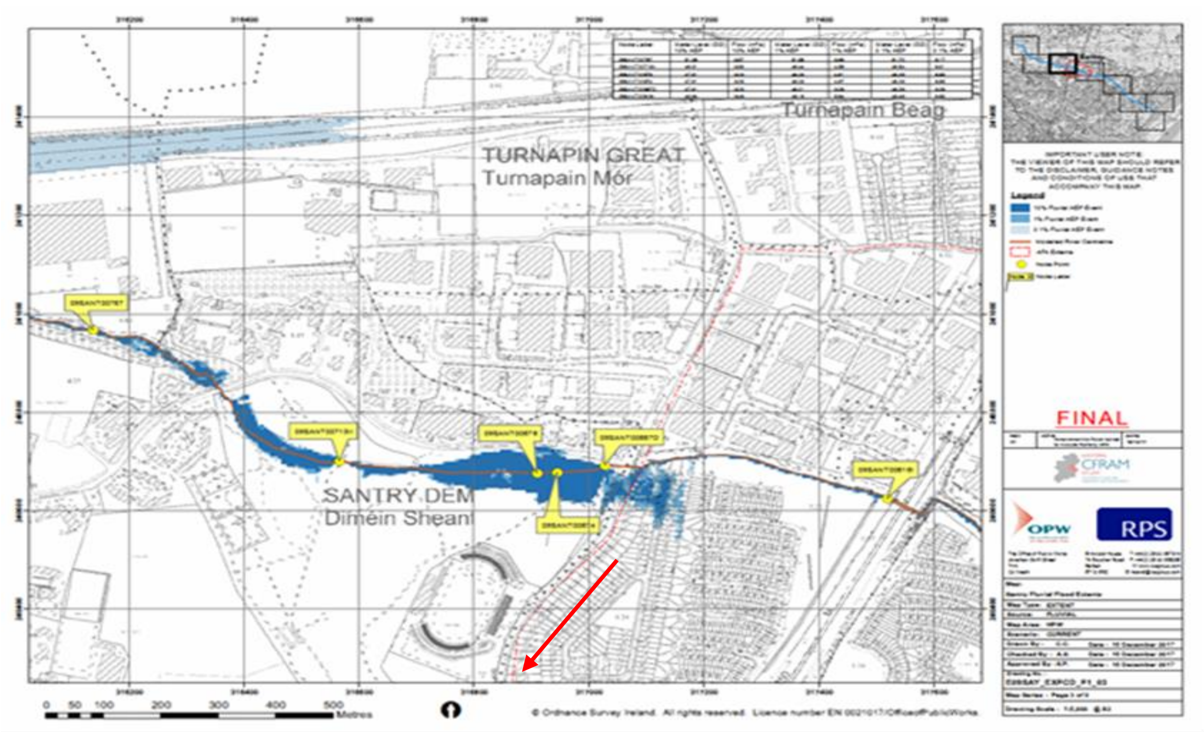

Figure 4.1 – Extract from ECFRAMS Mapping

(Site is to the south of the Santry River 0.1% AEP Flood Extents.)

Figure 3.2 – Extract from ECFRAMS Mapping, Location of 1958 Flood Event

Figure 3.3 – Extract from OSI Historical Mapping (1888-1913)

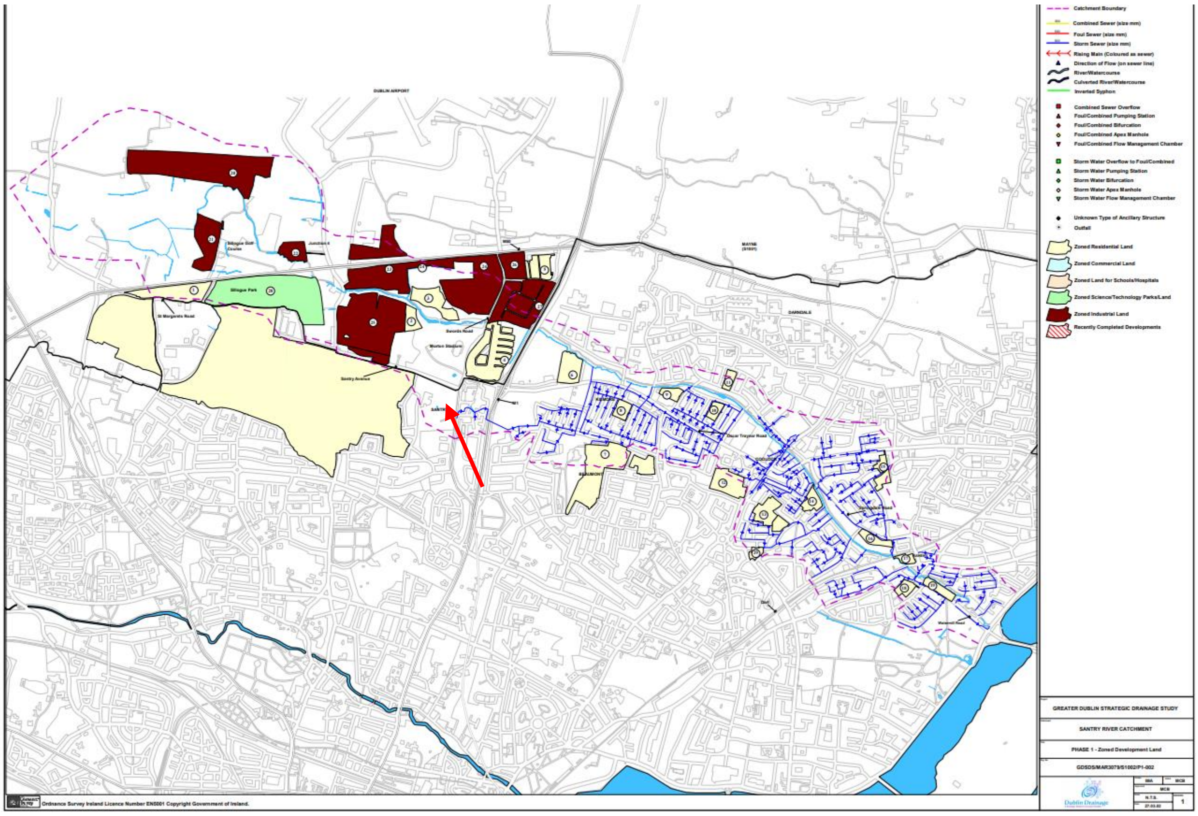

Figure 3.4 – Extract from Greater Dublin Strategic Drainage Study (GDSDS)

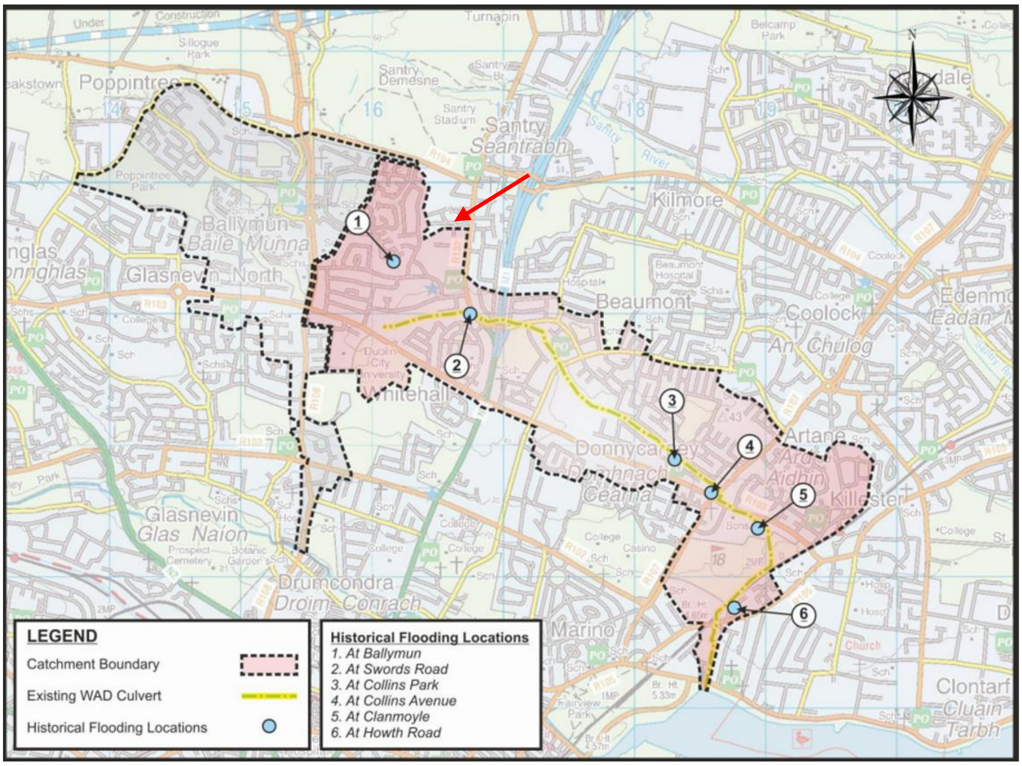

Figure 3.5 – Extract from 'River Wad Catchment Study – Full Catchment Report Rev. E'

(Site outside River Wad Catchment.)

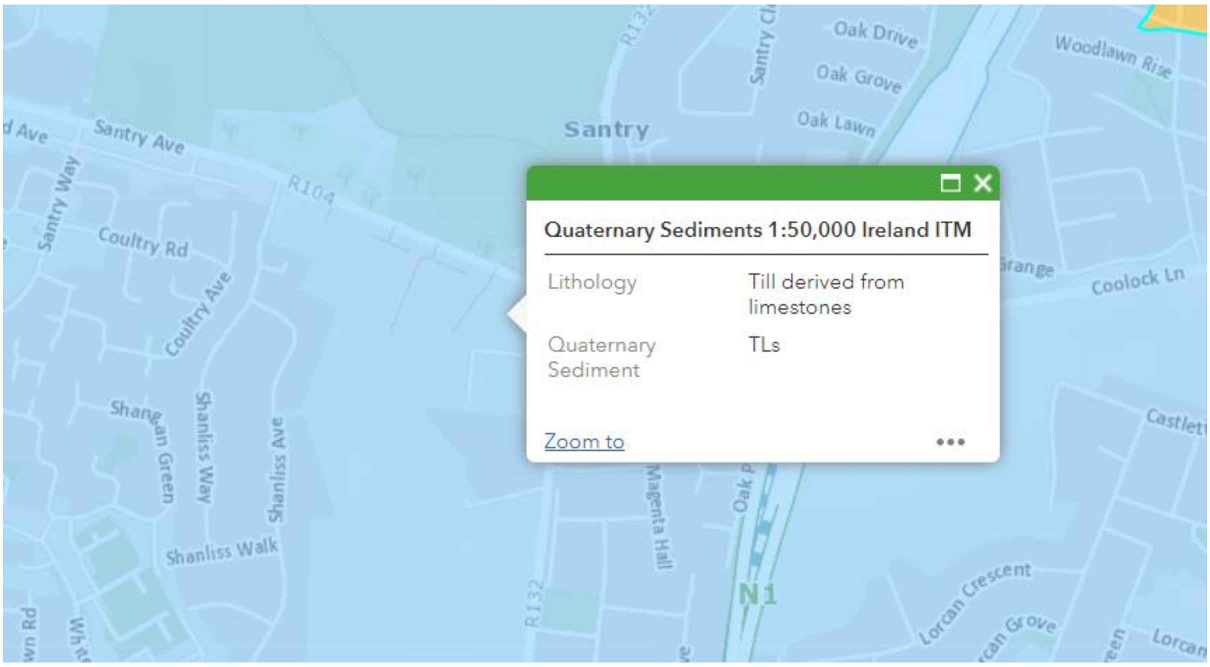

Figure 3.6: Extract – Quaternary Sediments 1:50,000 Ireland (ROI) ITM (GSI Maps)

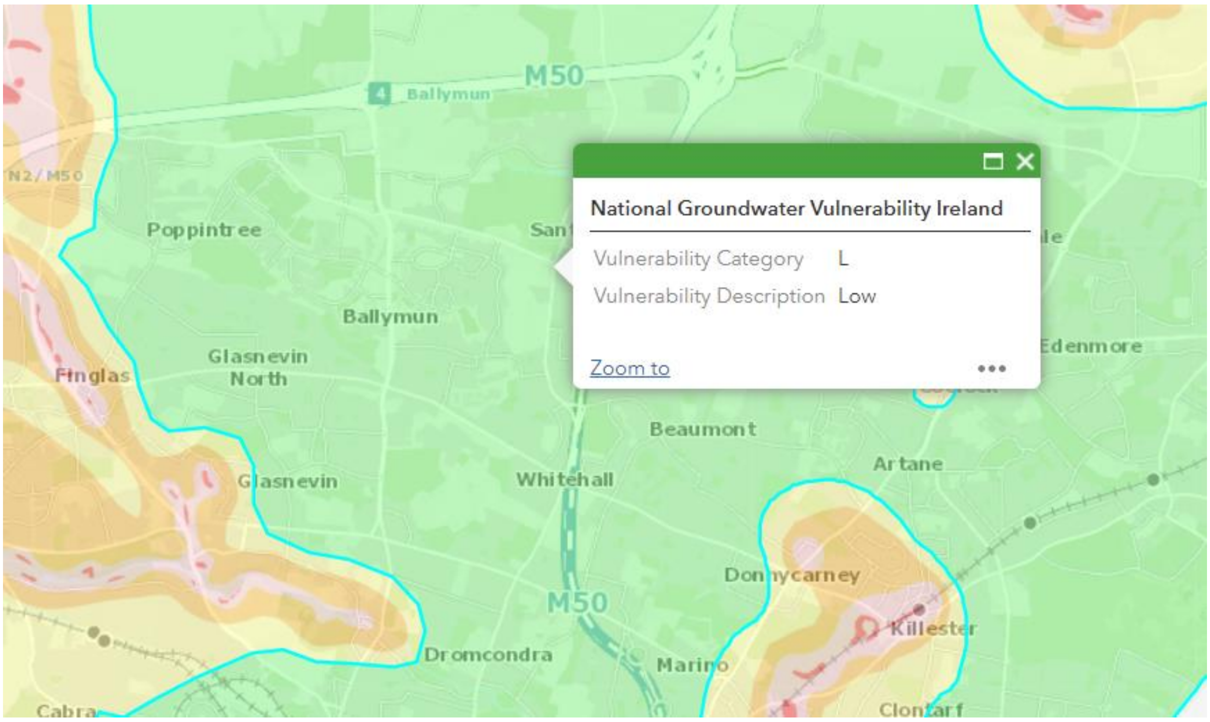

Figure 3.7: Extract – Groundwater Vulnerability (GSI Maps)

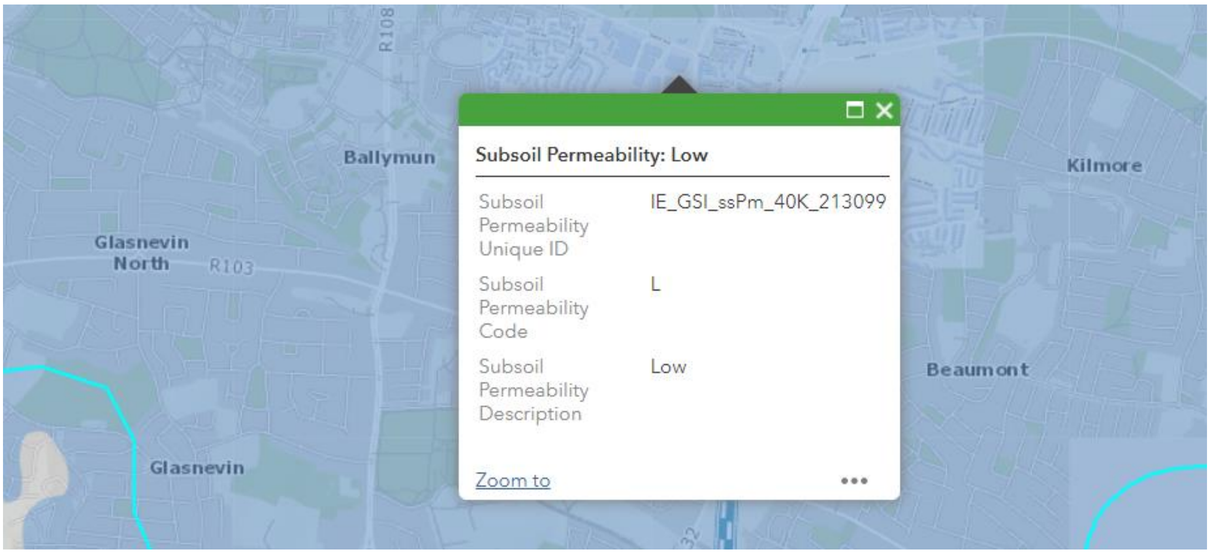

Figure 3.8: Extract – Groundwater Subsoil Permeability (GSI Maps)

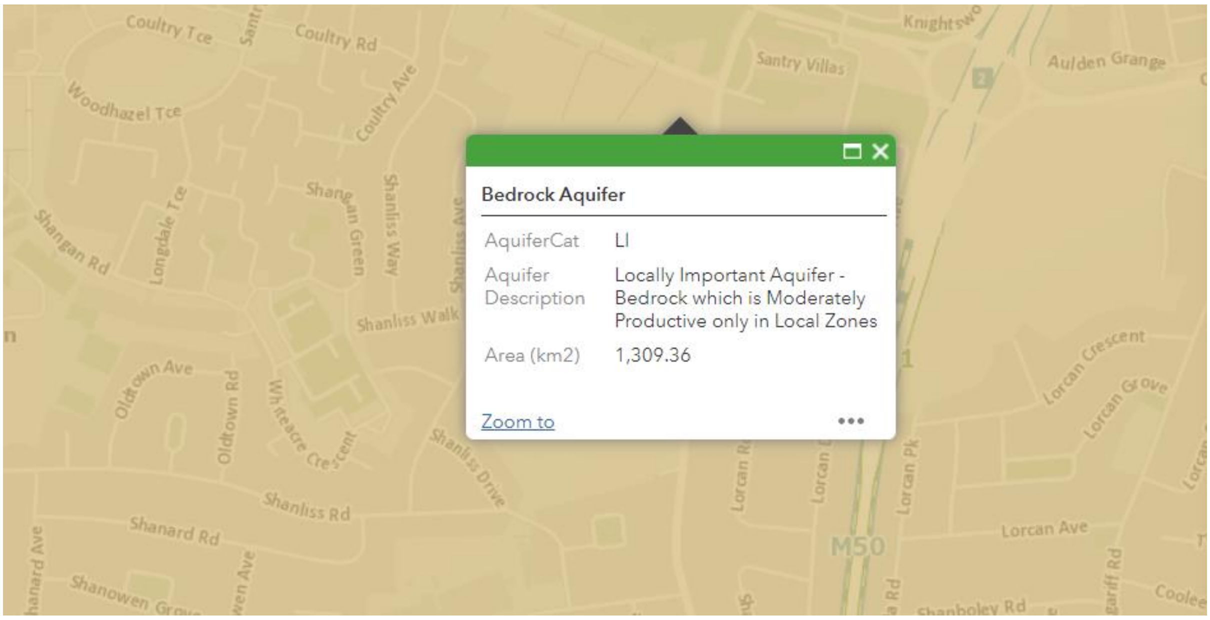

Figure 3.9: Extract – Groundwater Resources (Aquifers) (GSI Maps)

3.3 Source – Pathway – Receptor Model

A Source-Pathway-Receptor model was produced to summarise the possible sources of floodwater, the people and assets (receptors) that could be affected by potential flooding (with specific reference to the proposals) and the pathways by which flood water for a 0.1%AEP (Annual Exceedance Probability) and 1% AEP storms could reach the receptors. This table provides the probability and magnitude of the sources, the performance and response of pathways and the consequences to the receptors in the context of the post primary development proposal.

Source	Pathway	Receptor	Likelihood	Impact	Risk
Tidal	Tidal flooding from coast 6.5km away.	**Residents (people)** development, **visitors** and the **buildings** themselves and other **property** such as **vehicles** located in basement car park.	Remote	High	Very Low
Fluvial	Flooding from Santry River.	**Residents (people)** development, **visitors, Road Bridge** and the **buildings** themselves and other **property** such as **vehicles** located in car park areas, basement.	Remote	High	Low
Surface Water - Fluvial	Flooding from River Wad.	**Residents (people)** development, **visitors** and the **buildings** themselves and other **property** such as **vehicles** located in car park areas, basement.	Remote	High	Low
Surface Water - Pluvial	Flooding from surcharging of the development's drainage systems.	**Residents (people)** development, **visitors** and the **buildings** themselves and other **property** such as **vehicles**	Possible	High	Moderate

Source	Pathway	Receptor	Likelihood	Impact	Risk
		located in car park areas, basement.			
Surface Water - Pluvial	Flooding from internal sources – overland flows.	**Residents (people)** development, **visitors** and the **buildings** themselves and other **property** such as **vehicles** located in car park areas, basement.	Possible	High	Moderate
Surface Water - Pluvial	Flooding from external sources – overland flows.	**Residents (people)** development, **visitors** and the **buildings** themselves and other **property** such as **vehicles** located in car park areas, basement	Possible	High	Moderate
Groundwater Flooding	Rising GWL on the site.	**Residents (people)** development, **drainage infrastructure**, **basements**, **visitors** and the **buildings** themselves and other **property** such as **vehicles** located in car park areas, basement	Possible	High	Moderate

Source	Pathway	Receptor	Likelihood	Impact	Risk
Human or Mechanical Error (Pluvial)	Petrol interceptor and hydrobrake.	Areas of development draining to the surface water network; **Residents (people)** development, **visitors** and the **buildings** themselves and other **property** such as **vehicles** located in car park areas, basement.	Possible	High	Moderate

Table 3.5 – Source – Pathway – Receptor Analysis

3.4 Source-Pathway-Receptor Model Results

It is clear from the above flooding analysis that the proposed site is not at risk from tidal or fluvial flooding due to its geographic location and topography.

There is a moderate risk of groundwater flooding the basement of the site. GSI records state that groundwater vulnerability is low. A ground investigation conducted by GII on an adjacent site in January 2019 as part of Planning Ref: 2713/17 & 2737/19 (directly south of the proposed development) noted that perched water was encountered in one of the three boreholes drilled but no significant water bearing gravels were identified. It has also been noted that no groundwater was encountered during the construction of the basement on the development to the south (planning ref: 2713/17 & 2737/19). A full site investigation will be undertaken prior to construction and following grant of planning approval, the basement design/construction will take the findings into account.

There is also a moderate risk of pluvial flooding due to the potential surcharging and blockage of the proposed drainage network.

4 Initial Flood Risk Assessment Stage

4.1 Initial Pluvial Flood Risk Assessment

The flood risks to the proposed residential development identified from Stage 1 are a moderate risk of groundwater flooding of the underground drainage system and basement and a moderate risk of flooding due to the potential surcharging, blockage and mechanical failure of the proposed drainage network.

The Source-Pathway-Receptor model identified that there could be potential for pluvial flood risk within the development site related to the drainage system that could cause local flooding unless it is designed in accordance with the regulations e.g. Greater Dublin Strategic Drainage Study (GDSDS) and to take account of flood exceedance for storm return periods exceeding 1%AEP (Annual Exceedance Probability).

Proper operation and maintenance of the drainage system should also be implemented to reduce the risk of human or mechanical error causing pluvial flood risk from blockages etc.

Finally, the Source-Pathway-Receptor model identified that there could be potential for groundwater flood risk within the development site. A detailed site investigation will be carried out prior to construction, following grant of planning approval. It should be noted however that there was no groundwater encountered during construction of the development adjacent, to the south of the proposed development.

4.2 Flood Zone Category

Following the assessment of the flood risks to the site and the available information it is considered that the proposed site is located within Flood Zone Category C as defined by the Guidelines and as indicated by the ECFRAMS maps – refer to Fig 3.1. Therefore, the proposed residential development on the subject site is appropriate for this flood zone category, and a justification test is not required.

4.3 Mitigation Measures

Proposed mitigation measures to address residual flood risks are summarized below;

M1. The drainage network is designed in accordance with the recommendations of the GDSDS and provides attenuated outlets and associated storage up to the 100 year event plus 20% climate change.

M2. The proposed drainage system including the tanked attenuation system to be maintained on a regular basis to reduce the risk of blockages and unidentified damage.

M3. A maintenance contract for the hydrobrake should be entered into with a specialist maintenance company.

M4. In the event of storms exceeding the design capacity of the drainage system, water will be routed away from the proposed buildings onto green areas. Overland flow routes for pluvial events should not be built on or become blocked off.

M5. All proposed finished floor levels are at minimum 400mm above the calculated water level of a 1 in 100yr storm event.

5 Residual Risks

There is a low risk of pluvial flooding of the development from surcharging of the development's drainage system. However, the surface water network is designed in accordance with the recommendations of the GDSDS and provides attenuated outlets and associated storage up to the 100 year event plus 20% climate change.

DBFL CONSULTING ENGINEERS

February 2024

Appendix A – River Tolka Flood Report

CITY ENGINEER'S DEPARTMENT.

24th April, 1958.

Report to: City Engineer.

Re: Wad River.

Enclosures: Design Criteria, Design Sheets, Drainage Areas
6" Plan S.M.D. 638. 12" Plan S.M.D. 639.
Longitudinal Section S.M.D. 640.

The attached 6" Plan S.M.D. 638 shows the catchment of the Wad River which has an approximate area of 1824 acres. The catchment is bounded on the North by the Santry and Nanniken catchments, on the West by the Finglas and in the South by the Claremont and Tolka River catchments.

The peak run-offs shown on the design sheets have been calculated by the Lloyd-Davies method. The catchment area of approximately 3 sq. miles comes within the limiting 5 sq. miles size recommended by Rouse for treatment by the Lloyd-Davies method (see Design Criteria). Furthermore the usual objection to this method on account of the retardations due to storage in the watercourse do not have any serious effect on the accuracy of the calculations as the catchment is highly developed. The major portion of the catchment within the City boundary is zoned for housing and the agricultural land in the upper reaches, outside the City, could possibly be developed in the future.

The time of concentration for various points in the river have been calculated on the assumption that the entire river upstream has been culverted. An impervious factor of 30% (fully developed area, on the partially separate system) has been used throughout to determine the peak run offs. This factor is considered safe both for present and future conditions of development in the catchment area. The attached report recommends that a 40% factor should be adopted when calculating peak run off from open agricultural land. The run off produced however, by this factor is accommodated in part by the considerable flood storage usually available in open ditches and streams and the velocity of flow in the main watercourse is lower than that which results from proper culverting.

Since 584 acres of the catchment upstream of the Wad Bridge on Ballymun Road is at present mainly composed of farmland a check was made on the peak run-off by using the open stream Kirpich formula with an impervious factor of 40%. The calculated peak run off amounts to 12 cumins per acre. This rate agrees with the result got from the Lloyd-Davies calculation for culverting, using a 30% factor. Hence the effect of building up an area and culverting the stream reduces the time of peak but this is compensated for by a reduction in the impervious factor from 40% to 30%.

Rainfall intensities have been derived from Ministry of Health curves. Pipe culvert sizes have been calculated from the Crimp & Bruges formula and box culverts using the Chezy formula with a constant C = 100 and considering invert, sides and roof as wetted perimeter.

The available gradients shown on the longitudinal section S.M.D. 640 have been taken along the course of the existing river except between points E and F where the proposed culvert is shown crossing Ballymun Road and following the line of the proposed Collins Avenue Extension.

The river is culverted at the following points:

(i) Alongside Ballymun Road - short length of 36" dia. concrete pipes.

(ii) Wad Bridge, Ballymun Road - 3'9" x 4'6" high stone arch.

(iii) Albert Agricultural College to Swords Road 4'0" x 3'6" concrete box culvert.

(iv) Swords Road to Beaumont Road 4'0" x 4'0" concrete box culvert.

(v) Under Beaumont Road 8'5" x 4'2" stone arch.

(vi) Malahide Road to Clontarf Golf Club. 4'0" x 4'0" concrete box culvert and 48" dia.concrete pipes.

(vii) Under G.N.R. 5' x 2'6" stone arch.

(viii) Under Howth Road twin 36"diam.concrete pipes, 4'6" x 8'0" and 5' x 12' high stone arches.

(ix) Under Clontarf Road twin 4' x 3'6" high box culvert.

Provision has been made in the North Dublin Drainage Scheme for culverting this river from the storm water overflow in the Clontarf Golf Club to Clontarf Road.

The culvert sizes and gradients indicated for various sections of the river should not be finally fixed until such time as a detail survey of the road, house and drain levels in the surrounding area is carefully made. This survey is of particular importance between Doyle's Bridge on Beaumont Road and Malahide Road. The River between these points provides considerable flood storage during storms and the adjacent low lying Celtic Park area suffers from occasional flooding.

Any culverting proposal for the river should make provision for the construction of suitable wiring walls and a properly designed grid at the inlet. Serious blockages have taken place at River grids in the past. Finally, measures should be adopted to connect up all surface water drains and ground water which flows to the existing river and as constructed details of these connections should be recorded and produced on a large scale drawing.

SEN.ENGINEER I/C SEWERS AND MAIN DRAINAGE DEPARTMENT

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SEWERS AND MAIN DRAINAGE DEPARTMENT

22nd November, 1955.

REPORT TO/
CITY ENGINEER

re: Drainage of Ballymun Road

Arising out of flooding of Ballymun Road on the 8/12/1954 and, to a minor extent, on subsequent occasions, a surface water drainage examination of the area has been carried out. The original flooding of 1954 was due to (1) chokage of the Wad bridge at point B, which caused the Wad River to flow down Ballymun Road with subsequent flooding at C on the Claremont Stream, and (2) insufficient capacity of the surface water drainage system of Ballymun Road itself. Remedial proposals in respect of these items are set out below. The attached plan, to scale 12" = 1 mile, elaborates the points made.

(1) Wad Bridge

The catchment area draining to Wad Bridge at B is 626 acres, mainly composed of grasslands, for which a capacity of 6,260 cumins being 10 cumins per acre should be provided. This would keep it generally uniform with the downstream culvert capacities which are known to behave adequately. At present the Wad is piped from A to B in a 36-in. pipe of capacity 2,500 cumins. This pipe was choked but has now been cleaned and a grid placed at A. Wad Bridge itself (B) is a large culvert 3'9" wide by 4'8" high (arched) but is obstructed by a gas main and E.S.B. cables. The watermain in this road was carried under the culvert. The obstruction by the gas main is only minor, but the E.S.B. cables diminish the area of flow to 3'9" wide by 1'10" high. It has been found possible to deepen the culvert so as to give an area of flow of 3'9" by 2'8" high under the cables; this gives a capacity approximating to 6,000 cumins. As a temporary expedient this is adequate but due to the probability of silting-up would not be satisfactory as a permanent arrangement. It is proposed therefore that when plans are made in respect of the Collins Avenue Extension, in which I understand Messrs. Wates are interested, the Wad should be culverted along the line AD, thus by-passing the tortuous course ABCD. The section BCD would require to be piped in a small size. The proposed realignment would be obstructed by a watermain, a gas main and two lines of E.S.B. oil filled cables at A; these will require alteration, and it will be noted from the attached letter of the 24/9/1955 from the E.S.B. that the latter are prepared to undertake the cable alterations free of cost to the Corporation. They also offer a contribution of £20 towards cleaning of the culvert which is reasonable, having regard to the fact that the cables were carried through the culvert, to the best of my knowledge, with the approval of Dublin County Council, the responsible local authority previous to 1953. It is recommended that the E.S.B. proposals as set out in theirs of the 24/9/1955 be accepted and that they be informed to that effect.

The Gas Company, by letter of the 3/10/1955, have indicated their willingness to alter their main in the culvert when required; they should be requested to transfer this offer to cover alterations at A when the Collins Avenue Extension becomes more real.

In addition to the above, at the lowest road point between A and B, three 9-inch outlets have been made from the road channel through the east bank of Ballymun Road to permit copious road drainage to the Wad River upstream of the culvert at B.

over/ ....

To/
City Engineer

22.11.1955

(2) Ballymun Road

The surface water drainage of Ballymun Road is non-uniform, consisting, in part, of a stone built drain equal in capacity to a 12-inch pipe, and for the remainder of a 9-inch pipe. There are insufficient manholes and gullies, the drainage of the east channel between B and F consists only of gripes cut into the roadside ditch. The drainage area involved is estimated at 59 acres to the point G and pipe sizes of 15" - 18" would be required to deal with this as the present system is inadequate. Due to the fall southwards to the Claremont at G, surplus drainage accumulates at G with resultant flooding; temporary provision for this will be made by installing a number of arterial gullies.

The Special Works Department have at present road improvement proposals in respect of Ballymun Road before them. Provision for adequate drainage of the road should be included in the scheme prepared; this has been indicated verbally to who appears in agreement. The area of 59 acres to be provided for is shown coloured "orange" on attached plan.

At the point G, the road valley at the Claremont Stream, there are seven gullies which are readily choked with leaves. It is proposed therefore as a safeguard to lift four of these gullies and replace them with arterial gullies, three of which can be sited to give direct access to the Claremont Stream. This will give vastly improved outlet capacity and provide drainage less liable to chokage. This work can be carried out by this department to the Paving Department's order, who have verbally agreed with the proposal.

To summarise the points made above:-

(a) The E.S.B. and Gas Company proposals should be agreed to as set out above;

(b) Provision in the Collins Avenue Extension should be made for straightening the Wad River;

(c) The Ballymun Road improvement scheme being prepared by Special Works Department should provide an adequate road drainage system;

(d) The Paving Department should be instructed to issue an order to this department to install four arterial gullies at the Claremont Stream at Ballymun Road.

JHC/CG

Encl:

....
A/SENIOR ENGINEER I/C SEWERS
AND MAIN DRAINAGE DEPARTMENT

NB: It will be necessary to provide in the S.W. drainage of Ballymun Rd sufficient capacity to take overflow from the "feeder" Sewer to N.D.D.S. at ~~Claremont~~ Griffith Ave

9/3/60

CITY ENGINEER'S DEPARTMENT

JHR/MJ

29th January, 1965.

Report to City Engineer.

Re: Council Question No.29.

wishes "to ask the City Manager to state the cause of the recent flooding at Santry, and if he could indicate what remedial measures he proposes to prevent flooding recurring at this point. Further to state if the gullies were in working order in the neighbourhood, and if there is any provision to compensate persons who have suffered losses by flooding."

The cause of the flooding was due to the partial chokage of the protecting grids at the south east corner of Buckley's Sports Field in the Albert College Grounds. Upstream of these grids, the Wad River is in open cut and runs along adjacent to the rear of a number of industrial sites. Hedges cut at the rear of these industrial sites, together with factory refuse, large tins, plastic bags, etc. were embedded in the grid, and caused the chokage. While it is probable that the grids were clear prior to the flood, as they are cleared by our routemen at least once a fortnight, and more frequently in inclement weather, the flood water would carry debris from the open banks of the river down to the grids in a very short time. As this river is in private lands, the Corporation have not control of the catchment.

The cause of the flooding on the roadway at Santry arose because the water, being unable to enter the culvert, re-routed itself overground and flowed to the lowest part on the roadway and was impounded there. The gullies on the roadway could be expected to deal with road drainage, and were overpowered by this excess flow. There are seven gullies in the vicinity of the hollow, and it is probable that some of these choked during the flood as considerable silt and papers would be carried to them.

These gullies were cleaned on the following dates, the 7th, 8th, 14th, 17th, 18th and 20th December, 1964.

Following this flooding, it is proposed to alter the layout of the gullies in the roadway so that similar type of flooding would be carried by the gullies more swiftly. In view of the development at Ballymun Housing Project, and the consequent increase in run-off from the upper catchment, it will be necessary to carry out major improvements to the culverting of the Wad River by diversion of the upper reaches to either the Tolka River or to the Claremont Stream. This investigation will be put in hands within the next six months, and should be completed within two years.

There is no provision for compensation for those who suffered losses by flooding.

Flooding on 20th Jan. '65.

Vico Lounge – Swords Rd. ÷ carpet damaged. (243 Swords Rd. Santry)
{Lowet / Bar} 20 Houses in neighbourhood, ÷ gardens + ground floor flooded. (18" water)
÷ ground floor flooded.
Collins Av. Ext. ÷ 10 garden flooded.
Cloghran 200 yds Belfast Rd., flooded by 2' water. (Santry River)
Merrion Gates ÷ Tide caused road flooding
Churchtown }
Milltown } flooding caused traffic diversions.
Dundrum }
Ballybrack }
~~Naas Rd~~
Naas Rd. at Messrs. Volkswagen. floods made road impassable to light traffic for several hrs. (Camac River).
Whitechurch – Rathfarnham ÷ road flooding caused by overflowing of Dodder tributary.
Blackhall St., one house flooded.

Above summary taken from "Irish Independent" 21st Jan. '65.

Appendix B – Wad River Catchment Study

Dublin City Council
Comhairle Cathrach Bhaile Átha Cliath

WAD DRAINAGE CATCHMENT STUDY

FULL CATCHMENT REPORT

Rev E – August 2012

Nicholas O'Dwyer
CONSULTING ENGINEERS

FloodResilienCity

DUBLIN CITY COUNCIL

WAD DRAINAGE CATCHMENT STUDY

FULL CATCHMENT REPORT

Nicholas O'Dwyer Ltd.,
Consulting Engineers,
Nutgrove Office Park,
Nutgrove Avenue,
Dublin 14.

Rev E - August 2012

PROJECT NO. 20446					
Revision	**Reason for Revision**	**Prepared by**	**Reviewed by**	**Approved by**	**Issue Date**
-	First Issue	S. Hanrahan A. O'Farrell T. O'Flanagan	M. Davitt	J. Power	26/02/10
A	DCC Comments incorporated	A. O'Farrell	M. Davitt	J. Power	01/04/10
B	DCC Comments incorporated	A. O'Farrell	M. Davitt	J. Power	26/04/10
C	DCC Comments incorporated	M. Davitt	M. Davitt	J. Power	30/04/10
D	DCC Comments incorporated	L. Cogan	M. Davitt	J. Power	23/08/10
E	DCC Comments incorporated	N. Delaney	N. Delaney	J. Power	13/08/12

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1. INTRODUCTION

1.1 BACKGROUND

Nicholas O'Dwyer Ltd was appointed by Dublin City Council (DCC) in December 2009 to carry out a full catchment study of the Wad River. The study was project managed by Dublin City Council and was funded by the Office of Public Works (OPW).

1.2 STUDY CONTEXT

The purpose of the Study was to examine the hydraulic performance of the existing surface water drainage system and recommend works to improve flood protection within the Wad River catchment.

1.3 STUDY AREA

The Wad River drains a catchment area of approximately 483 hectares, including parts of Ballymun, Santry, Donnycarney, and Killester to the seafront at Clontarf in north County Dublin. The Wad River, originally in open channel, has been completely replaced with culverts and pipelines of varying dimensions over the 6 km route from Albert College Park on Ballymun Road to the seafront at Clontarf Road.

The Wad River catchment area formerly included parts of Glasnevin to the west of Ballymun Road. The surface water flows from this area (approximately 227 hectares) were diverted via a new culvert along Ballymun Road to the River Tolka in 1967. This diversion scheme was carried out to alleviate flooding problems further downstream in the Wad River catchment at Collins Avenue. An overflow from the new diversion culvert to the original Wad River culvert at Albert College Park was included as part of this scheme. This small 375 mm diameter overflow was removed by Dublin City Council in December 2009. However, the pipe's carrying capacity was insignificant and therefore this overflow had little impact on the catchment.

The extent of the catchment and the route of the main Wad River culvert is highlighted in Figure 1.1 and shown on attached Drawing No. 20446-01.

1.4 HISTORICAL FLOODING

There have been a number of historical flooding events reported within the catchment area of the Wad River, as detailed below in Table 1.1. The locations of these historical flooding events are highlighted in Figure 1.2.

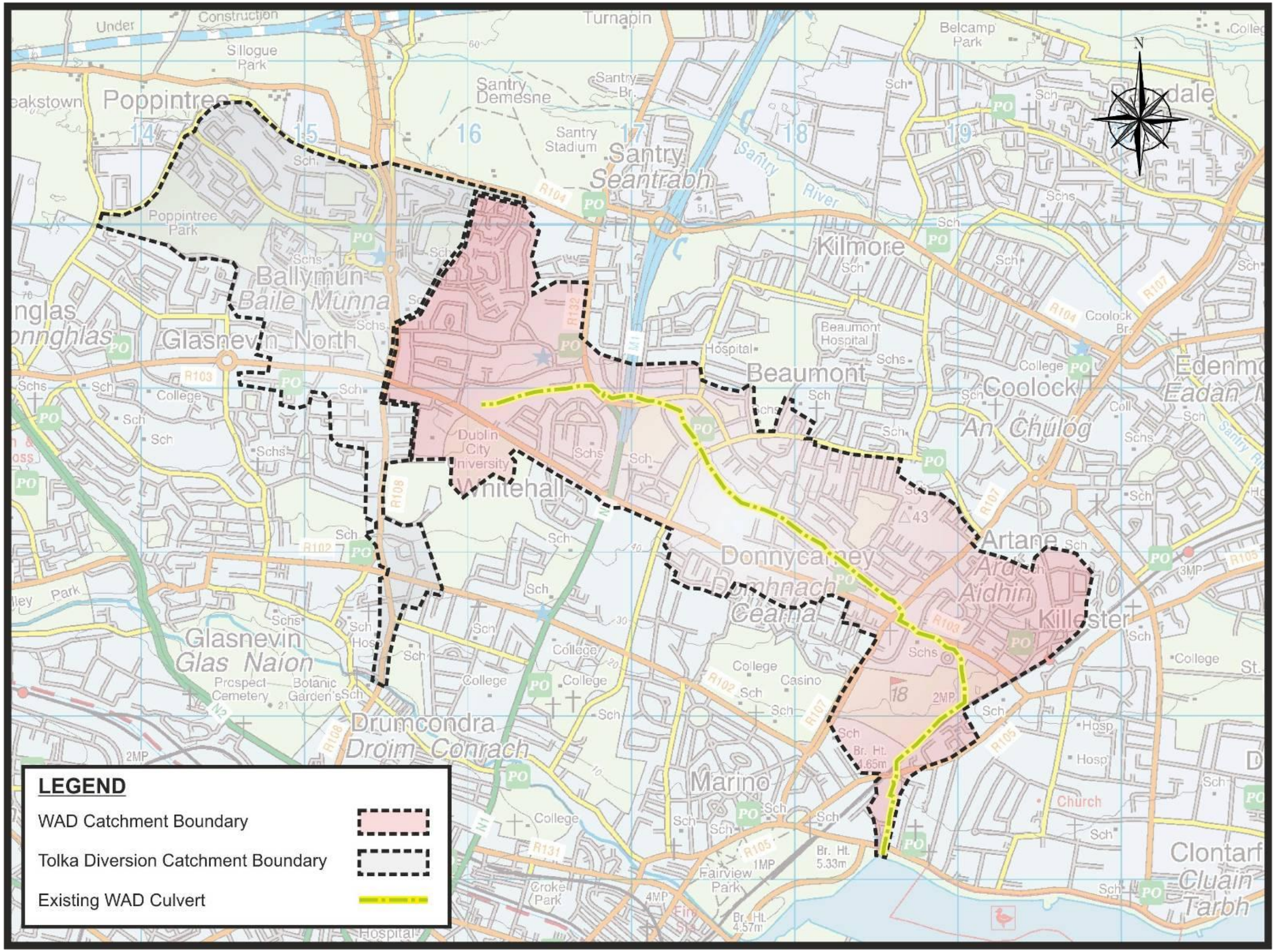


Figure 1.1 – Existing Catchment Boundary and Route of Wad River

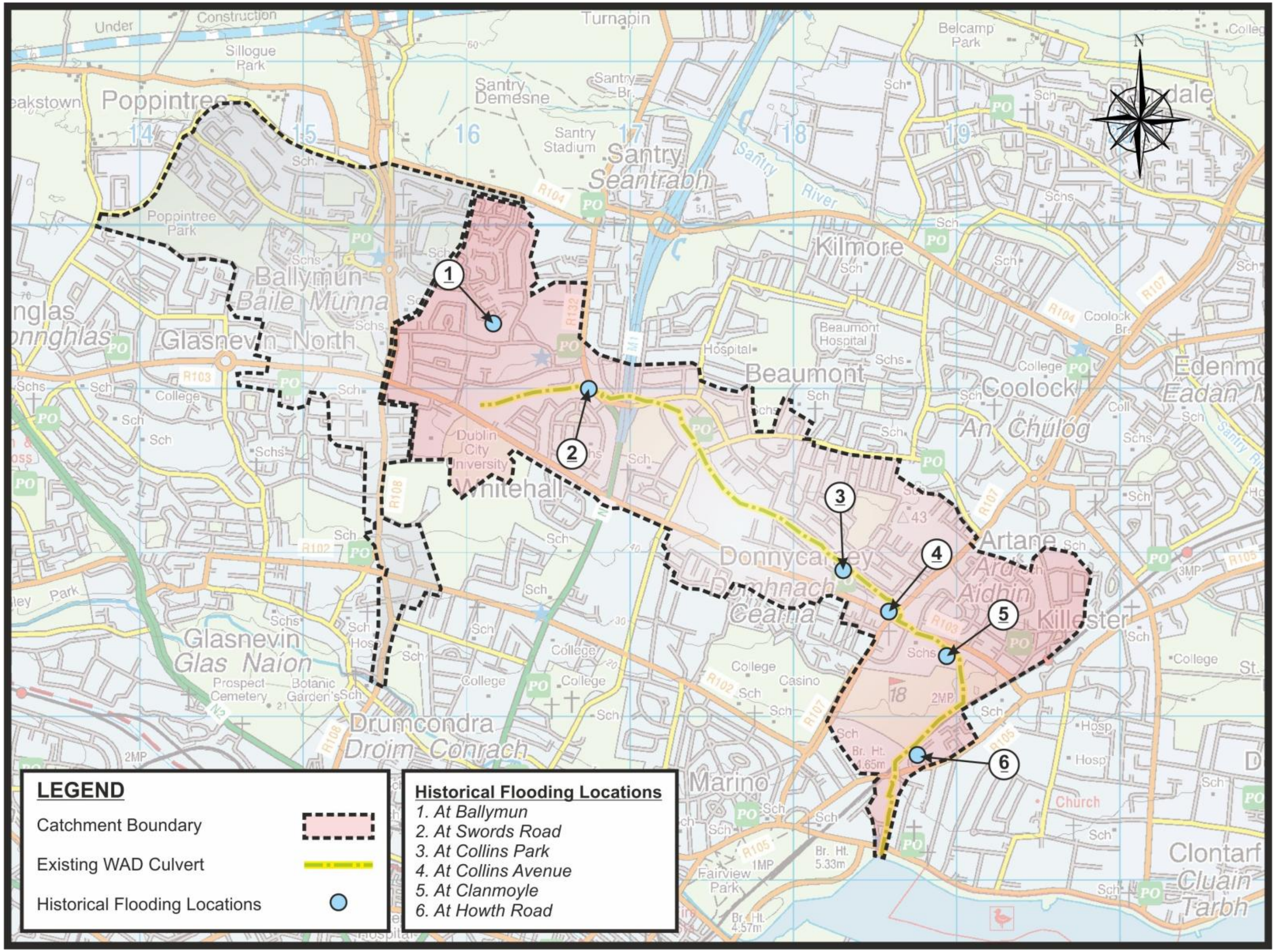


Figure 1.2 – Historical Flooding Locations within Wad River Catchment

Table 1.1 – Historical Flooding Events within Wad River catchment.

Date	Location(s) [1]	Comments
December 1954	Ballymun	44.5 mm at Clontarf [2]
June 1963	Collins Avenue	43.9 mm at Clontarf [2]
January 1965	Collins Avenue	N/A
February 2002	Clontarf	2.95 m OD at Dublin Port [3]
August 2008	Clanmoyle	76.2 mm at Dublin Airport [2]
July 2009	Clanmoyle	42.4 mm at Dublin Airport [2]
October 2011	Clanmoyle, Howth Road	71mm at Dublin Airport [2]

(1) - Flooding Locations from Office of Public Works

(2) - Rainfall data from Met Eireann

(3) – Tidal data from Dublin Coastal Flooding Report by Royal Haskoning

Note: *More extreme events were identified at local locations.*

The construction of the partial diversion of the Wad River to the Tolka River was intended to reduce flood risk to properties downstream of Ballymun, which were flooded during the rainfall events of December 1954, June 1963 and January 1965. However, the extreme rainfall events of August 2008, July 2009 and October 2011 resulted in damage to a large number of properties, particularly at Collins Park and Clanmoyle Road, within these areas of the Wad River catchment. The extent of reported flooding is highlighted, throughout the catchment, on attached Drawing Nos. 20446-05 to 20446-09. A study of the Wad River catchment area was commissioned by Dublin City Council in response to the flooding events of August 2008 and July 2009.

The flooding experienced at Clontarf seafront in February 2002 resulted from extreme tidal conditions.

1.5 PREVIOUS REPORTS

The 2009 Interim Report for this catchment included the following works:

- Analysis of the extreme rainfall events in August 2008 and July 2009.
- Analysis of the flooding events of August 2008 and July 2009.
- Construction of a 1D and a 2D hydraulic model of the Wad River drainage system.
- Verification of the hydraulic models with historical flood data.
- Identification of outline options for local flood risk alleviation on Clanmoyle and Collins Avenue East.

The 2009 Interim Report for the Wad catchment determined that:

- There were extreme rainfall events with localised peaks that may have exceeded records at rainfall gauging stations.
- The extreme rainfall events overwhelmed parts of the surface water drainage system and caused pluvial flooding within low lying areas of the catchment.
- Clanmoyle Road was built on the original course of the Wad River.
- A 1D model analysis indicated that the main Wad River culvert between Beaumont Road and Clanmoyle Road had insufficient capacity to cater for the extreme rainfall events of August 2008 and July 2009.
- A 2D model analysis identified a number of areas (Swords Road, Collins Park, Malahide Road and Clanmoyle Road) within the catchment that were vulnerable to pluvial flooding from extreme rainfall events.
- The predicted flood extents from the 2D model were similar to the recorded flood plain at Collins Avenue and Clanmoyle.
- A full catchment study would be required in order to adequately design flood alleviation works at Clanmoyle Road without increasing the risk of flooding downstream.

1.6 PROJECT REQUIREMENTS

The full catchment study was required by Dublin City Council to include for achieving certain aims by completing specified objectives and producing specified deliverables as follow:

Project Aims

- Carry out duties of PSDP from the time of appointment up to the production of a Preferred Options report.
- Produce modelling and design results protecting property flooding for 5-year, 10 year, 30 year, 50 year and 100 year storm events (20%, 10%, 3.33%, 2% and 1% AEP).
- Carry out a catchment study to final options stage, incorporating the 2009 Interim Report for the Wad catchment, which will recommend the optimal proposals for the construction of a culvert(s), attenuation ponds/tanks, etc, for progression to tender stage. It will include, but not be limited to the following:
  - Determine Planning/ Legal implications of the proposed solution(s).
  - Review if an EIS or an EIA is required.

- Develop Project Implementation Strategy for the proposed solution(s).
- Ensure that any new flood alleviation works integrate fully with the existing drainage network at all stages.
- Liaise with main stakeholders and carry out duties in close co-operation with them.
- Review existing outfall location and make recommendations as appropriate.

Project Objectives

- Carry out duties of PSDP from the time of appointment to production of final Options report.
- Review the 2009 Interim Report of the Wad catchment and carry out a design review of it in the light of current legislation plus topographical extent.
- Review of 2009 River Wad study.
- Carry out any further topographical surveys required.
- Adapt and verify existing catchment model and use this model to provide short, medium and long-term scenarios and options to reduce property flooding in the catchment from the Collins Park area downstream to the outlet. This shall include an analysis of the outfall including joint tidal/fluvial probability analysis and testing of sea level rise scenarios. Analysis of the introduction of tidal flaps on the existing and any proposed outfalls should also be carried out. Analysis of potential downstream flooding from the Howth Road to the Clontarf outfall is an essential part of this study.
- Review whether EIS or EIA is required with Dublin City Council, An Bord Pleanala and any other relevant agencies.
- Develop Project Implementation Strategy for proposed alleviation works.
- Plan construction programme, commissioning, including but not limited to the following:
  - Liaison with DCC Flood Defence Unit
  - Drainage Maintenance Services Division.
  - Golf Club
  - DCC roads & traffic.
  - Other individuals and organisations as required.
  - Best practice in Ireland & abroad.

Project Deliverables

An Options Report, for the approval of Dublin City Council, outlining flood reduction proposals for short-term (immediate), medium-term (one to two years) and long-term time periods is the expected deliverable. It shall include but not be limited to:

- Surveying of the catchment downstream of the golf club (Howth Road to Clontarf Road including floor levels of buildings modelled to flood).
- Full modelling using a verified model of the total catchment to prove previous floods and verify proposed alleviation works.
- An assessment of procurement options including a recommendation on a preferred Procurement Option and the suitable selection and award criteria in accordance with relevant procurement legislation.
- An assessment of outfall options and a recommendation on a preferred option.
- An assessment (with drawings) of Planning and Legal constraints to implementing the proposed works including the impact of relevant EU Directives. Key concerns and issues should be identified.
- An assessment of the short listed options suitable for the proposed works.
- Adequate Cost Estimates for the options/main scenarios for the proposed works and setting out the basis for the Cost Estimates. A return period assessment of the 9th August 2008 & the 2nd July 2009 and cost benefit analysis of all main scenarios and proposed alleviation works. A benefit cost ratio of 1.0 or more is required to change a scenario to an option. This assessment was subsequently extended to include for the 24th October 2011 flood events.
- A review of European and National standards to be adhered to on the Project, covering designs, processes and materials etc.
- A Risk Assessment based on the Risk Acceptability Assessment and which includes the Risk Register.
- A Preliminary Project Programme for the construction of the proposed works including technical and financial milestones.
- An Environmental Report Statement for the proposed works
- A buildability report of the proposed option(s) including locations of all existing underground and overground services, environmental areas, landownership, wayleaves, etc.

1.7 REPORT OUTLINE

The objective of this Report is to detail the methodology undertaken in carrying out the full catchment study and to recommend works to alleviate flooding within the Wad River catchment. The following structure was adopted in this report to include for each required project objective and deliverable:

- A 2D model of the catchment, developed as part of the 2009 Interim Report of the Wad catchment, highlighted reduced capacity issues within the drainage network and identified areas at risk of pluvial flooding. The development and verification of the hydraulic model with results from detailed topographical and asset surveys is detailed in Section 2 of this report.
- The reaction of the catchment to a number of design rainfall events and the analysis of existing flood risk within the catchment is detailed in Section 3 of this report. This section also includes an analysis of August 2008, July 2009 and October 2011.
- The requirements for systems to manage and control the flood risk within the catchment are detailed in Section 4 of this report.
- The recommended alleviation works to provide appropriate levels of flood protection to properties within the catchment are detailed in Section 5 of this report.
- The implementation strategy and preliminary programme for the recommended flood alleviation works is detailed in Section 6 of this report.
- The estimated cost and an economic assessment of the recommended flood alleviation works are detailed in Section 7 of this report. The benefit-cost ratio is also included in this section.
- A summary of the main conclusions and recommendations arising from the study of the Wad River catchment are detailed in Section 8 of this report.
- The detailed results of the asset survey of the Wad River culvert between Collins Park and Clontarf seafront are included as Appendix I of this report.
- The existing flood plain maps for 1/5, 1/10, 1/20, 1/50/, 1/100 and 1/200 year return period critical storms events are detailed as Appendix II of this report. It should be noted that these drawings show the computer modelled outputs before any of the alleviation works have been carried out.
- An environmental report in relation to the recommended flood alleviation works is also included in Appendix III of this report.

- A review report of European and National Standards in relation to the construction of the recommended flood alleviation works is included in Appendix IV of this report.
- A review report in relation to the construction, planning and legal constraints associated with the recommended flood alleviation works is included in Appendix V of this report.
- A preliminary project programme for the construction of the proposed works including technical and financial milestones is included as Appendix VI of this report.
- Drawings of the Recommended Scheme are presented in Appendix VII.
- Drawings of the Recommended Scheme (using aerial photography mapping and simplified terminology) are presented in Appendix VIII.
- Detailed cost estimates are included in Appendix IX.

2. DATA COLLECTION, SURVEY WORKS AND MODEL DEVELOPMENT

2.1 INITIAL DATA COLLECTION

A data collection exercise was carried out to gather any available data pertinent to the objectives of the Wad River catchment study. The following data was received from Dublin City Council:

- 1D & 2D Infoworks CS Models including simulation runs and associated data
- Gully location data
- Information from an initial walk through survey of the culvert
- OS Mapping of catchment in AutoCAD and MapInfo format
- M1 Port Tunnel Pump Station data
- Aerial photography in MapInfo format
- Digital terrain model / LIDAR data
- GIS data for all water and wastewater services in the catchment
- Overflow data for North Dublin Diversion Sewer
- Overland flow route discussions with stakeholders
- Details of Coastal Flood Scheme at Clontarf
- Any available CCTV data in the catchment
- Tolka River Flood Study Information
- Rainfall data collected for flood events
- Discovery Series Mapping

All available data relating to utility and service records were obtained from the following service providers:

- ESB
- Bord Gais
- Eircom
- Chorus NTL (UPC)
- BT
- Colt

The above data was received in vector digital format.

2.2 SURVEYS UNDERTAKEN BY NICHOLAS O'DWYER LTD

A number of additional surveys carried out to augment the available data and facilitate the catchment study are detailed below.

2.2.1 Topographical Survey

A detailed topographical survey of the Wad River catchment downstream of Clontarf Golf Club was undertaken. The extent of the topographical survey is shown on Drawings 20446-03 and 20446-04. The topographical survey included the following elements:

- Cover levels for the main Wad Culvert from No. 56 Collins Park to the outfall in Clontarf
- Ground floor levels of buildings in flood plains.
- Details of remedial works carried out by DCC in Clanmoyle Road in 2009
- Survey of the boundary between Clontarf Golf Course and the DART Railway Line
- Survey of Sports Grounds in Mount Temple Comprehensive School
- Detailed survey of the low lying area on Howth Road where the road crosses under the DART Railway Bridge
- Survey of Glasslyn, Hollybrook, Brooklawn and Strandville House apartment complexes

2.2.2 Comprehensive Walk through Survey of Wad Culvert

A comprehensive walk through survey of the Wad Culvert from No. 56 Collins Park to the outfall in Clontarf was carried out in conjunction with Dublin City Council staff and the Northside Depot Crews. The results of the survey are detailed on drawings included in Appendix I to this report. Information gathered during the survey includes:

- Locations and diameters of connecting surface water sewers
- Invert levels of chambers on the Wad Culvert
- Service intrusions
- Culvert dimensions
- Sudden changes in gradient, direction, width or height (Figure 2.1)
- Structural issues (Figure 2.2)

Figure 2.1 – Narrow section of Wad Culvert under Howth Road

Figure 2.2 – Formwork in Wad Culvert at Seapoint Development on Clontarf Road

2.2.3 Review of Remedial Works at Clanmoyle Road

Dublin City Council carried out remedial works in the Clanmoyle Road in 2009. The remedial works consisted of drainage slots in the walls between back gardens and the adjoining Clontarf Golf Course. The work also involved the lowering of the driveway in front of No. 8 in Clanmoyle and the creation of an above ground channel between No. 8 and No. 9. The purpose of these works was to alleviate the impact of future flooding in the Clanmoyle Road. A detailed survey of the works was carried out and included site visits, photographs and the locations and dimensions of each drainage slot. A typical drainage slot and the constructed channel are shown in Figures 2.3 and 2.4.

2.2.4 Survey of Residents in Affected Areas

A number of residents who had experienced flooding were consulted. Information gathered from residents included photographs, description of flood damage, approximate flood depth, flood area, overland flow paths, etc.

Table 2.1 - Addresses of Resident Interviews in relation to Flooding Events.

Address	Address (cont'd)
71 Shangan Gardens	294 Elm Mount Avenue
49 Shangan Avenue	244 Collins Avenue East
Garda Station, Shanowen Road	246 Collins Avenue East
St Kevin's Sports Ground, Shanowen Road	248 Collins Avenue East
2 Shanrath Road	117 Collins Avenue East
5 Shanrath Road	120 Collins Avenue East
13 Shanrath Road	125 Collins Avenue East
226 Swords Road	Scoil Chiarain, Collins Avenue East
243 Swords Road	St Mary's Secondary School, Collins Avenue
123 Crestfield Road	8 Clanmoyle Road
28 Shanowen Road	32 Clanmoyle Road
47 Celtic Park Road	40 Clanmoyle Road
49 Celtic Park Road	37 Clanmaurice Road
22 Collins Park	84 Clanranald Road
96 Collins Park	42 Ashbrook
102 Collins Park	52 Ashbrook
282 Elm Mount Avenue	27 Castlecourt
284 Elm Mount Avenue	89 Howth Road
286 Elm Mount Avenue	96 Howth Road

Figure 2.3 – Remedial Works to Rear of House at Clanmoyle Road

Figure 2.4 – Channel to Rear of House at Clanmoyle Road

The addresses of these properties are detailed in Table 2.1 and the locations of these properties are shown on drawing nos. 20446-02 to 20446-04.

2.2.5 LIDAR - Digital Terrain Model Data

The LIDAR data obtained under the 2009 Interim Report for the Wad catchment covered the majority of the Wad catchment. The LIDAR data has not been fully processed and ground truthed for the study location. The data was processed urgently for the 2009 Interim Report for the Wad catchment and it has not been updated since then.

It was also noted that a significant area in the vicinity of the outfall in Clontarf was not covered by the LIDAR data, see Figure 2.5. Additional LIDAR data was purchased from Ordnance Survey Ireland (OSi). The data was merged with the existing LIDAR data to provide a digital terrain model for the entire Wad catchment.

2.2.6 Review of Impact of Dublin Port Tunnel

The project brief indicated that storm runoff in the Dublin Port Tunnel is pumped to the Wad at a rate of 200 l/s. It was found during the course of this study that this is not the case. Storm runoff in Dublin Port Tunnel pumps to a pumping station in Fairview Park which ultimately pumps flows to the Tolka River. It should be noted that the contributing runoff to the Wad from the re-aligned M1 / Dublin Port Tunnel works has not increased. In fact it has slightly decreased as there is less hard standing available than before.

There is, however, a pumping station on Shantalla Road which drains a section of the M1 from Coolock Lane Interchange to Ellenfield Park. Shantalla Pumping Station pumps to the Wad at an estimated maximum rate of 200 l/s. Model analysis shows that this inflow has only a marginal impact on the Wad.

2.2.7 Review of Overflow from Clontarf Storm Tank

There is an overflow from the Clontarf Storm Tank, on the North Dublin Diversion Sewer, to the Wad Culvert in Clontarf Golf Course. It was noted in the 2009 Interim Report of the Wad catchment that during the July 2009 flooding event, the overflow from the Storm Tank peaked at 1.8m^3/s. It has been assumed that during the extreme rainfall events being modelled, that a similar overflow rate will apply. However, no additional information on flow rates from the Clontarf Storm Tank was made available during this study.

2.3 MODEL DEVELOPMENT

A 2D hydraulic model of the Wad River catchment was developed as part of the 2009 Interim Report of the Wad catchment. This initial hydraulic model was based primarily on existing drainage records and a digital terrain model generated from an OSi LIDAR survey. The further construction and verification of the 2D hydraulic model with the additional data capture and survey results, as outlined above, is detailed below.

2.3.1 Model Construction

The following are the principal adjustments made to the construction of the initial 2D hydraulic model:

- The physical dimensions and levels of the main Wad River culvert were adjusted in the initial 2D hydraulic model based on data from the walk through survey of the culvert and topographical surveys of areas of particular interest from Collins Park to the seafront at Clontarf.
- The general topography of the 2D surface within the hydraulic model was extended to include the additional area of digital terrain model obtained for the seafront at Clontarf.
- The 2D surface was also adjusted to more accurately represent the overland flood paths and floodplain of the Wad River catchment based on detailed topographical survey results and site visits to areas of particular interest. The detailed topographical survey results and site visits were also used to adjust the representation of buildings, walls, kerbs and roads within the 2D hydraulic model in areas of particular interest within the Wad River catchment.

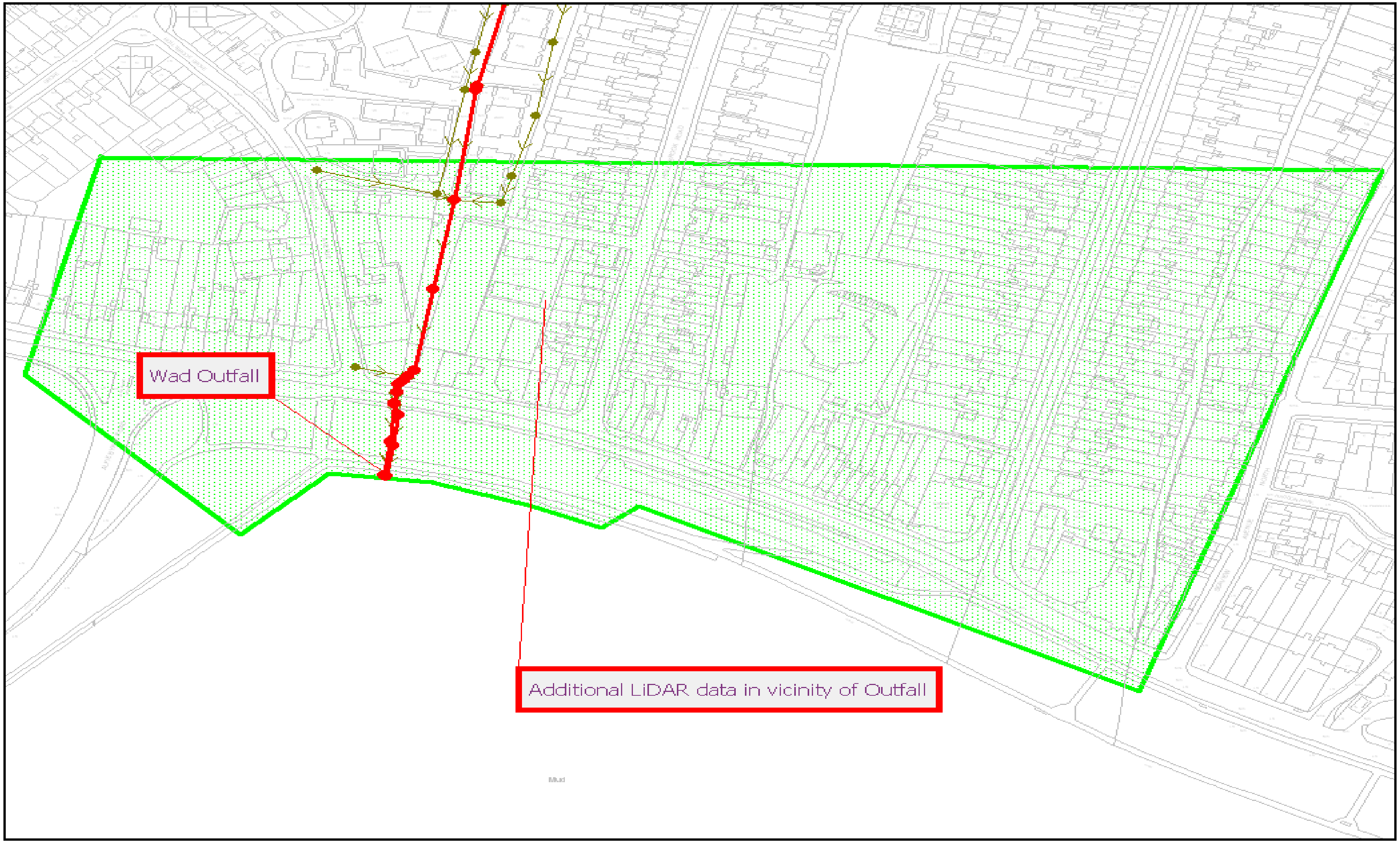


Figure 2.5 – Additional LIDAR data obtained in vicinity of Wad Outfall in Clontarf

- The runoff surfaces for road, roof (impermeable areas) and field (permeable area) in the initial 2D hydraulic model were assumed to be constant throughout the Wad River catchment. The assumed run-off surfaces were checked by analysing two randomly selected control areas (~1 hectare) within the catchment. The extent of one of the control areas is illustrated in Figure 2.6. A comparison of the assumed and measured area types is detailed in Table 2.2 and suggests that the initial model assumptions in relation to the surface run-off areas within the catchment were conservative. It is considered acceptable to continue with the original run-off values as the primary purpose of the 2D model is to simulate extreme return period events. However, the run-off volume model module of the 2D hydraulic model is sensitive to the definition of impermeable areas within a catchment. As a result, the conservative nature of the above assumption, while acceptable for extreme storms, could lead to over-prediction of run-off volumes for shorter return period events.

Table 2.2 – Comparison of Assumed and Measured Run-Off Types

Surface Run-Off Type	Model Assumption (%)	Measured Check (%)
Road (Grey)	30%	25%
Roof (Red)	25%	15%
Field (Green)	45%	60%

Any adjustments to the original 2D hydraulic model have been based on higher quality data sources and have improved the confidence in the representation of the behaviour of the Wad River catchment.

2.3.2 Model Verification

The revised 2D hydraulic model, as described above, was considered suitable for use in the historical verification of storm events within the Wad River catchment. The verification process, firstly, involved simulating the reaction of the Wad River catchment to recorded rainfall data from extreme storm events of August 2008 and July 2009. The simulation results were then used to create predicted flood plains for each of the historical events from August 2008 and July 2009. The verification process, finally, involved comparing the predicted and reported flood plains for the August 2008 and July 2009 storm events. This analysis was subsequently extended to include for the extreme storm event of October 2011.

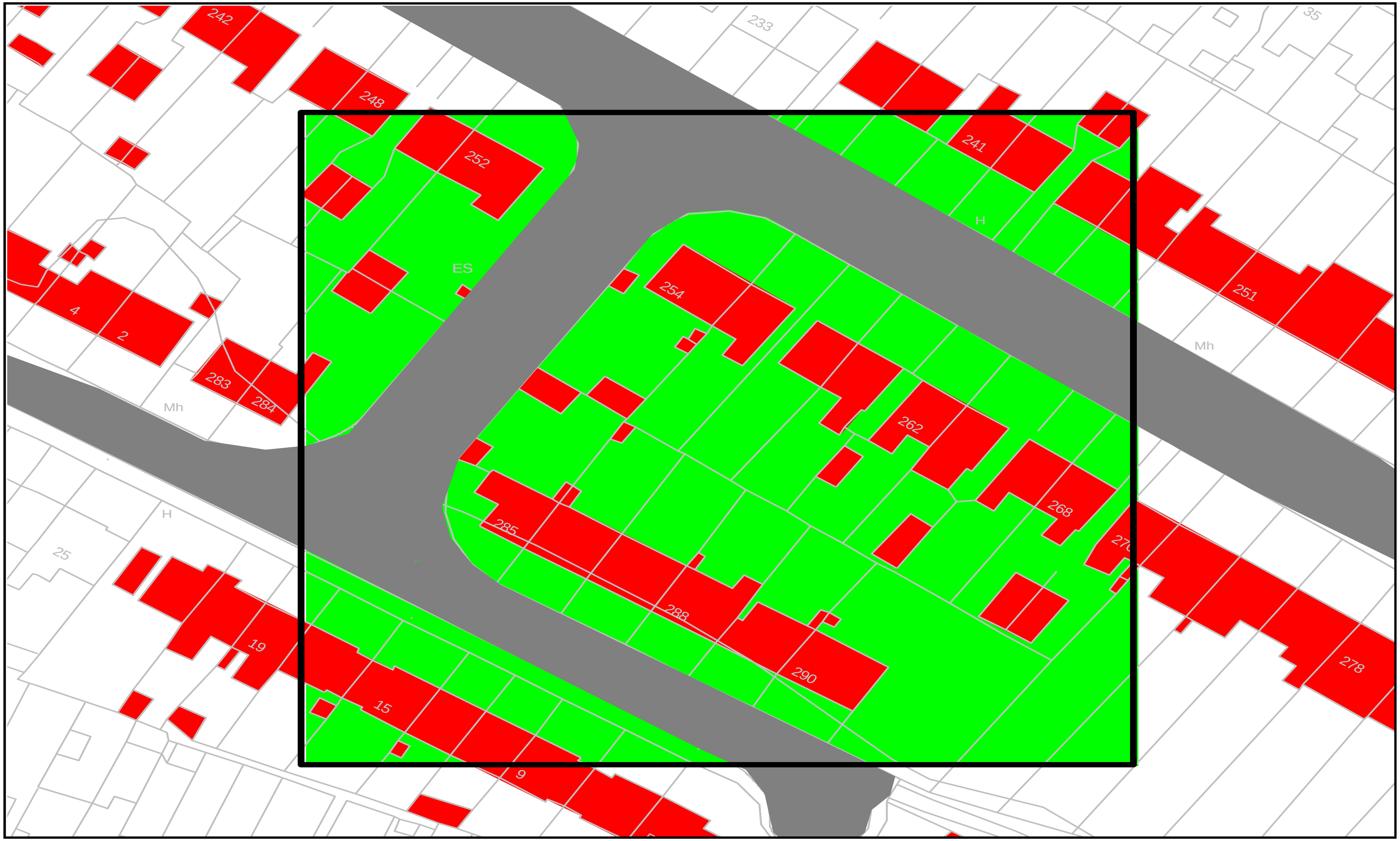


Figure 2.6 – Control Check of Surface Run-Off Types within Random Area of Wad River Catchment

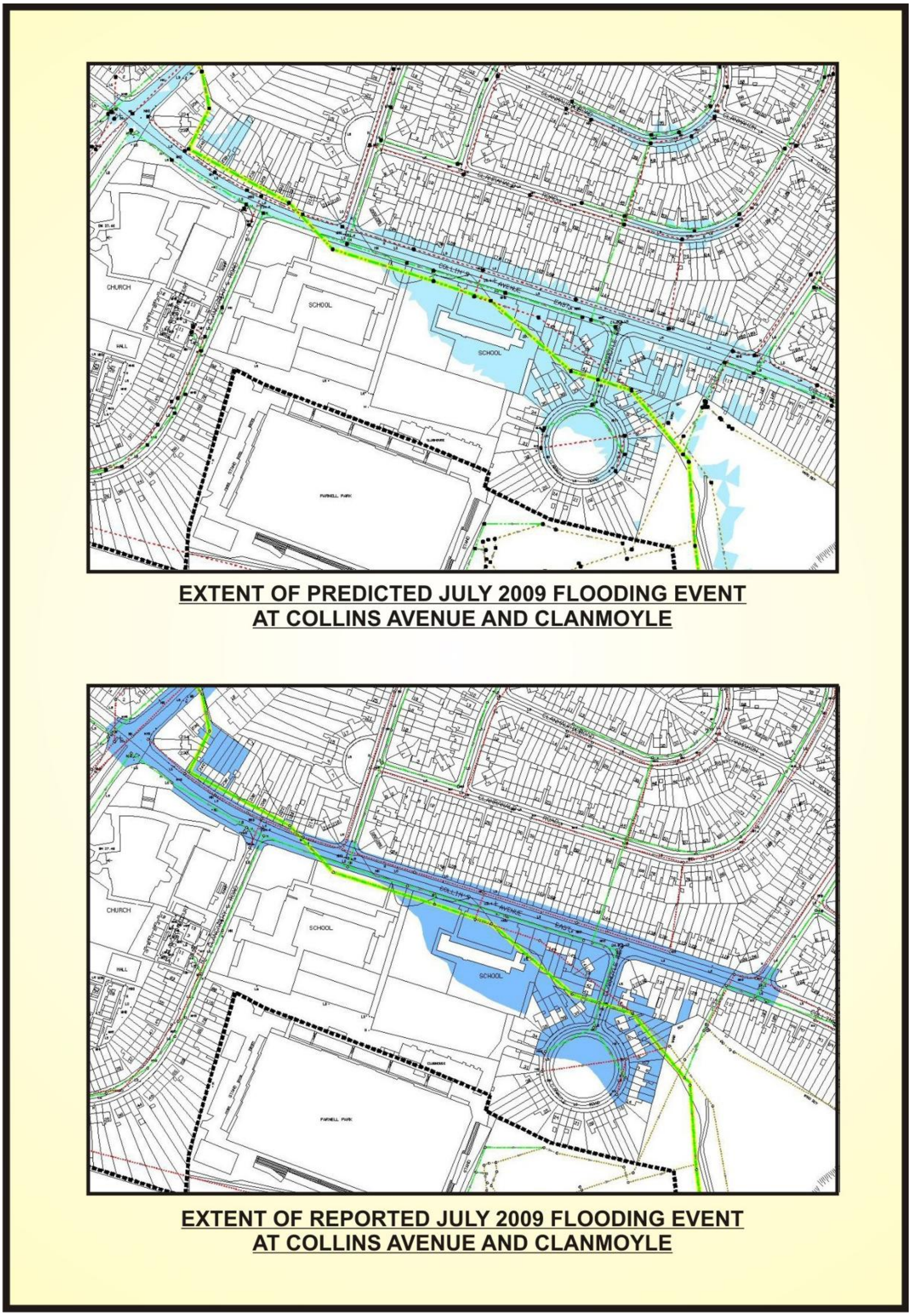


Figure 2.7 – Comparison of Predicted and Reported Flood Plains (July 2009)

The predicted flood plains for each storm in the areas between Collins Park and Clontarf are shown in drawing nos. 20446-10 to 15. The reported flood plains for each of the events was based on photographic, video and eyewitness evidence and are illustrated on Drawings 20446-05 to 20446-09. A comparison of the predicted and reported flood plain at Clanmoyle Road for the July 2009 storm event is shown in Figure 2.7.

The correlation between the reports and predictions for the flooding extents and depths were considered reasonable for both historical storm events. As a result, the 2D hydraulic model was considered to be verified for high return period storm events.

2.3.3 Impact of Future Development

The Greater Dublin Strategic Drainage Study (GDSDS) describes the land use within the Wad catchment as "*discontinuous urban fabric.*" As the catchment is already an urbanised area there is little scope for substantial additional development. Any potential infill development should follow the GDSDS Code of Practice and therefore would be an improvement on the existing scenario, albeit a slight one. The Clontarf Golf Course represents a large green area within the catchment and any urbanisation of this area could lead to increased runoff to the Wad Culvert.

As stated above, all future development will have to comply with the GDSDS Code of Practice. The Code of Practice aims to, *inter alia*:

- Comply with the Water Framework Directive
- Minimise the risk of flooding
- Comply with the Planning and Development Act 2000
- Ensure consistent drainage design and construction

The above measures will be achieved with the aid of sustainable urban drainage systems (SUDS). SUDS are a method of replicating the natural characteristic of rainfall runoff from any site. They provide hydraulic, water quality and environmental benefits. Some form of infiltration or retention/storage normally achieves this. SUDS include devices such as swales, permeable pavements, filter drains, storage ponds, constructed wetlands, roof gardens, soakaways, etc. Further guidance on SUDS is available in the comprehensive *SUDS Manual, CIRIA C697, 2007*. Any future development, in line with the above policies, should result in a reduction in the peak storm flow to the Wad River culvert and, as a consequence, a marginal improvement in the flood protection to vulnerable properties within the catchment. It is therefore not considered necessary to input any future development scenario into the hydraulic model of the catchment.

2.4 SUMMARY OF MODEL DEVELOPMENT

The initial 2D hydraulic model has been enhanced with the addition of higher quality data from topographical and site surveys of below and above ground flow paths within the catchment. A check on run-off areas has confirmed that the assumed values within the 2D hydraulic model are conservative and appropriate for use with high return period storm events. A model verification process demonstrated a reasonable correlation between reported and predicted flooding for the August 2008, July 2009 and October 2011 storm events.

The verified 2D hydraulic model is deemed satisfactory for the purposes of carrying out an analysis of existing flood risk and determining appropriate flood alleviation proposals within the Wad River catchment.

3. EXISTING FLOOD RISK ANALYSIS

3.1 DESIGN STANDARDS

The recommended design standards used for a flood relief scheme are based on the theoretical probability of a particular storm event occurring within a discrete period of time. This is usually expressed as the return period of a storm event. For example, a 100 year return period event refers to an extreme storm that would likely only occur once every 100 years. The risk of a 100 year return period storm can be expressed alternatively as a 1% chance of such a storm occurring in any given year. The magnitude of the storm is determined from statistical analysis of long term records of meteorological and hydrological data.

The following design standards, extracted from the relevant sections of the Regional Drainage Policies developed as part of the Greater Dublin Strategic Drainage Study, are proposed for use in this catchment study:

- There should be no flooding from surface water pipelines for a return period of less than 30 years.
- There should be no property flooding from river flows for a return period of less than 100 years.
- There should be no property flooding from tidally influenced rivers for a return period of less than 200 years.

The Regional Drainage Policies also highlights the importance of pluvial flooding in consideration of flood protection within a drainage system. The term 'Pluvial Flooding' refers to the accumulation of overland flows within local low-lying areas of a catchment due to the failure of surface water drainage systems, in particular gullies and local collector pipelines, after an extreme high intensity rainfall event. The impact of pluvial flooding will be included in the assessment of the existing surface water drainage system and incorporated into any flood alleviation proposals within the catchment.

The Regional Drainage Policies also takes into account the potential impact of tidal flooding with particular emphasis on the potential for coincidence with fluvial flooding. The policy report acknowledges the difficulty in calculating the joint probability of tidal and fluvial events and also outlines the uncertainties involved.

The recommend approach to joint tidal and fluvial flood risk assessment are summarised as follows:

- The Dublin Coastal Flood Risk Assessment Study 2005 recommends a level of 3.13m for the 200 year return period high tide.
- The Intergovernmental Panel on Climate Change indicates a predicted rise in sea level of 150mm to 200mm over the next 40 years.
- The 2.95m high tide measured in Alexandra Basin Dublin Bay in February 2002 is considered to have a return period of 68 years according to the Dublin Coastal Flood Risk Assessment Study.
- Strategic long term Dublin area planning and highly sensitive areas should use 4.0m OD for the design extreme high tide level.
- A pragmatic approach to joint probability analysis has been developed which recommends the following for a river flooding evaluation (100 years):
  - Mean high water spring tide with 100 year river event
  - 1 year tide with 5 year river event
  - 5 year tide with 1 year river event
- Detailed joint probability analysis should be used for storage where alleviation works are very expensive.
- Simple combination of events (as outlined above) for pragmatic assessment of joint occurrence should be used for outline design and inexpensive schemes.

3.1.1 Pluvial and Fluvial Flooding Design Standards

The rainfall records for the extreme rainfall events experienced in the Wad River catchment on 9th August 2008 (from Dublin Airport weather station), July 2nd 2009 (from Drumcondra rain gauge) and October 24th 2011 (from Dublin Airport Weather Station) were obtained from Met Eireann. A comparison of the recorded rainfall events and statistical design rainfall events for Dublin Airport is detailed in Table 3.1 and illustrated in Figure 3.1. The above comparison indicates that the return period of the 2008 and 2009 rainfall events were both in excess of the 100 year but less than the 200 year storm event whereas the 2011 rainfall event had a return period in excess of a 1 in 200 year event. The rainfall events resulted in extensive flooding in the catchment as shown in Drawings 20446-05 to 20446-09.

The over-riding purpose of the project is to prevent flooding in the 1:100 year storm event and to alleviate flooding events similar in nature to those experienced in August 2008, July 2009 and October 2011. It is therefore recommended that the design return period for the flood alleviation scheme is increased from the 1:100 year recommended in the Regional Drainage Policies to a 1:200 year storm event. Notwithstanding this, the Cost Benefit Calculation (Section 7) is calculated against the 1:100 year event, as per OPW methodology.

Table 3.1 – Extreme and Recorded Rainfall Data from Met Eireann

	Cumulative Rainfall (mm)					
Duration (Mins)	1:50 Year	1:100 Year	1:200 Year	July '09 (Drumcondra)	August '08 (Dublin Airport)	October '11 (Dublin Airport)
5	11.2	13.5	16.2	4.0	2.6	4.0
10	15.6	18.8	22.6	8.6	6.7	9.0
15	18.4	22.2	26.6	10.6	10.0	13.0
30	22.9	27.4	32.7	16.2	18.8	29.0
60	28.5	33.9	40.1	30.8	33.9	60.0
120	35.5	41.9	49.3	43.0	44.3	66.0
180	40.4	47.4	55.5	43.8	48.0	66.0
240	44.3	51.8	60.4	44.0	53.8	66.0
360	50.3	58.6	68.1	-	67.7	-

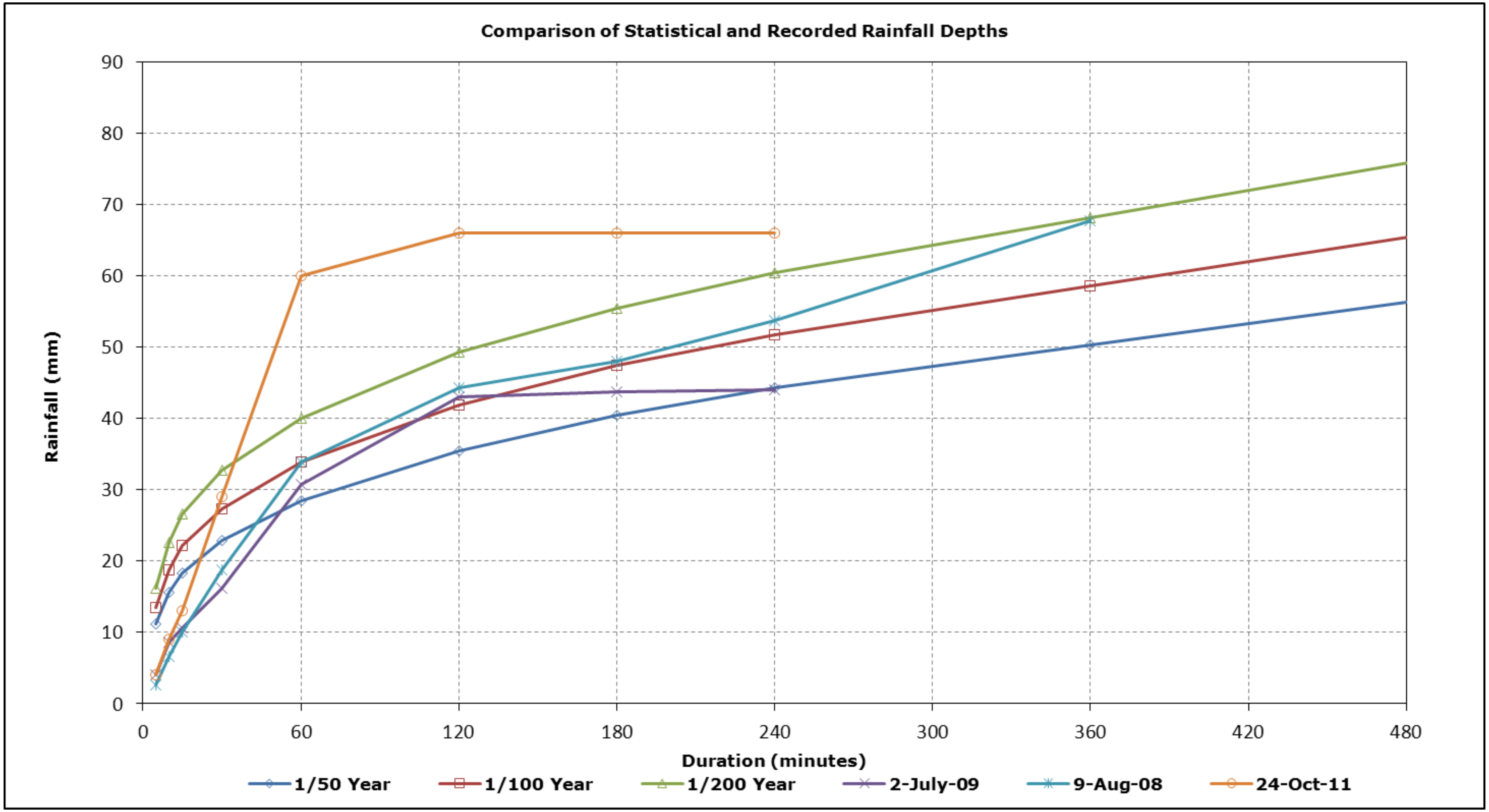


Figure 3.1 – Comparison of Statistical and Recorded Rainfall Events

3.1.2 Tidal Flooding Design Standards

On 1st February 2002, a combination of unfavourable meteorological conditions and the bimonthly spring tide led to the highest recorded sea level in Dublin since 1924. The predicted astronomical tide level for 1st February 2002 was 4.44m LAT (Lowest Astronomical Tide = -2.51m OD), whereas the actual high tide measured that day was 5.46m LAT.

The meteorological conditions led to an increase of 1.02m on the expected tide level. Figure 3.2 shows the predicted and recorded tidal levels for the flooding event in question. The meteorological conditions that led to the flooding consisted of a deep depression that spread across the country from the Atlantic combined with severe gusts and gale force southerly winds.

To deal with the problem of coastal flooding, Dublin City Council established a centre of excellence to provide flood risk management through prediction, prevention, preparation, response and recovery. This work has involved collaboration with a number of organisations including EU INTERREG projects, SAFER and Flood ResilienCities.

The Dublin Coastal Flooding Protection Project – Final Report recommended the provision of additional flooding defences as the existing measures in Clontarf offer limited protection against major flooding events and projected rising sea levels.

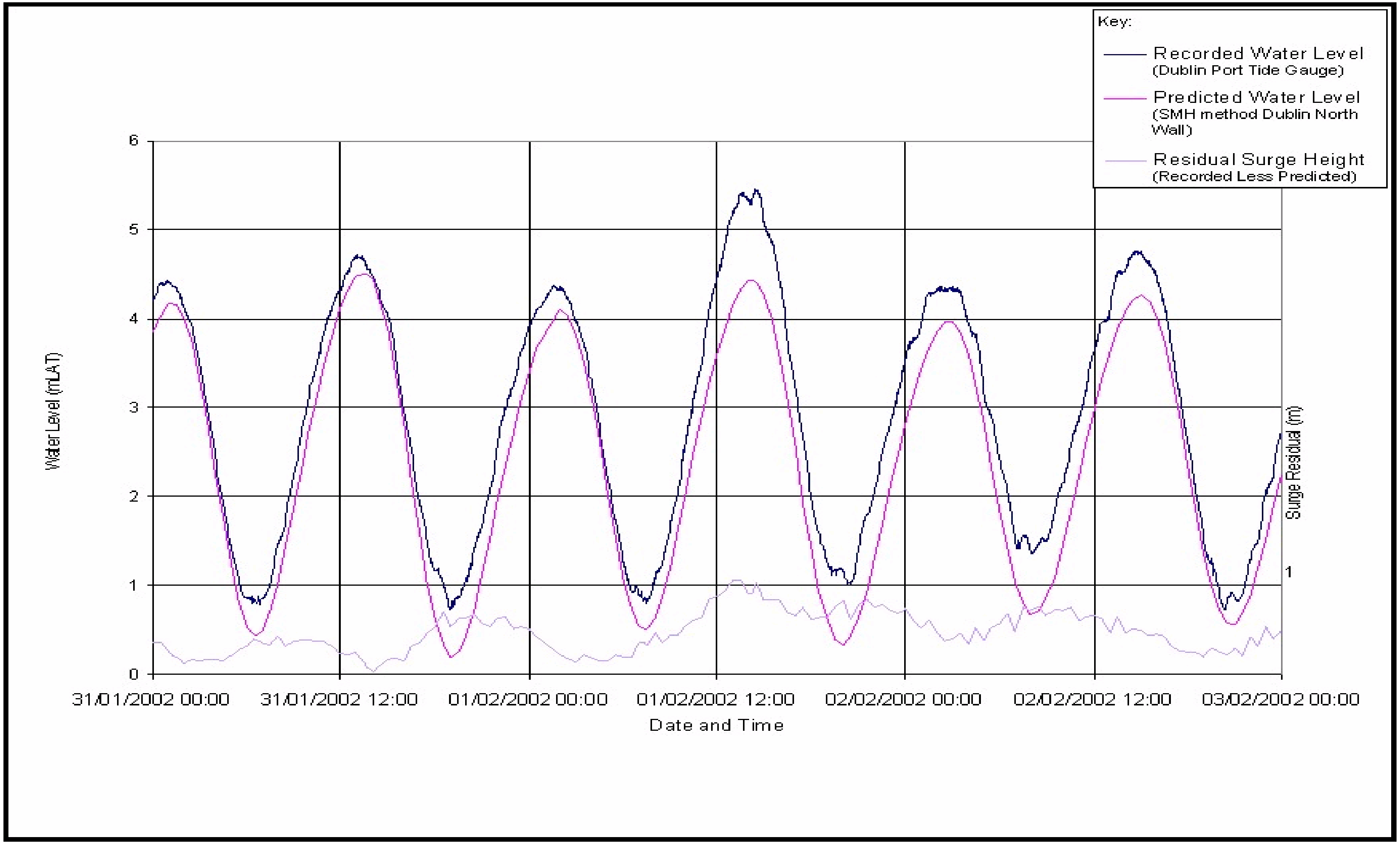


Figure 3.2 - Observed tidal level graphed against predicted tidal level (Dublin Coastal Flooding Protection Project)

The report outlined 5 options for coastal flooding defence:

1. Raise the existing sea wall with a new promenade
2. New set back re-curve sea wall with a new promenade
3. Replacement of the secondary wall at the back edge of the promenade
4. Offshore breakwater or a series of breakwaters with defences combined with option 1, 2 or 3
5. Construct new earth bund at the back edge of the new promenade

Option 5 was selected as the most economically advantageous option.

3.2 ASSESSMENT OF FLUVIAL AND PLUVIAL FLOODING

The verified 2D hydraulic model was used to produce flood risk maps for the 5, 10, 20, 50, 100 and 200 year return period storm events. The predicted flood plains for the Wad Catchment can be viewed in the Flood Plain Drawings in Appendix II.

The simulation results verified the occurrence of flooding at the following locations:

Predicted Flooding Locations West of Swords Road (M1)

- Residential Properties (Apartment Blocks) at Whiteacre Crescent
- Residential Properties (Houses) at Shanard Road
- Institutional Property (Sports Club) at Crestfield Road
- Residential (Houses) and Commercial Properties at Old Swords Road
- Residential Properties (Houses) at Shanrath Road

Predicted Flooding Locations between Swords Road (M1) and Rail Line

- Residential Properties (Apartment Blocks) at Collins Park
- Residential (Houses) and institutional (School) properties at Collins Avenue
- Residential Properties (Houses) at Clanmoyle Road

Asset data west of the M1 is unclear in some areas and the connectivity of the network has not been accurately proved. For example the Ballymun Regeneration project is still ongoing and full details of the drainage network there and it’s interaction with the Wad requires further investigation.

The simulation results also indicated flooding in areas where flooding had not been reported previous to 2011. The simulation results suggest that the effect of the remedial works at Clanmoyle Road was to reduce the predicted flood level on the road by approximately 300 mm (max depth of 1.46m predicted in Clanmoyle reduced to 1.16m) for the 1:100 year rainfall event and to create an overland route through Clontarf Golf Club to the Howth Road. It should be noted that the remedial works in Clanmoyle will only be effective if the drainage slots are maintained and kept free from any blockages. A back garden wall collapse in Clanmoyle would also result in this overland route. The following flooding locations are predicted as a result of this overland flow path:

Predicted Flooding Locations East of Rail Line

- Residential (Apartment Blocks) and Commercial Properties at Howth Road

It was not possible to gain access to the railway line for the purposes of the detailed topographical survey and, consequently, the overland path for flood waters at the railway line is based on cruder data from the LIDAR survey of the catchment. There appears to be a culvert, associated with the formerly open-channel Wad River, crossing of the railway line that could function as an alternative path for the overland flood waters. This culvert is shown in Figure 3.3. However, despite the above access difficulties, it should be noted that the potential flood locations at Howth Road and Glasslyn are within the former flood plain of the open channel Wad River. It is likely that, regardless of the precise nature of the modelled overland flow path, these properties would remain vulnerable to flooding.

The model indicates flooding on the railway line for a 5 year return period rainfall event. However, the model has not been verified for low flow events and it is suspected that flooding extents and volumes are over predicted for lower return period events. Nonetheless, the railway line does lie in a flood plain and it is therefore vulnerable to flooding. Furthermore, Infoworks 2D makes no allowance for soil permeability on overland flow paths, i.e. the model assumes that the 2D surface is completely impermeable, and this could lead to an over estimation of flooding in non-paved areas.

Each of the above potential flooding points is located at local low points upstream of constrictions to the overland flow paths within the catchment. These locations are, by their nature, vulnerable to pluvial flooding when local surface water drainage systems are unable to cater for localised high intensity rainfall events. The depth of water predicted at each location, as a result of such pluvial flooding, is a function of the depth of rainfall, the possible contributing area and the extent of the constriction to the overland flow path. The above potential flooding points are also affected, to varying degrees, by sections of the main Wad River culvert that have insufficient hydraulic capacity to cater for surface water flows resulting from higher return period rainfall events within the catchment. Any proposed alleviation works will need to address the flood risk from constricted overland and piped flow paths at each of the above locations.

Figure 3.3 – Former Wad River Culvert Crossing of Railway Line.

It should be noted that the precise details of the surface water drainage system serving the flooding locations west of Old Swords Road (M1) are uncertain and that the 2D model in this area is based on coarse topographical data from a LIDAR survey. It was not possible to produce detailed flood alleviation works for these flooding locations as a result of these design limitations. However, an estimate of flood damage cost and construction cost for alleviation works in these areas has been included in the cost benefit of the overall proposed scheme. This is detailed fully in Section 8 of this report.

3.3 ASSESSMENT OF TIDAL AND FLUVIAL FLOODING

The verified 2D hydraulic model was used to carry out an analysis of the effects of a joint tidal and fluvial event at the seafront in Clontarf. There is a risk of flooding in the coastal area if high flow in the Wad River coincides with an extreme high tide event. The predicted impact of such a joint probability event is shown in Drawing 20446-18.

3.4 SUMMARY OF EXISTING RISK ANALYSIS

The flood risk analysis of the existing system indicates that a number of properties are at risk of flooding in the Wad River catchment. It is necessary to assess a range of flood alleviation options to address these issues. The risk of tidal flooding has also been taken into account. The proposed design sea level at Clontarf will impact on the Wad River and any flood alleviation scheme will need to address the possibility of a joint tidal / fluvial flooding event. A summary of the properties potentially affected is provided below in Tables 3.2 and 3.3

Table 3.2 – Estimation of Existing Flood Risk in the Wad Catchment

Tidal Flooding - 5 year high tide and 1 year return period rainfall			
		Houses	**Other**
Seafront at Clontarf	Houses	31	
	Garda Stn		1
	Church		1
	Care Home		1
	Restaurant		1
TOTAL		**31**	**4**

Table 3.3 – Estimation of Existing Flood Risk in the Wad Catchment

Wad Flooding - 100 year return period storm			
		Houses	**Other**
Howth Rd	Houses	24	
	School		1
	Rail track		1
Clanmoyle	Houses	26	
	Golf Course		1
Collins Avenue	Houses	30	
	School		1
Elm Mount Avenue	Houses	10	
Collins Park	Houses	32	
West of M1	Houses	74	
	Pub		1
	Clubhouse		1
TOTAL		**196**	**6**

4. CATCHMENT MANAGEMENT

The Water Framework Directive (2000/60/EC) and the Floods Directive (Directive 2007/60/EC) both address the issue of flooding. They require an integrated and sustainable approach to flood prevention, and it is in this context that the management of the Wad Catchment is of key importance.

The Wad catchment is classified as a small urban catchment (less than circa $50km^2$). Such small urbanised catchments typically have rapid response times to rainfall events. In relation to extreme events, the scale of the flood waters is initially invisible, being underground in pipes, however, as the storm progresses and the floodwaters reach bottlenecks in the drainage system, the floodwaters may burst out of the drainage system, often leading to extreme damage. This leads to an impression of flash flooding in such small catchments.

Flood alleviation focus in recent years has shifted from traditional structural measures to reduce flooding to an acceptance that some level of flooding is inevitable due to climate change, and that a variety of structural and non structural measures will be required in order to address flooding in a sustainable manner.

The FloodResilienCities Project (FRC) is a European Union (EU) funded project which enables responsible public authorities in cities in North West Europe to better cope with floods in urban areas. Dublin City forms part of the group of cities. The FRC promotes a variety of principles including:

- Flood reduction through the use of roads for rivers, streets for streams
- The 4 A's: Awareness, Avoidance, Alleviation, and Assistance

The FRC project will be implemented through a combination of transnational cooperation and regional investments.

4.1 FUTURE CATCHMENT MANAGEMENT FRAMEWORK

In line with the policies of the FRC, the following catchment management framework is recommended, under the headings of the 4 A's:

4.1.1 Awareness

Floodplain Mapping

It is important that occupiers of properties at risk of flooding have an understanding of the risk. Flood maps can help in this regard, and should be used as a tool to disseminate information, in conjunction with education programmes. The areas at risk of flooding within the catchment have been identified and mapped in this Report for various return periods. These are presented in Appendix II. Due to the modelling constraints, it should be noted that these maps should be considered as indicative rather than absolute. However, the maps are considered sufficiently accurate for the purposes of this Report and the floodplain mapping conservatively indicates vulnerable areas.

Flood Forecasting and Warning

Given the nature of the Wad catchment (small and urbanised), there is a limited reaction time available to provide an effective warning system. Monitoring stations (flow and rainfall) could be set up in the Wad to monitor the behaviour of the catchment. However, rainfall radar warning systems would provide the earliest warning of the risk of extreme pluvial events. Rainfall radar monitoring, combined with water level monitoring should provide a correlation to flood risk over time, and this could be used to inform Community Groups in relation to implementation of Emergency Action Plans. For example an early warning system would allow residents to move vehicles away from high risk areas.

4.1.2 Avoidance

Maintenance of Conveyance System

Conveyance systems in small urban catchments are particularly vulnerable to blockages of pipes and culverts, given the relatively small diameter of sections of pipe. In this regard it is important that the system is monitored and maintained on a regular basis to ensure that the conveyance system is available to be utilised to its maximum capacity in the event of a storm. This monitoring should be carried out through higher frequency CCTV (Sewer Condition Survey) or walk through surveys as compared to standard sewer monitoring.

Sustainable Drainage Systems (SUDS)

Heavily urbanised catchments have significant amounts of impermeable surfaces and this leads to a situation where there are rapid discharge of storm water during rainfall events. The general aim of SUDS is to reduce the impact of urbanisation by modifying the discharge flow from any area to match the discharge that would occur if the site was a natural green field site. SUDS forms part of the GDSDS and as such forms policy for all future developments within the catchment.

Numerous SUDS / Attenuation Systems have been installed in new developments in the catchment since circa 1999. It will be necessary to maintain these attenuation devices and to ensure that flow control limitations specified in the planning permission are still being adhered to. These devices form an integral part of the Wad Catchment Network and recording and maintaining them will reduce the risk of future flooding.

Planning and Building Control

Planning permission should be avoided in areas with a flood risk greater than 1 in 100 years, or 1 in 200 years for the tidal areas of the catchment. This can be implemented through the Planning and Development Act, 2000. In the event that refusal of planning is not feasible, conditions should be imposed to enforce dry flood protection measures on the buildings.

4.1.3 Alleviation

Flood Routing

One of the principles of the FRC project is to use roads as rivers and streets as streams. It is important that natural drainage paths are kept clear to allow surface water to drain away, rather than accumulate and cause flooding. Clanmoyle is in the natural drainage path of the Wad with surface flood waters naturally flowing to the area. As such, it is important that an outlet exists from Clanmoyle to cater for extreme events where surface water does not enter the conveyance system. This could happen due to blockage or a particularly high intensity rainfall event.

Local Flood Protection/ Individual Property Protection

It is possible to protect individual properties through the use of sand bags, flood barriers, caps for vents, walls and embankments. However, this approach to flood protection is generally most appropriate for isolated properties in flood risk areas where larger scale flood alleviation works are not economically viable or in advance of the installation of flood protection measures. Further information on individual flood protection products can be found at www.flooding.ie.

Local householders who have flooded in the past, or who are indentified as vulnerable to flooding, should implement alleviation measures such as dry/wet proofing. Dry proofing is where buildings are made completely water proof, and doors and openings can prevent water ingress despite rising water levels outside. Wet proofing is where building materials are used which are resistant to flooding, i.e. the building can flood internally, but there is no residual damage once the flood waters abate.

In small urban catchments, the preferred approach is dry proofing for all buildings up to 900mm water depth. This prevents potentially contaminated water from entering premises and the amount of internal repair/recovery is reduced / eliminated. Because of the short response times that are available in small catchments, it is recommended that permanent dry proofing be utilised over any form of temporary (wet or dry) proofing.

Some of the properties in the catchment suffered basement flooding, with flood waters entering through external vents. In some instances, this also led to flooding of the ground floor level. Any premises in the vulnerable areas should ensure that basements are protected by extending vents to above the flood risk level, though the use of snorkels, or other similar measures.

4.1.4 Assistance

A communications programme should be established between Dublin City Council and local Residents Associations to provide assistance in information and education in relation to flooding issues. DCC's existing Flooding Emergency Plan should include the actions and responsibilities in response to an impending or occurring flood event for the Wad. The programme should address informing of the flood risk and of alleviation measures available to property owners.

5. FLOOD ALLEVIATION SCHEME

5.1 OVERVIEW OF EXISTING HYDRAULIC PERFORMANCE

The assessment of the existing hydraulic performance of the drainage system has identified sections of lower transfer capacity within the main Wad River culvert and identified locations within the catchment that are vulnerable to pluvial flooding. An assessment of the effects of joint high tide and high flow situation has also determined that any alleviation works should incorporate sealing of manholes in the vicinity of the Clontarf Sea Outfall to prevent flooding during extreme high tides. In conjunction with this, the local drainage in the area where manholes are sealed would need to be reviewed at detail design stage. Non return fittings would need to be installed on each inlet to the Wad at this location to prevent the Wad flowing out of the inlets, and pumping may be required on some or all of the inlets. This is particularly of relevance to the gullies on Strandhill Avenue East, Clontarf Garda Station, and the Seapoint Building (including basement).

The types of possible approaches to alleviate flooding and the consideration of the optimum implementation of these approaches within the Wad River catchment to alleviate predicted flooding is detailed below.

5.2 POSSIBLE APPROACHS TO FLOOD ALLEVIATION WORKS

5.2.1 Approach 1 – Diversion of Flow Only

The hydraulic restriction within the main Wad River culvert between Collins Park and Clontarf Golf Course could be alleviated by constructing a new diversion culvert from the Wad River catchment to the Tolka River. The following route, outlined in Figure 5.1, was identified for such a diversion culvert. The route is approximately 2.3 km long, starts from the main Wad River culvert at Beaumont Road and continues along Grace Park Road to the Tolka River at Tolka Park. A 1,800 mm diameter culvert laid at a minimum gradient of 1/200 would be required to cater for the peak flows from the Wad River diversion at Beaumont Road.

5.2.2 Approach 2 – Attenuation Storage Only

The hydraulic restriction within the main Wad River culvert between Collins Park and Clontarf Golf Course could be alleviated by diverting excess storm flows to storage upstream of the hydraulic restriction in order to attenuate peak flows within the Wad River catchment. The following locations within the Wad River catchment, highlighted in Figure 5.2 and detailed in Table 5.1, were identified as possible sites for attenuation areas:

Table 5.1 – Required Attenuation Volumes Upstream of Clanmoyle

Name	Required Volume (m^3)	Type
Public Park at Ellenfield Park	25,000	Above Ground Pond
Dublin Port Tunnel Shaft	38,000	Below Ground Tank
Old Veterinary College Site	27,000	Below Ground Tank
Public Area at Beaumont Road	3,000	Below Ground Tank
Public Area at Collins Wood No. 1	3,000	Below Ground Tank
Public Area at Collins Wood No. 2	2,000	Below Ground Tank
Public Area at Collins Park	4,500	Below Ground Tank
Public Park at Malahide Road	4,500	Below Ground Tank

The following locations, detailed in Table 5.2 with a possible storage volume, within the Wad River catchment downstream of Clanmoyle were also identified as possible sites for attenuation areas. The locations at Clontarf Golf Course and Mount Temple are downstream of the vulnerable flooding locations and additional conveyance capacity would be required to utilise these locations as attenuation ponds.

Table 5.2 - Available Attenuation Volumes Downstream of Clanmoyle

Name	Available Volume (m^3)	Type
Clontarf Golf Course	57,000	Above Ground Pond
Sports Ground at Mount Temple	31,000	Above Ground Pond

5.2.3 Approach 3 – Piped Conveyance Only

The hydraulic restriction within the main Wad River culvert between Collins Park and Clontarf Golf Course could be alleviated by constructing a duplicate culvert from Collins Park to the seafront at Clontarf. The following routes, shown in Figure 5.3, were identified for such a duplicate culvert. The first route is approximately 2.4 km long, starts from the main Wad River culvert at Collins Park, continues along Malahide Road to Collins Avenue through Clontarf Golf Course, crosses the railway line from Mount Temple school grounds to Howth Road and continues along Hollybrook Grove / Strandville Avenue East to the seafront at Clontarf. The second route is approximately 2.4 km long, starts from the main culvert at Donnycarney Bridge and continues along Malahide Road to the mouth of the Tolka River at Fairview Park. A 2,100 mm diameter culvert laid at a minimum gradient of 1/200 would be required to cater for the peak flows from the Wad River diversion at Collins Park.

5.2.4 Approach 4 – Overland Conveyance Only

The hydraulic restriction within the main Wad River culvert between Collins Park and Clontarf Golf Course could be alleviated by constructing an overland flow path with sufficient capacity to convey flood waters from vulnerable locations at Elm Mount Avenue, Collins Park, Collins Avenue and Clanmoyle Road to the seafront at Clontarf. The following route, shown in Figure 5.4, was identified for such an overland flow path. The route is approximately 2.1 km long, starts from Collins Park, continues along Malahide Road to Clanmoyle Road via Collins Avenue, continues across the railway line from Clontarf Golf Course to Ashbrook, continues parallel to the railway line and crosses Howth Road, via Glasslyn and Strandville Avenue East, to the seafront at Clontarf. The construction of a suitable overland flow path would effectively be an attempt to re-use the route of the original, open channel Wad River to provide additional capacity during flood events. This would involve the following works:

- Construction of an overland path within private property at Collins Park.
- Re-grading of roads between Collins Park and Malahide Road.
- Demolition of houses at Elm Mount Avenue.
- Re-grading of roads between Collins Avenue and Clanmoyle Road.
- Demolition of houses at Clanmoyle Road.
- Construction of new channel and rehabilitation of original Wad River channel in Clontarf Golf Course.
- Rehabilitation of Wad River culvert crossing of railway line at Ashbrook.
- Construction of channel from Ashbrook, across Howth Road, to Glasslyn.
- Demolition of walls and re-grading of roads within Glasslyn/Strandville Avenue.

- Demolition of walls within linear park by seafront at Clontarf.

5.2.5 Summary of Possible Approaches

A summary of the relative cost and any significant construction issues or constraints associated with each of the above approaches is detailed in Table 5.3. It is clear from examination of Table 5.3 that there are significant difficulties in implementing any of the above approaches on a 'standalone' basis. It is further clear that the inclusion of flow attenuation, in an appropriate form, will improve the cost-benefit of any proposed alleviation scheme.

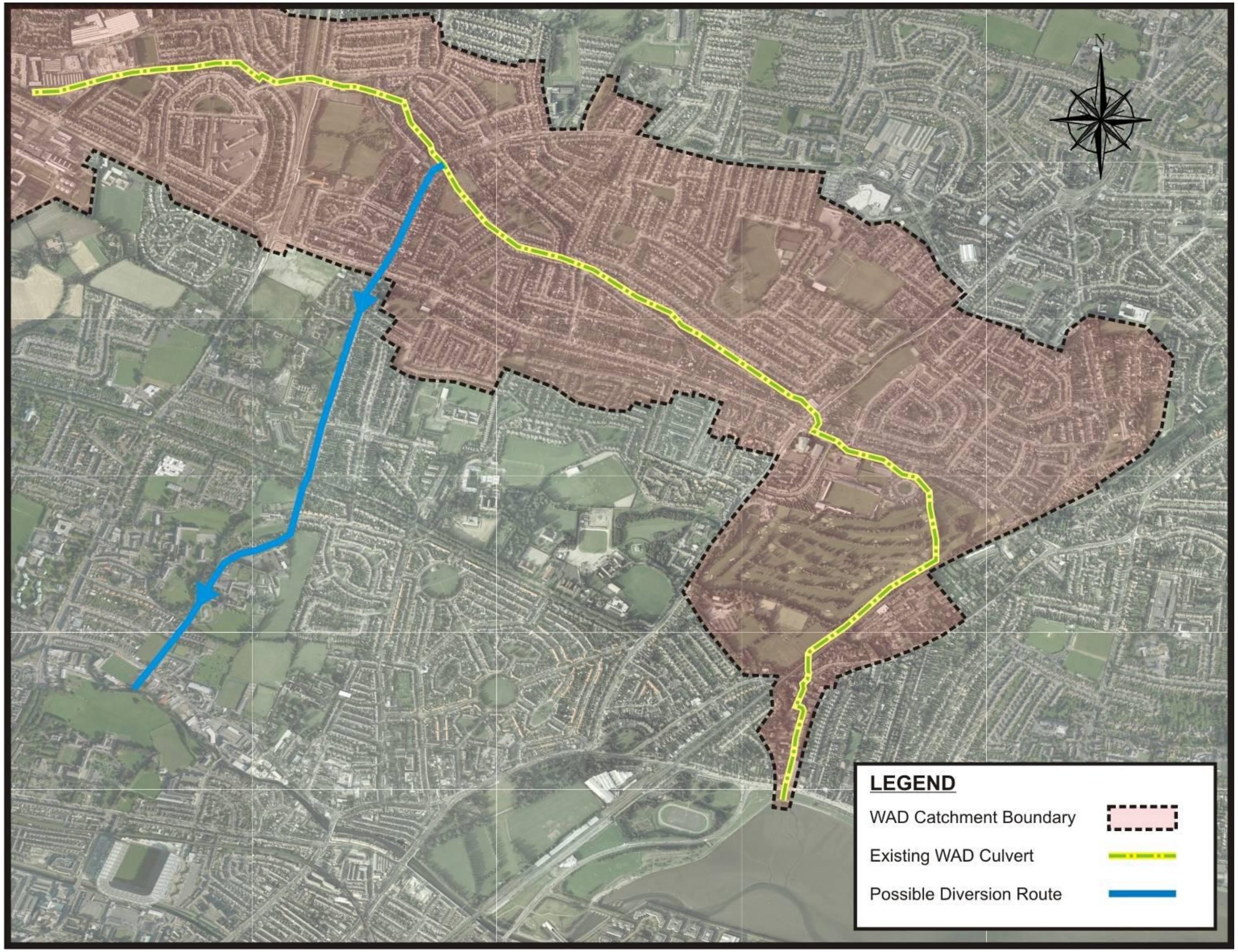


Figure 5.1 – Possible Diversion Route on Beaumont Road to River Tolka

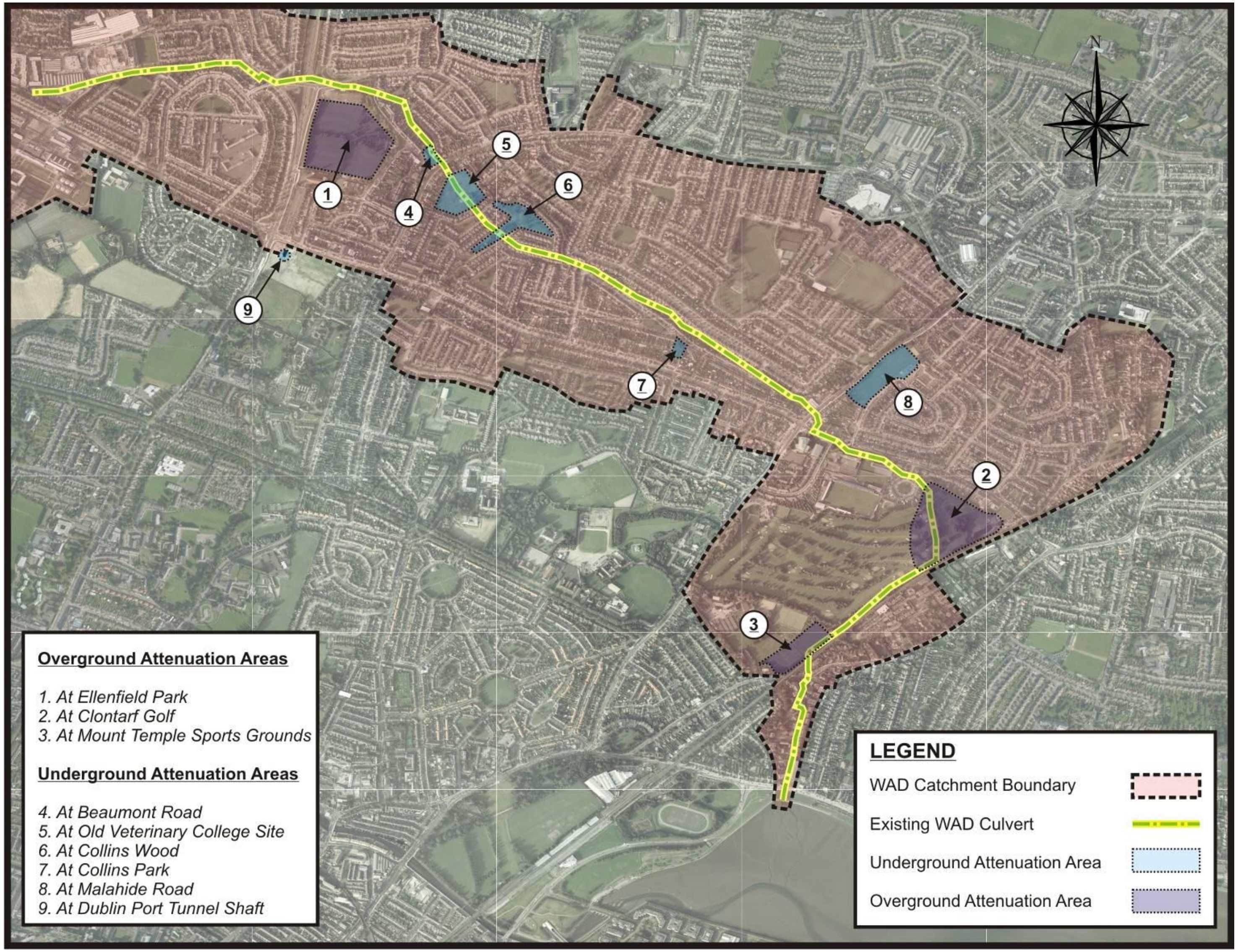


Figure 5.2– Possible Attenuation Areas within Wad River Catchment

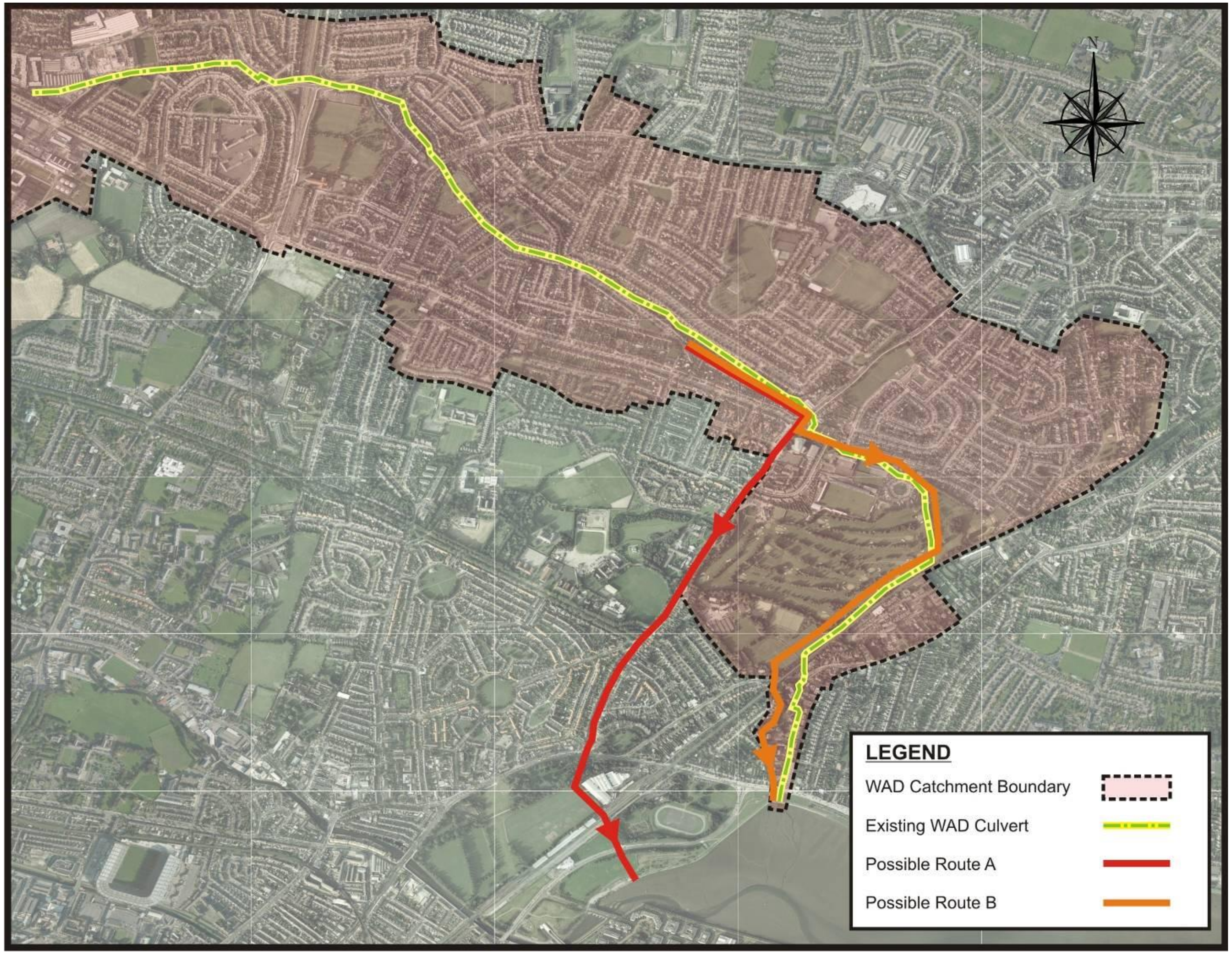


Figure 5.3 – Possible Routes for Piped Conveyance to Seafront

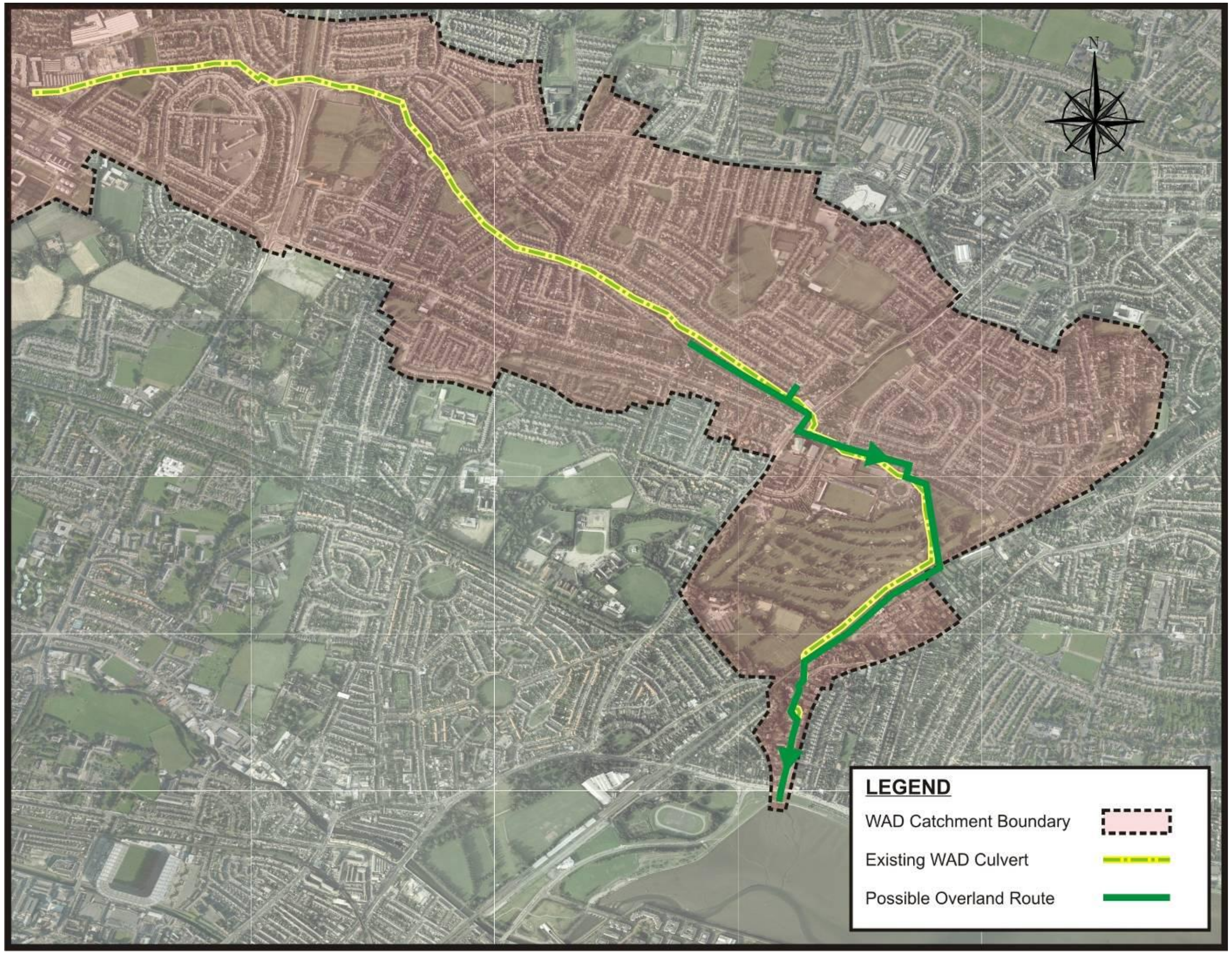


Figure 5.4 – Possible Routes for Overland Conveyance to Seafront

Table 5.3 – Summary of Cost, Constraints and Construction Issues with Each Possible Approach to Flood Alleviation Works

Approach	Ranked Cost Estimate (€)	Significant Constraints/Issues
Flow Diversion Only	2	Expensive to construct. Significant impacts on traffic during construction. Does not fully resolve flooding problems further downstream in catchment. Impact on River Tolka has not been fully assessed. Likely to require temporary and permanent wayleave agreements with private land owners.
Attenuation Only	4 - Lowest	No suitable public lands available for sites of above ground ponds. Adequate attenuation storage requires multiple, large underground tanks which would be every expensive to construct. Planning of tanks would be vulnerable to opposition by local population. Significant operational and maintenance problems associated with underground tanks.
Piped Conveyance Only	3	Expensive to construct. Significant impacts on traffic during construction. Likely to require temporary and permanent wayleave agreements with private land owners.
Overland Conveyance Only	1 - Highest	Requires third party agreements to construct an overland flow path, through or adjacent to, the property of approximately 200 households, 6 large apartment/office developments, 2 schools and 1 golf club. There would be a requirement for some demolition of property and boundary walls. The cost estimate does not include any third party agreements, local property protection or land acquisition costs. The use of main and local roads as part of the overland flow path would cause disruption during flood events. The flow path would need to be maintained and have access for maintenance.

5.3 SCENARIOS FOR PROPOSED FLOOD ALLEVIATION SCHEME

A more detailed assessment of the significant issues / constraints was performed to determine the combination of the above approaches that would provide the most suitable scheme to provide flood alleviation in the Wad River catchment. The following constraints / issues, in no particular order, were included in this assessment:

- Health & Safety Issues
- Planning Issues
- Traffic Issues
- Environmental Issues
- Human Issues
- Cost Issues
- Programme of Works
- Existing Services and Utilities
- Operational Issues

The assessment of the above constraints / issues resulted, via the application of engineering judgment, in the identification of two scenarios that maximise the use of existing hydraulic capacity within the main culvert, minimise the impact of the above constraints / issues to acceptable levels and achieve the over-riding purpose of the project, namely to alleviate the flooding risk within the Wad River catchment. The two scenarios are described in detail in Section 5.3.1 and 5.3.2.

5.3.1 Scenario 1 – Attenuation Area at Clontarf Golf Course

This scenario includes for new pipelines to increase the flow capacity downstream of the flooding locations in order to maximise the use of the existing Wad River culvert to transfer peak storm flows to the seafront at Clontarf. It is therefore proposed to provide:

- A new 550 m length of 2,100 mm diameter (or equivalent) surface water culvert from Malahide Road to Clontarf Golf Course including 89 m on Malahide Road, 340 m on Collins Avenue East and 121 m on Clanmoyle Road.
- A new 30 m length of 1,500 mm diameter surface water culvert at Howth Road.

- A new 45 m length of 1,500 mm box surface water culvert outlet at the seafront at Clontarf.

The above works will improve the overall hydraulic performance of the main Wad River culvert but are insufficient to cater for extreme storm events, such as those of August 2008, July 2009 and October 2011 and do not address the vulnerability of property at Elm Mount Avenue, Collins Park, Clanmoyle Road, Ashbrook and Mount Temple to the effects of pluvial flooding. It is therefore also proposed under this scenario to address these additional design requirements by providing:

- A new 710 m length of 1,200 mm diameter surface water pipeline (480 m along Collins Park and 230 m along Elm Park), with additional gully capacity, to drain vulnerable points of Elm Mount Avenue and Collins Park to the new 2,100 mm diameter culvert at Malahide Road.
- The construction of a new retaining wall and earthen bunds to create an attenuation pond within Clontarf Golf Course with sufficient storage volume to reduce peak flows within the downstream capacity of the Wad River culvert (allowing for proposed local improvements to culvert at Howth Road and at Clontarf) for extreme storm events.
- The construction of a new chamber on the existing Wad River culvert with suitably sized flow control device, inlet and outlet pipelines to limit flows downstream of the new 2,100 mm diameter surface water culvert and transfer flows to / from the new attenuation pond in Clontarf Golf Course.

The proposed flood alleviation works associated with Scenario 1 meet the over-riding purpose of the project and are detailed in plan on Drawing Nos. 20446-19 and 20.

5.3.2 Scenario 2 – Attenuation Area at Ellenfield Park and Clontarf Golf Course

This scenario includes for new pipelines to increase the flow capacity at local hydraulic constrictions downstream of the flooding locations in order to maximise the use of the existing Wad River culvert to transfer peak storm flows to the seafront at Clontarf. There are local hydraulic constrictions at the culvert between Collins Park and Clontarf Golf Course, at the culvert crossing of Howth Road and at the culvert to the seafront within Clontarf Park. It is proposed to provide:

- A new 550 m length of 2,100 mm diameter (or equivalent) surface water culvert from Malahide Road to Clontarf Golf Course including 89 m on Malahide Road, 340 m on Collins Avenue East and 121 m on Clanmoyle Road.
- A new 30 m length of 1,500 mm diameter surface water culvert at Howth Road.
- A new 45 m length of 1,500 mm box surface water culvert outlet at the seafront at Clontarf.
- The construction of new earthen bunds to create an attenuation pond within Ellenfield Park with sufficient storage volume to reduce peak flows to below the available downstream capacity of the Wad River culvert (allowing for proposed local improvements to culvert at Malahide Road, Howth Road and at Clontarf) for extreme storm events.
- The construction of a new pumping station adjacent to the existing Wad River culvert at Ellenfield Park with suitably sized pumps, inlet and outlet pipelines to transfer flows to / from the new attenuation pond in Ellenfield Park.

The above works will improve the overall hydraulic performance of the main Wad River culvert but are insufficient to cater for extreme storm events, such as those of August 2008, July 2009 and October 2011, and do not address the vulnerability of property at Elm Mount Avenue, Collins Park and Clanmoyle Road to the effects of pluvial flooding. It is also proposed under this scenario to address these additional design requirements by providing:

- A new 230 m length of 1,200 mm diameter surface water pipeline, with additional gully capacity, to drain vulnerable points of Elm Mount Avenue and Collins Park to the new 2,100 mm diameter culvert at Malahide Road.
- The construction of a new retaining wall and earthen bunds to create an attenuation pond within Clontarf Golf Course with sufficient storage volume to reduce peak flows to within the downstream capacity of the Wad River culvert (allowing for proposed local improvements to culvert at Howth Road and at Clontarf) for extreme storm events.
- The construction of a new chamber on the existing Wad River culvert with suitably sized flow control device, inlet and outlet pipelines to limit flows downstream of the new 2,100 mm diameter surface water culvert and transfer flows to / from the new attenuation pond in Clontarf Golf Course.

The proposed flood alleviation works associated with Scenario 2 meet the over-riding purpose of the project and are detailed in plan on Drawing Nos. 20446-21, 22 and 23.

5.3.3 Alternative Attenuation Area - Mount Temple School

It should be noted that the sports grounds at Mount Temple School could be used as an alternative location for the attenuation pond proposed at Clontarf Golf Course. There would be a requirement for the construction of a suitably sized conduit through the grounds of Clontarf Golf Course to convey storm flows to the sports grounds and for significant additional earthworks to alter the topography of the site to function as an attenuation pond.

5.3.4 Comparison of Scenario 1 and Scenario 2

The alternative scenarios have been described above and the core elements are summarised below in Table 5.4.

Table 5.4 – Summary of Scenario 1 and Scenario 2

Scenario 1	Scenario 2
550m of 2.1m diameter (or equivalent) culvert	550m of 2.1m diameter (or equivalent) culvert
710m of 1.2m diameter culvert	230m of 1.2m diameter culvert
75m of 1.5m diameter culvert	75m of 1.5m diameter culvert
Retaining wall and bund in Clontarf Golf Course	Retaining wall and bund in Clontarf Golf Course
No works at Ellenfield Park	Construction of 60m of 600mm diameter surface water sewer, pumping station and bund at Ellenfield Park

5.4 RECOMMENDED FLOOD ALLEVIATION SCHEME

A comparison of the two scenarios identified for the scheme highlighted the following points in relation to the relative merits of each scheme:

- The reduction in peak flow and required storage volume achieved by the additional attenuation pond at Ellenfield Park, proposed under Scenario 2, would not significantly reduce, in comparison with Scenario 1, the length of pipelines from Malahide Road to Collins Park or the earthworks required at Clontarf Golf Course.
- The implementation of Scenario 1 would function automatically and would not require the intervention of mechanical and electrical equipment, with the associated risk of failure, associated with Scenario 2.
- An attenuation pond of sufficient storage volume could be carefully designed and constructed within Clontarf Golf Course to minimise the loss of utility of the course for significant storm events. There would be a more significant impact on the use of the playing fields at Ellenfield Park as a result of any controlled flooding from significant storm events. In essence, the flooding of Ellenfield Park prohibits the use of the playing fields but by careful landscaping the golf course could be used in a flood event.

For the above reasons, it is considered that the works proposed under Scenario 1 represent the optimum alleviation solution to the existing flooding problems within the Wad River catchment.

The results of the hydraulic modelling indicated that there is a risk of flooding on Clontarf Road during extreme high tide events. It will be necessary to seal manholes in the vicinity of Clontarf Road to prevent flooding occurring during such an event. In addition, any inlets to the Wad in the area where manholes are sealed will require non return fittings to be installed. At detailed design stage, local drainage in this area will need to be thoroughly reviewed to make allowances for the manhole sealing and ensure that there is no additional risk of flooding to properties.

6. IMPLEMENTATION OF PROPOSED WORKS

6.1 OVERALL APPROACH

The proposals described in this report aim to reduce the flood risk in the Wad Catchment to the National Standard. It is possible to construct the proposals as individual distinct contracts. This approach may be desirable for economical and logistical reasons. There are three possible sub-schemes that would eventually form the overall works. The first sub-scheme is the Clanmoyle Flood Alleviation Scheme which is recommended to go ahead immediately. The remaining sub-schemes, the Middle Wad Flood Alleviation Scheme and the Upper Wad Flood Alleviation Scheme require further ground/site investigation and therefore will be constructed at a later date.

The Flood Risk Analysis indicates which properties are most at risk and has been used to aid the development of an implementation strategy. The deciding factors used to organise the different project segments are summarised (in no particular order) as follows:

- Level of public disruption involved
- Number of properties impacted by predicted flood plain
- Estimated cost
- Estimated duration of construction
- Level of planning, preliminary surveys and detailed design involved
- Level of risk involved if nothing is done

6.2 PLANNING AND LEGAL CONSTRAINTS

The project is currently at the Feasibility Phase and the important remaining stages are listed chronologically as follows:

1. OPW approval of Feasibility Report/Full Catchment Report

2. Preliminary Phase:
   - Preliminary Contracts, e.g. site investigations
   - Preliminary Report
   - OPW approval of Preliminary Report

3. Design Stage:
   - Procurement of Consultant
   - Appointment of Project Supervisor Design Process (PSDP)
   - Part 8 Planning Permission
   - Land Acquisition
   - Wayleaves
   - Foreshore Licence

4. Detailed Design:
   - Contract Documents
   - Contract Drawings
   - Cost Estimates
   - OPW Approval of proposals

5. Tender Stage:
   - Advertisement Tender *(to be actioned directly by DCC / OPW)*
   - Tendering Period *(to be actioned directly by DCC / OPW)*
   - Tender Evaluation *(to be actioned out directly by DCC / OPW)*
   - OPW Approval of successful tenderer *(this won't be required if works to be carried out by DCC/OPW direct labour)*
   - Appointment of PSCS
   - Contract Award

6. Construction Stage
   - Works may be constructed by using DCC or OPW labour

7. Handover Stage

6.3 PROCUREMENT OPTIONS

6.3.1 Project Segmentation Options

The proposed flood alleviation scheme has been tested in the hydraulic model against a range of design rainfall events. It may be easier, for economic, technical and logistical reasons, to undertake the construction of the recommended scheme in segments. As such, it is recommended that the elements of the scheme are bundled together as follows:

Sub Scheme 1 - Clanmoyle Flood Alleviation Scheme

A. Construction of a flood attenuation pond in Clontarf Golf Course including bund construction, retaining wall, flow control device, outlet pipework and landscaping.

B. Construction of inlet pipework from Clanmoyle Road to Clontarf Golf Course.

Sub Scheme 2 - Middle Wad Flood Alleviation Scheme

C. Provision of an additional culvert crossing of Howth Road.

D. Construction of a new 2.1m diameter (or equivalent) culvert from Collins Park to Clanmoyle Road including connections to the existing Wad culvert and provision of additional gully capacity in Collins Park, Elm Mount Avenue, Collins Avenue and Clanmoyle Road.

E. Construction of a new sea outfall(s) and sealing of manholes. This work should also include the removal of intruding services which obstruct the flow to the outfall. In addition, the work should include a structural rehabilitation of the pressurised section of the Wad, if a structural survey shows that this is necessary.

Sub Scheme 3 - Upper Wad Flood Alleviation Scheme

F. Construction of attenuation and relief sewers west of M1. The exact nature of this work needs further investigation, but would be similar in nature to work carried out in D above.

Elements A and B consist of relatively straightforward work, and can be procured as a single contract. Elements C, D, E and F involve greater cost and complexity and should therefore be procured separate to elements A and B.

6.3.2 Procurement Options

The procurement routes to be examined are:

- Conventional (i.e. employer design)
- Design & Build (i.e. contractor design)

When considering the preferred procurement route the following key issues need to be taken into account:

- Initial Output Specification

  - Provision of flood alleviation works as described in Section 7

- Risk Allocation
  - Unforeseen services
  - Unforeseen ground conditions

- Value for Money Assessment
  - Limited scope for innovation

- Stakeholder Consultation
  - Existing staffing level
  - Potential delays as a result of consultation if DB adopted

- Environmental Assessment

The choice is therefore between a conventional contract with an employer led design or a design build contract with a contractor led design within defined constraints. There is little scope for innovation in this project as the flood alleviation works have been identified through extensive design and analysis. **Furthermore, the politically sensitive nature of flooding and the level of public interest in this project may not be suited to a contractor led design.**

There are some risks in the contract that could be transferred to a contractor that could give cost certainty to Dublin City Council and ensure a robust tender price. The design build approach has a fundamental principle of transferring risk but the lack of potential for innovation and the requirement for specific flood alleviation works mean that there is little to be gained from a contractor design. The Public Works form of contract with an employer led design permits the transfer of certain risks while allowing the employer to define the scope of the works to reflect specific requirements.

In pursuing any strategy, consideration has to be given to the procedure to be adopted in accordance with the EU Public Procurement Directive. Three options exist namely: open, restricted and negotiated. These are discussed below.

The negotiated procedure is only relevant where the outcome of the project is uncertain or difficult to define. This is not the case here and thus this procedure is not suitable. The open and restricted procedures are commonly used for public works contracts. The open procedure invites tenders from the market whereas the restricted procedure is a two stage approach where a shortlist is derived following an Expression of Interest stage and the shortlisted applicants tender the contract.

6.4 PROCUREMENT OF SUB-SCHEME 1 WORKS

The Sub-Scheme 1 (elements A and B) Works are relatively straightforward and mainly require ground works with an element of structural concrete work. These works can provide immediate benefit and thus an open procedure is proposed as it is a shorter process and will provide for keen pricing. Care must be taken in determining the minimum qualifying criteria to ensure a basic standard of contractor qualifies. Therefore this assessment recommends "Public Works Contract for Civil Engineering Works Designed by the Employer" procured under the open procedure, or that the works are carried out by OPW/DCC direct labour.

6.5 PROCUREMENT OF SUB-SCHEME 2 AND 3 WORKS

The restricted procedure is preferred for Sub-Scheme 2 (elements C, D, E and F) and Sub-Scheme 3 due to the difficulties in working in the centre of the capital city and complex nature of the co-ordination (i.e. liaison with public, DCC, utilities etc) required on this project. The restricted procedure affords the council the opportunity to shortlist suitably experienced and competent contractors to tender this project thus providing a greater degree of certainty in the outcome of the contract and in the ability of any of the tenderers to deal with the variety of issues that could arise in the course of the contract. Therefore this assessment recommends the works be carried out using the "Public Works Contract for Civil Engineering Works Designed by the Employer" procured under the Restricted Procedure or that the works are carried out by OPW/DCC direct labour.

6.6 PROGRAMME

The preliminary programme for the proposed alleviation works is included in Appendix VI to this report.

The critical items on the programme include:

- Procurement of Engineering Consultant(s).
- Ground Investigation Contracts.

- Sub-Scheme 2 and 3 Works.

7. PROJECT COSTS AND ECONOMIC ASSESSMENT

7.1 COST ESTIMATE OF THE PROPOSED SCHEME

A summary of the projected construction costs for Sub-Schemes 1, 2 and 3 of the recommended flood alleviation works are presented in Tables 7.1 to 7.3. The Emergency Works and Feasibility Costs have also been included. The detailed breakdown of the cost estimates is contained in Appendix IX.

Table 7.1 – Construction Cost Estimate (Sub-Scheme 1 and Emergency Works)

Item	Description	Total (€)
1	***Emergency Works- Clanmoyle***	
1.1	Emergency Works in Clanmoyle and Feasibility Study	350,000
	Sub Total (Emergency Works)	***350,000***
2	***Sub-Scheme 1***	
2.1	Storage Works - Golf Course (Overground Storage)	950,000
2.2	Pipeline Works within Clanmoyle and Golf Course	953,355
	Sub Total (Sub-Scheme 1)	***1,903,355***

The costs for the Sub-Scheme 2 works have been examined using trenchless technologies to minimise disruption, and also using a mixture of trenchless and open cut technologies. It was found that the mixed trenchless/open cut option was the most cost effective, and therefore the costs presented here relate to this combined option.

Table 7.2 - Construction Cost Estimate for Sub-Scheme 2 Works

Item	Description	Total (€)
3	***Sub-Scheme 2***	
3.1	*Tunnelling*	
3.1.1	Tunnelling Works - 1200mm Diameter (DP1-RP1, DP1-RP2, DP2-RP3)	2,035,000
3.1.2	Tunnelling Works - 2100mm Diameter (DP3-RP3)	520,000
3.1.3	Tunnelling Works - 1500mm Diameter (DP5-RP5 & RP5-Existing WAD)	327,500
	Sub Total (Sub Scheme 2 - Tunnelling)	*2,882,500*
3.2	*Open Cut*	
3.2.1	Open Cut - 1200mm Diameter Pipe (233 Elm Mount Ave-267 Elm Mount Ave, 21 Collins Park-233 Elm Mount Ave & RP1-MH72810)	241,875
3.2.2	Open Cut - 2.1m Box Culvert (DP3-RP4) equivalent to 2.1m diameter	1,310,200
	Sub Total (Sub Scheme 2 -Open Cut)	*1,552,075*
3.3	*Other*	
3.3.1	Outfall Works (New 1.5m*1.5m Box Culvert from manhole between MH65203 and MH65104-New Clontarf Outfall, Seal 7 manholes, 3 No. Teleflex Non Return Valves)	273,938
3.3.2	Additional Gullies (22 Collins Park, 288 Elm Mount Avenue, 186 Collins Avenue East, 137 Collins Avenue East & 40 Clanmoyle Road)	75,000
	Sub Total (Sub Scheme 2 - Other)	*348,938*
	Sub-Total (Sub Scheme 2)	***4,783,513***

Table 7.3 - Construction Cost Estimate for Sub-Scheme 3 Works

Item	Description	Total (€)
4	***Sub Scheme 3***	
4.1	West of M1	2,300,000
	Sub-Total (Sub Scheme 3)	***2,300,000***

Rates for civil works were based on recent tendered rates for projects of a similar scale. Rates for flow control devices were obtained from suppliers. The cost estimates for tunnelling were obtained from tunnelling contractors. Cost estimate for works required west of the M1 is an approximation based on reported problems, site visits and relative cost of flood alleviation proposals east of the M1. Additional research in the Wad Catchment is required west of the M1 in order to improve the cost estimate for this location.

It is important to note that no site investigation works have been undertaken to date, and this could impact on the cost estimates. A comprehensive site investigation will be required in advance of the contracts for sub schemes 2 and 3. Unfavourable ground conditions could significantly increase the cost of the works.

Table 7.4 – Total Construction Cost Estimate

Item	Description	Total (€)
1	*Emergency Works*	*350,000*
2	*Sub-Scheme 1*	*1,903,355*
3	*Sub-Scheme 2*	*4,783,513*
4	*Sub-Scheme 3*	*2,300,000*
	Total	**9,336,868**

7.2 ADDITIONAL COSTS FOR OVERALL CATCHMENT SCHEMES USING OPW METHODOLOGY

The Office of Public Works (OPW) recommends a methodology for calculating additional contract costs based on the estimated construction cost. The methodology is outlined and applied in Table 7.5.

Table 7.5 - Construction Cost Estimate

Item	Description	Percentage	Applied to Item	Cost (€)
1	Emergency Works Construction Costs	100%		350,000
2	Basic Construction Costs (Sub Schemes 1, 2 & 3)	100%		8,986,868
3	Contingencies (Preliminaries)	20%	2	1,797,374
4	Contingencies	20%	2+3	2,156,848
	Sub-total (Capital Budget)		**1+2+3+4**	**13,291,089**
5	Design Fees	6%	2+3	647,054
6	Contract Supervision	5%	2+3	539,212
7	Archaeology	15%	2+3	1,617,636
8	Environmental Mitigating Measures	6%	2+3	647,054
9	Compensation and Land Acquisition	12.50%	2+3	1,348,030
10	Art	1%	2+3	107,842
11	Maintenance Costs	27%	2+3	2,911,745
	Sub Total			**21,109,664**
	VAT @ mixed rate			3,166,450
	TOTAL			**24,276,114**

The additional costs outlined in Table 7.5 are based on generalised flood alleviation works which may not apply to this project. For example archaeology and maintenance would be far more onerous items for an above ground river flow scheme. These two items have been altered appropriately to suit the Wad Catchment and the cost estimate is summarised in Table 7.6.

Table 7.6 - Construction Cost Estimate using alternative OPW costs

Item	Description	Percentage	Applied to Item	Cost (€)
1	Emergency Works Construction Costs	100%		350,000
2	Basic Construction Costs (Sub Schemes 1, 2 & 3)	100%		8,986,868
3	Contingencies (Preliminaries)	20%	2	1,797,374
4	Contingencies	20%	2+3	2,156,848
	Sub-total (Capital Budget)		**1+2+3+4**	**13,291,089**
5	Design Fees	6%	2+3	647,054
6	Contract Supervision	5%	2+3	539,212
7	Archaeology	5%	2+3	539,212
8	Environmental Mitigating Measures	6%	2+3	647,054
9	Compensation and Land Acquisition	12.50%	2+3	1,348,030
10	Art	1%	2+3	107,842
11	Maintenance Costs	2%	2+3	215,685
	Sub Total			**17,335,180**
	VAT @ mixed rate			2,600,277
	TOTAL			**19,935,457**

7.3 COST BENEFIT ANALYSIS OF THE OVERALL CATCHMENT SCHEME

In order to evaluate the benefits of carrying out the works, the estimated cost for the scheme is compared with the cost of doing nothing. The cost of doing nothing is effectively the estimated compensation cost for each property affected by the flooding. The OPW recommend using the Flood Hazard Research Centre (FHRC) Manual (The Benefits of Flood and Coastal Risk Management: A Manual of Assessment Techniques) for cost-benefit analyses. Projects are only economically viable if the benefits exceed the costs, i.e. the ratio of benefits to costs is greater than 1.0.

The stages identified in the Manual are summarised briefly below:

1. Define extent of future flooding
2. Assemble depth and damage data for properties in affected areas
3. Calculate annual average flood damages
4. Compare costs to benefits and identify economic viability of proposed scheme

The extent and depth of flooding for rainfall events with annual exceedance probabilities of 1%, 2%, 4%, 20% and 50% was assessed using the hydraulic model of the Wad Catchment. The Manual provides approximate costs per square metre of property for a range of flood depths. The OPW recommends applying a factor of 1.46 to convert British construction costs to Irish construction costs. The OPW also recommends doubling this value to cover intangibles (stress, health damage, emergency services, temporary relocation, etc.). The data is summarised in Table 7.7.

Table 7.7 – Estimated damage costs per square metre for a range of flood depths

Depth of flooding above ground floor level (mm)	Total Damage/Square Metre (£/m^2)	Adjusted for Irish Costs (€/m^2)
-300	11.28	32.94
0	11.28	32.95
50	202.50	591.29
100	249.25	727.81
200	429.80	1,255.02
300	481.75	1,406.72
600	540.11	1,577.11
900	576.97	1,684.75
1200	609.72	1,780.37
1500	638.92	1,865.64
1800	671.71	1,961.38
2100	698.51	2,039.66
2400	725.26	2,117.77

The cost of flooding damage for each rainfall event was estimated using the procedure described in Stages 1 to 3 above. A probability damage curve was plotted to illustrate the increasing damage cost associated with more extreme rainfall events as shown in Figure 7.1. As there are only 6 points on graph a linear curve is assumed as recommended in the CRUE European Flood Risk Management Research Report No I-1.

It has already been discussed in Section 3 that there is a low confidence level for lower return period events. This is because the model has not been verified for low flow events. Figure 7.1 shows significant damage costs for a 50% annual exceedance probability (AEP) event. This frequency of flooding damage appears excessive. In the interests of carrying out a meaningful cost-benefit analysis, it can be assumed that no flooding damage is experienced for a 50% AEP event. This assumption is deemed reasonable based on discussions with residents in the affected areas. The adjusted probability-damage curve based on the above assumption is shown in Figure 7.2. The true curve can only be determined if the model is verified for low flow events. However, the assumption above is deemed conservative for cost benefit purposes.

The area under the graph is defined as the annual average flood damage cost. In Figure 7.2 the area under the graph is equal to €994,582 per annum. The OPW recommends calculating a net present value (NPV) for the damage costs based on a 50 year period at a discount rate of 4%. Therefore the estimated NPV for the damage cost is €21,665,800, including an allowance for disruption to the railway line.

7.4 SUMMARY

A cost estimate for the proposed flood alleviation works has been prepared based on current construction costs. The total scheme cost has been estimated following the OPW methodology. The benefits of the proposed works have been calculated using the FHRC Manual as recommended by the OPW. A summary of the costs and benefits is provided in Table 7.8.

Table 7.8 –Cost Benefit Ratio for the proposed Flood Alleviation Works

COST	Total cost using OPW methodology	21,109,664
BENEFIT	Annual average flood damage cost over 50 years at 4% discount rate	21,665,800
	Benefit / Cost Ratio	**1.03**

The cost-benefit ratio is equal to 1.03 and therefore the proposed scheme is deemed economically viable.

The cost-benefit ratio using the "modified" OPW methodology presented in Table 7.6 is equal to **1.25**.

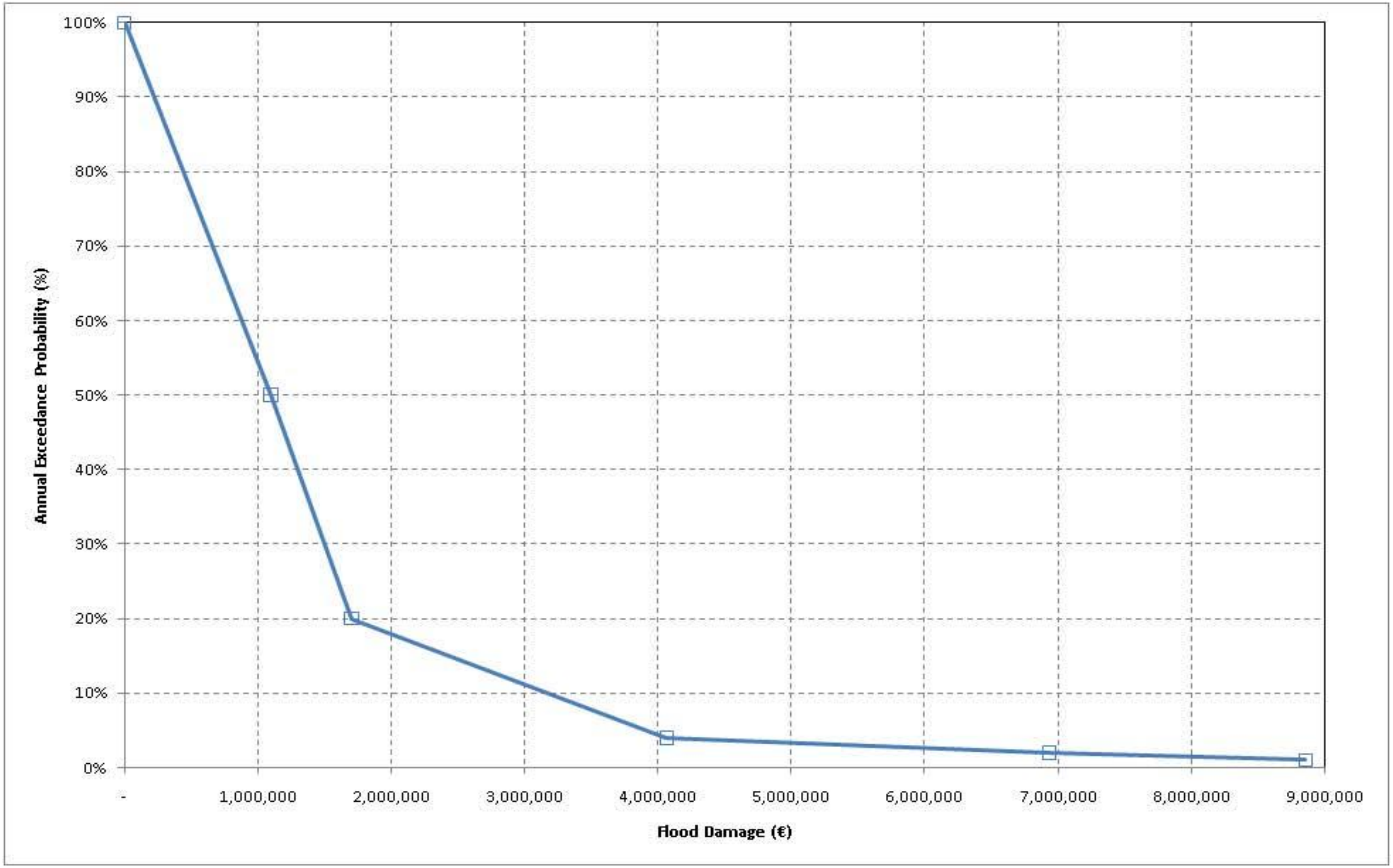


Figure 7.1 – Initial Damage – Probability Curve

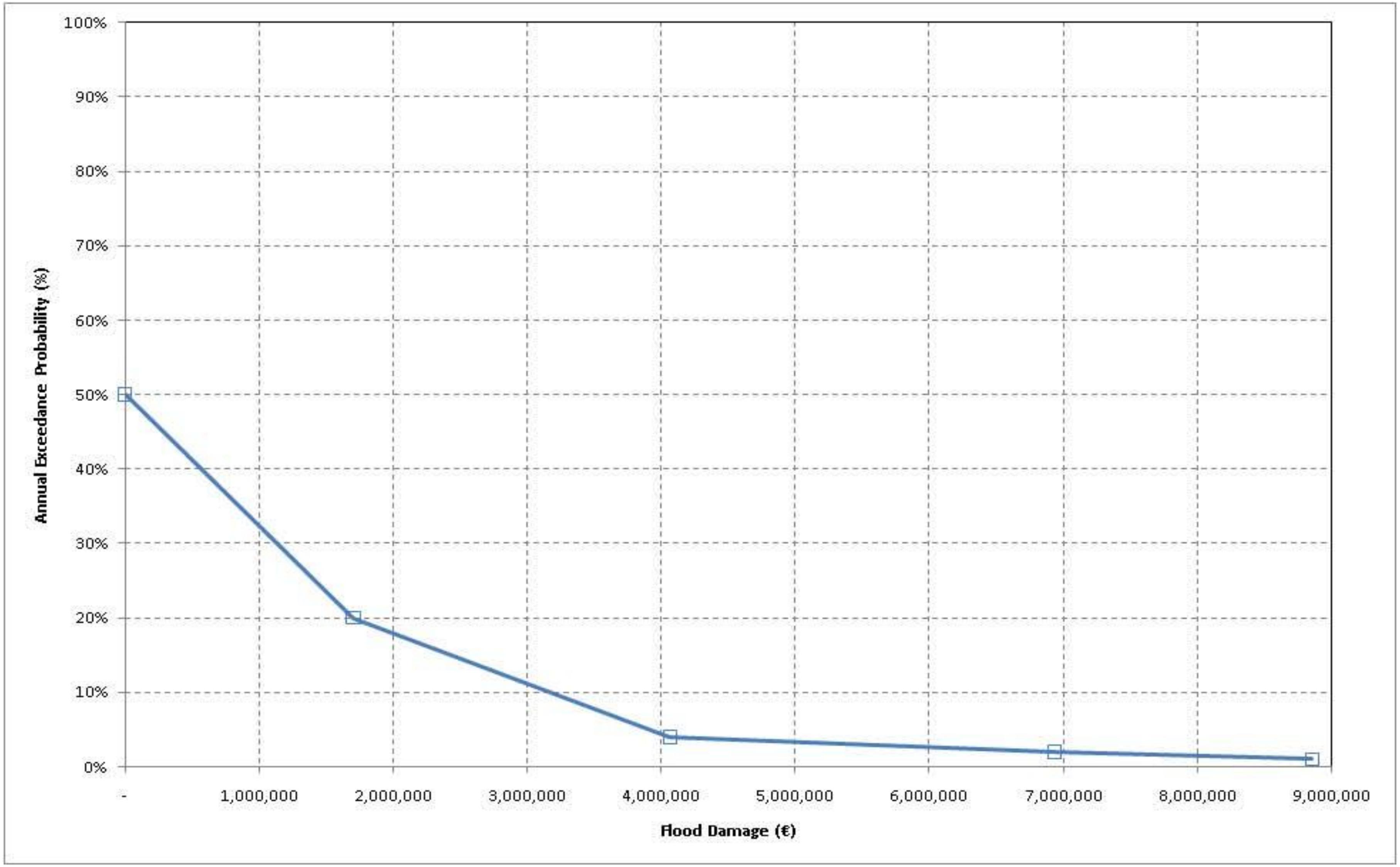


Figure 7.2 – Modified Damage – Probability Curve

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 SUMMARY OF CONCLUSIONS

- New survey data has been included in the model to provide a higher confidence level in its predictions.
- The predictions of the model to the known flood events are deemed to be representative of actual events based on consultation with property owners and individual records.
- The model is conservative in its predictions for severe events but has a low confidence level for minor storm events.
- The flood events of August 2008, July 2009 and October 2011 exceeded the 100 year storm event and these were extreme events outside previous and current required design standards.
- The 100 year current storm event has been used for design purposes.
- A walk through survey of the Wad Culvert has highlighted concerns with change in cross section, obstructions, gradient changes and structural issues.
- The model simulation indicates flooding is caused primarily from pluvial issues in the catchment.
- Further investigations are needed in relation to flooding issues west of the M1.
- Flooding alleviation measures were examined. These included Conveyance, Attenuation, Overland flow and Non Structural Measures. In isolation, none of these options provided a robust solution. Therefore a combination was examined to arrive at the preferred scenarios.
- Following analysis, the preferred scenario required a piped conveyance from Collins Avenue to Clontarf Golf Course where it reconnects to the Wad culvert; A hydraulic restriction then controls follow on flow and utilises green areas in the Golf Course for attenuation; Flood protection barriers and landscape works are also required on the Golf Course to contain the attenuated flows; A new culvert is also required at the Howth Road Crossing and at the Clontarf sea outfall. It is necessary to seal manholes in the vicinity of the Clontarf Sea Outfall to protect against flooding due to extreme high tides.

- The basic construction cost of the recommended scheme, calculated in accordance with OPW CFRAMS Methodology, is € 8,986,868 (excluding VAT , Preliminaries and Contingencies)
- The cost benefit ratio for the recommended scheme calculated in accordance with OPW CFRAMS Methodology is 1.03 which is higher than the required economic viability threshold of 1.0.
- The cost benefit ratio for the recommended scheme using the modified OPW CFRAMS Methodology is 1.25 which exceeds the required economic viability threshold of 1.0.
- The scheme will not require an Environmental Impact statement. However Part 8 Planning will be required for all elements of the scheme.

8.2 SUMMARY OF RECOMMENDATIONS

- The scheme should be advanced in three sub schemes namely:
  - Sub-Scheme 1: Clanmoyle Flood Alleviation Scheme. This involves the construction of pipework in Clanmoyle and a flood attenuation pond on Clontarf Golf Course. These works are recommended to progress immediately.
  - Sub-Scheme 2: Middle Wad Flood Alleviation Scheme. This involves the construction of a new culvert from Collins Park to Clanmoyle, a new culvert across the Howth Road and a new outfall culvert. These works require further site/ground investigation and once this is completed work can progress.
  - Sub-Scheme 3: Upper Wad Flood Alleviation Scheme. This involves carrying out localised works west of M1 in order to alleviate the risk of flooding at two locations. These works require further site/ground investigation and once this is completed work can progress.
- A consultation exercise should be undertaken with residents along the proposed route and in particular with the Clontarf Golf Course.
- The Sub-Scheme 1 works should be procured under the "Public Works contract for civil engineering works designed by the Employer" with the measurement risk transferred to the contractor. This Sub Scheme should be tendered under the Open Procedure with minimum requirements specified, and should be progressed immediately. An alternative to this would be that the works are carried out by OPW/DCC direct labour.
- Additional investigations should be carried out to address flood alleviation west of the M1.
- The other schemes (i.e. Sub-Schemes 2 and 3) should be procured under the "Public Works Contract for Civil Engineering Works Designed by the Employer" form of contract, with the unforeseeable utilities risk transferred to the contractor to ensure an expedient and cost certain contract. An alternative to this would be that the works are carried out by OPW/DCC direct labour.
- The Clanmoyle Flood Alleviation Scheme should be progressed to construction, at an estimated capital budget cost of €4.7 million (including preliminaries & contingency and excluding VAT, as per OPW Methodology)

- Ground investigations should be conducted to provide more certainty in the estimated capital budget for Sub Schemes 2 and 3, and this should be progressed immediately.

Appendix I

Appendix II

Appendix III

Appendix IV

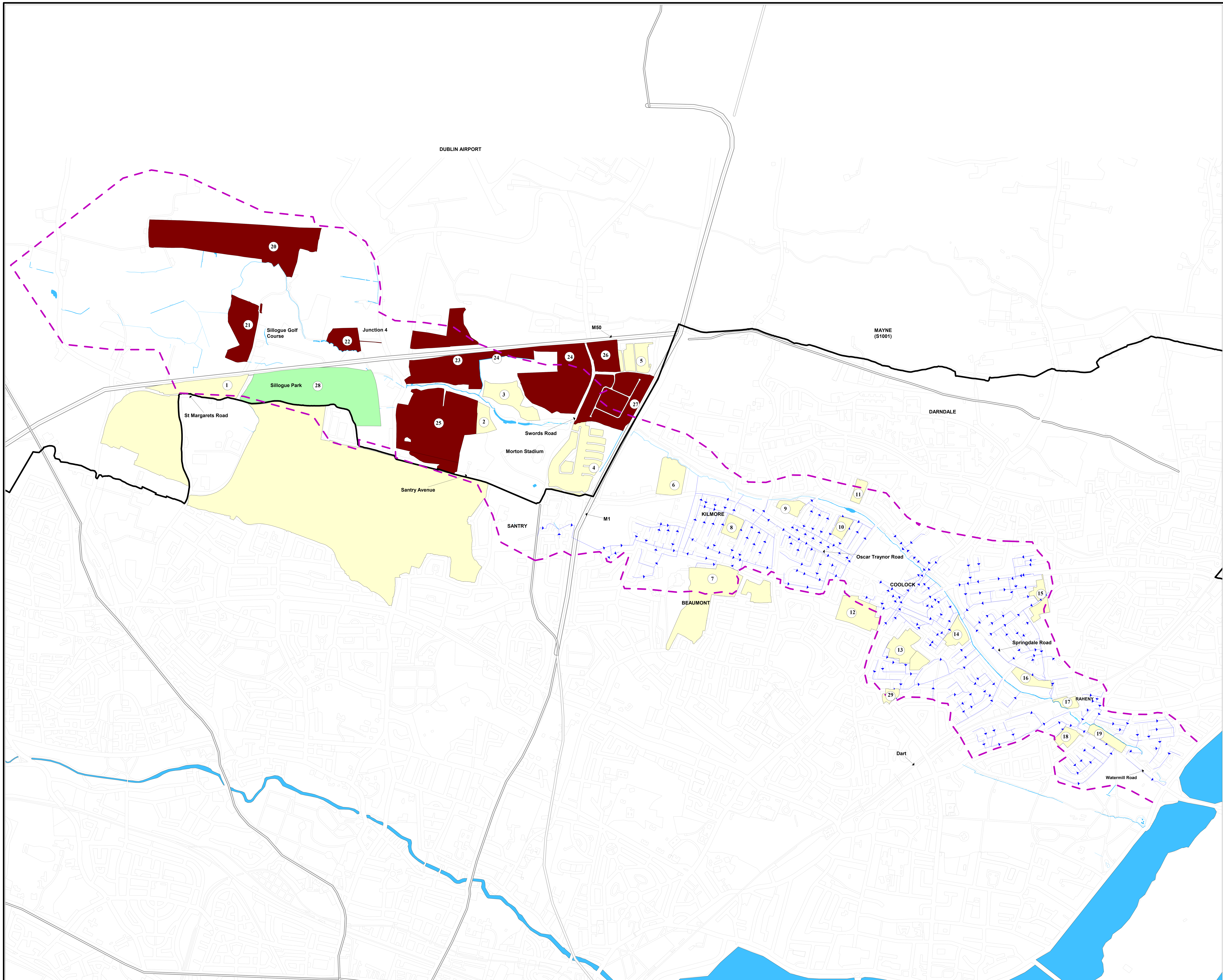
Appendix V

Appendix VI

Appendix VII

Appendix VIII

Appendix IX



Legend

- Wastewater Treatment Works
- County Council Boundaries
- Catchment Boundary
- Combined Sewer (size mm)
- Foul Sewer (size mm)
- Storm Sewer (size mm)
- Rising Main (Coloured as sewer)
- Direction of Flow (on sewer line)
- River/Watercourse
- Culverted River/Watercourse
- Inverted Syphon
- Combined Sewer Overflow
- Foul/Combined Pumping Station
- Foul/Combined Bifurcation
- Foul/Combined Apex Manhole
- Foul/Combined Flow Management Chamber
- Storm Water Overflow to Foul/Combined
- Storm Water Pumping Station
- Storm Water Bifurcation
- Storm Water Apex Manhole
- Storm Water Flow Management Chamber
- Unknown Type of Ancillary Structure
- Outfall
- Zoned Residential Land
- Zoned Commercial Land
- Zoned Land for Schools/Hospitals
- Zoned Science/Technology Parks/Land
- Zoned Industrial Land
- Recently Completed Developments

Project: GREATER DUBLIN STRATEGIC DRAINAGE STUDY

Catchment: SANTRY RIVER CATCHMENT

Title: PHASE 1 - Zoned Development Land

Drg. No. GDSDS/MAR3079/S1002/P1-002

Drawn	IMA	Chk'd	MCB
Approved	MCB		
Scale	N.T.S.	Revision	1
Date	27.03.02		

Dublin Drainage
A Strategic Study for Greater Dublin

Home (/) / Water, Waste and Environment (/main-menu-services/water-waste-and-environment) / Pluvial Flooding/Wad River

Pluvial Flooding/Wad River

(http://www.dublincity.ie/print/6308)

Wad River

Project Background & Current Status

There have been a number of historical floods within the river Wad catchment, most recently in 2008, 2009 & 2011 causing severe disruption and flooding damage to the area. During extreme rainfall events in the catchment the existing pipes and culverts along the Wad became overwhelmed and could not accommodate the increased flows. This resulted in surface water not being able to enter, and escaping from the River Wad system causing extensive localised flooding in areas such as Collins Avenue, Clanmoyle Road, Howth Road and Clontarf.

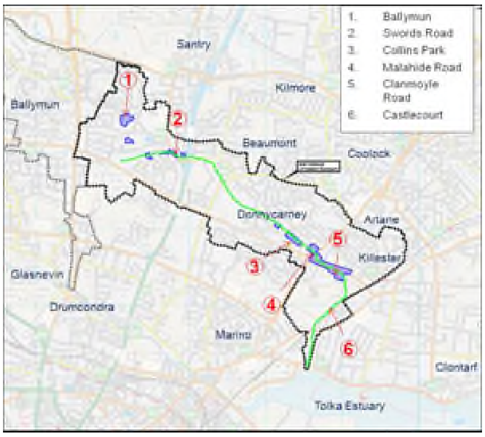


Fig 1: Wad catchment and locations of reported flooding

Dublin City Council commissioned a study to reduce and alleviate flooding within the Wad River Catchment (from Ballymun to an outfall into Dublin Bay at Clontarf). The Wad Catchment Study report in 2012 recommended that the following specific works be undertaken in a staged fashion:

1. Sub Scheme 1 – The Clanmoyle Road Flood Alleviation Scheme
2. Sub Scheme 2 – The Middle Wad Flood Alleviation Scheme

1. **Sub Scheme 1** – Clanmoyle Road Flood Alleviation Scheme – This scheme involved diverting flood waters emanating from the river wad away from Clanmoyle Rd and Collins Avenue through a series of underground pipe work and temporarily storing it in an attenuation pond located within the grounds of Clontarf Golf Club. Once the flood event has passed the retained water is slowly released in a controlled fashion back in to the River Wad. The system is fully automated and is controlled by the automated opening and closing of penstocks monitored by level sensors within the River Wad.

   Sub Scheme 1 was split into the following 3 separate Works Contracts for construction purposes:

Contract A – Civil Engineering – This work involved laying the upgraded and diversionary pipework, culverts and associated works. The Civils work was undertaken by the OPW and is currently fully complete with the exception of the following:

1. Landscaping of the Green Area within Clanmoyle Road. This work is being undertaken by a landscaping Contractor in conjunction with the DCC Regional Projects and Flood Advisory Office and DCC Parks and landscaping Section. A Contractor has been appointed and site works have commenced on the 16th April 2018. The Works are anticipated to take 4 weeks to complete.

Contract B - Golf Course Reinstatement Works – This landscaping contract was carried out by Clive Richardson Ltd. and is fully complete

Contract C - Mechanical & Electrical Works - This contract fully automated the scheme and was being carried out by Veolia Water Ireland. It is fully complete and operational.

(2) **Sub Scheme 2 – Middle Wad Flood Alleviation Scheme**. This Scheme is the next phase in the overall project and involves the following construction works:

1. Howth Road Crossing – This involves constructing a new culvert across the Howth Road at the junction of the Howth Road and Hollybrook Park. The existing Wad River Culvert at this location is hydraulically limited and needs upgraded. DCC Regional Projects and Flood Advisory Office are currently in the process of procuring Consultant Engineers to produce a full design package for this proposed work.
2. New Outfall at Clontarf – This work involves providing a new outfall for the wad River at Clontarf. Some advance works relating to this project have been already undertaken and completed during new watermain works at Clontarf Promenade in 2015. The remainder of this work is to be advanced in conjunction with the works at the Howth Road Crossing and similarly DCC Regional Projects and Flood Advisory Office are currently in the process of procuring Consultant Engineers to produce a full design package for this proposed work.

Historical Documents

In July 2009, an interim report was carried out by RPS Consulting Engineers. In December 2009 Nicholas O'Dwyer Consulting Engineers were appointed to carry out a study on the Catchment.

Flood Alleviation Investigations

A data collection exercise was carried out, information from which was used to verify a computerised hydraulic model of historical storm events, such as those of August 2008, July 2009 and October 2011.

Following this, potential generic scenarios for flood alleviation within the Wad catchment were identified. These included;

- Diversion of Flow Only
- Piped Conveyance Only
- Overland Conveyance Only
- Attenuation Storage Only
- Non-Structural Measures

More detailed assessments were carried out on all the scenarios based on a number of constraints, such as;

- Public Acceptance
- Relative Costs
- Practicality
- Health and Safety Issues
- Planning Issues
- Traffic Impacts
- Environmental Issues
- Programme of Works
- Existing services and Utilities
- Buildability & Reliability
- Long Term Operation
- Maintenance Issues

None of the above scenarios provided the required flood risk reduction on their own, thus a scheme using the beneficial elements of each scenario/flood alleviation measure was examined and assessed. The first phase of which is described below, and is called the Clanmoyle Flood Alleviation Scheme.

Clanmoyle Flood Alleviation Proposals

The proposal intends to pipe the flood waters in Clanmoyle Road in the quarry area of the Golf Club, and when the storm abates to release it slowly back into the existing Wad culvert. There are a number of proposed structures which are required to achieve this and detailed on the planning drawings listed below.

There is also a proposed tunnelled upgrade of the culvert capacity at Howth Road and an additional outfall to the bay alongside Clontarf Road.

The layout of the entire scheme is detailed on planning drawing numbers 20446-PP-01 to 12, downloadable below.

Future Scheme (not part of the recent Planning Application)

Localised works will be required to the west of the M1 in order to alleviate the risk of flooding and there is a proposed new culvert from Collins Park to link up with the proposed culvert on Clanmoyle Road.

Note: It should be noted that when the entire scheme is constructed, the overland flows will be diverted underground at Collins Park, further reducing the risk of overland flows and flooding in the catchment.

The locations of individual components of the schemes are presented in greater detail in the Catchment Report and on the appended drawings, listed below.

Consultations

Following the flooding of August 2008 and July 2009 meetings were held in the local community centre, Le Chéile, following these meetings, further consultations took place with the relevant landowners and stakeholders. The primary stakeholders, the Clontarf Golf Club, Iarnrod Eireann and Clanmoyle Residents gave approval in principle to proceed with the Part 8 Planning Process, which has resulted in the recent Part 8 Planning Submission.

Dublin City Council's Law Department and Valuers Department are also engaged in consultation with the relevant landowners, as there are legal items to be agreed, items such as wayleaves.

Liaisons with stakeholders are ongoing, and will continue during the planning process and until construction is complete.

Consultation has also taken place with the Foreshore Unit of the Department of the Environment, Community and Local Government, as a foreshore licence is required to construct the outfall in to the Tolka Estuary. Further details of this process are described below.

PART 8 Planning Application

- Please click here to read the newspaper Planning Notice.pdf (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Newspaper%20Planning%20Notice%203-9-12.pdf)

The Environment and Engineering Department of Dublin City Council were granted planning permission on the 14th of January 2013 (Application Reference Number: 3161/12). This approval allows for the first phase to proceed of a wider proposal to reduce and alleviate flooding within the Wad River Catchment to the National Design Standard, the 1:100 year rainfall event. They are also designed to reduce flooding downstream of the Golf Club in the Castlecourt and Auburn areas.

The proposal can be summarised into the structures listed below which require planning consent;

- Inlet structure in Clanmoyle Road green area
- Pedestrian bridge in the Clontarf Golf Course
- Retaining wall along the boundary of Clontarf Golf Club and the Dublin-Belfast railway
- Sports netting around the boundary of the Clontarf Golf Club and properties along Collins Avenue East
- Inlet and outlet structure in the Clontarf Golf Course
- Outfall into Clontarf Foreshore

List of Documents And Drawings

The attached documents outline the Wad River Catchment in more detail, and give a greater understanding of the catchment, its geographical area, and the history of flooding within it. The documents included are as follows;

Clanmoyle Flood Alleviation Scheme – Part 8 Planning Permission.pdf (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Clanmoyle%20Flood%20Alleviation%20Scheme%20-%20Part%208%20Planning%20permission%203-9-12.pdf)

Wad Drainage Catchment Study - Planning Drawings
(PDF Links to Drawings)

Drawing Number Drawing Title
20446-PP-01 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-01%20Rev%20A.pdf) Overall Scheme Keyplan
20446-PP-04 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-04%20Rev%20B.pdf) Recommended Alleviation Works Layout Plan (3 of 6)
20446-PP-05 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-05%20Rev%20B.pdf) Clanmoyle Road Alleviation Scheme (4 of 6)
20446-PP-06 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-06%20Rev%20B.pdf) Recommended Alleviation Works Layout Plan (5 of 6)
20446-PP-07 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-07%20Rev%20B.pdf) Recommended Alleviation Works Layout Plan (6 of 6)
20446-PP-08 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-08%20Rev%20A.pdf) Proposed Inlet Structure at Clanmoyle Road
20446-PP-09 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-09%20Rev%20A.pdf) Proposed Pedestrian Bridge Structure Details
20446-PP-10 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-10%20Rev%20A.pdf) Proposed retaining Wall in Golf Course
20446-PP-11 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-11%20Rev%20A.pdf) Proposed Ball catch netting in Golf Course
20446-PP-12 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-PP-12.pdf) Proposed inlet and outlet Structures

For greater clarity, there are a number of ancillary documents which accompanied the Part 8 documents they are described as follows;

- Wad River Catchment Study – Full Catchment Report Rev E (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Wad%20River%20catchment%20Study%20-%20Full%20Catchment%20Report%20Rev%20E.pdf)

This document primarily outlines the processes which have lead to the application for Part 8 Planning, its approval and why we wish to carry out the Clanmoyle Flood Alleviation Scheme. Our consultant was engaged to carry out an examination of the hydraulic performance of the Wad catchment, and recommend works which would improve flood protection within the catchment.

- Wad River Flood Alleviation Scheme – Environmental Report Rev B (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Wad%20River%20Flood%20Alleviation%20Scheme%20-%20Environmental%20Report%20Rev%20B.pdf)

This report addresses the main EIS (Environmental Impact Statement) themes which were requested by the Planning Department. This report also includes a Geophysical Survey carried out by Minerex Geophysics Limited.

Appropriate Assessment – Stage 1 Screening Report Rev C
This report is included in the Environmental report, and has been prepared by our consultants to determine the potential impacts, if any, Sub Scheme 1 (Clanmoyle Flood Alleviation Scheme) and Sub Scheme 2 (Middle Wad Flood Alleviation Scheme) may have on nearby sites with European conservation designations (i.e. Natura 2000 sites). Its conclusions were “No significant impacts on the North Bull Island SPA, the South Dublin Bay SAC, the North Dublin Bay SAC and Tolka Estuary/Sandymount Strand SPA (alone or in combination with other projects or plans) are anticipated.”

Wad River Catchment Study – Catchment Drawings

Drawing Number Drawing Title
20446 – 01 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-01%20Rev%20B.pdf) Overall Catchment Plan
20446 – 02 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-02%20Rev%20A.pdf) Survey of Study Areas (1 of 3)
20446 – 03 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-03%20Rev%20A.pdf) Survey of Study Areas (2 of 3)
20446 – 04 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-04%20Rev%20A.pdf) Survey of Study Areas (3 of 3)
20446 – 05 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-05%20Rev%20B.pdf) Areas of Reported Flooding (1 of 5)
20446 – 06 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-06%20Rev%20A.pdf) Areas of Reported Flooding (2 of 5)
20446 – 07 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-07%20Rev%20A.pdf) Areas of Reported Flooding (3 of 5)
20446 – 08 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-08%20Rev%20B.pdf) Areas of Reported Flooding (4 of 5)
20446 – 09 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-09%20Rev%20C.pdf) Areas of Reported Flooding (5 of 5)
20446 – 10 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-10%20Rev%20C.pdf) Model Output; Flood Plain - August 2008 (1 of 2)
20446 – 11 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-11%20Rev%20C.pdf) Model Output; Flood Plain - August 2008 (2 of 2)
20446 – 12 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-12%20Rev%20C.pdf) Model Output; Flood Plain - July 2009 (1 of 2)
20446 – 13 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-13%20Rev%20C.pdf) Model Output; Flood Plain - July 2009 (2 of 2)
20446 – 14 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-14%20Rev%20D.pdf) Model Output; Flood Plain – October 2011 (1 of 2)
20446 – 15 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-15%20Rev%20E.pdf) Model Output; Flood Plain – October 2011 (2 of 2)
20446 – 16 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-16%20Rev%20E.pdf) Model Output; Flood Plain - 1/100 Year Return Period (1 of 2)
20446 – 17 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-17%20Rev%20D.pdf) Model Output; Flood Plain - 1/100 Year Return Period (2 of 2)
20446 – 18 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-18%20Rev%20E.pdf) Predicted Flooding For A Joint Tidal / Rainfall Event
20446 – 19 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-19%20Rev%20E.pdf) Potential Alleviation Works - Scenario 1 (1 of 2)
20446 – 20 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-20%20Rev%20E.pdf) Potential Alleviation Works - Scenario 1 (2 of 2)

20446 – 21 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-21%20Rev%20E.pdf) Potential Alleviation Works - Scenario 2 (1 of 3)
20446 – 22 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-22%20Rev%20E.pdf) Potential Alleviation Works - Scenario 2 (2 of 3)
20446 – 23 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-23%20Rev%20E.pdf) Potential Alleviation Works - Scenario 2 (3 of 3)
20446 – 24 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-24%20Rev%20E.pdf) Potential Alleviation Works – Keyplan
20446 – 25 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-25%20Rev%20E.pdf) Potential Alleviation Works – Layout Plan (1 of 6)
20446 – 26 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-26%20Rev%20E.pdf) Potential Alleviation Works – Layout Plan (2 of 6)
20446 – 27 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-27%20Rev%20D.pdf) Potential Alleviation Works – Layout Plan (3 of 6)
20446 – 28 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-28%20Rev%20A.pdf) Potential Alleviation Works – Layout Plan (4 of 6)
20446 – 29 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-29%20Rev%20A.pdf) Potential Alleviation Works – Layout Plan (5 of 6)
20446 – 30 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/20446-30%20Rev%20A.pdf) Potential Alleviation Works – Layout Plan (6 of 6)

Application for a Foreshore License

- Please click here to read the Newspaper Foreshore Notice.pdf (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Newspaper%20foreshore%20notice.pdf)

The river Wad discharges to the sea through a culvert outfall at Clontarf Promenade opposite Clontarf Garda Station. As part of the scheme, it is intended to construct a second culvert with a second outfall to the sea. This latter element requires a Foreshore Licence. To that end, Dublin City Council applied to the Department of Environment, Community and Local Government (DOECLG) for a Foreshore Licence. The minister signed and approved the draft Foreshore Licence and it has now being referred to the Chief State Solicitors Office and Dublin City Councils Law Agent for final drafting.

Figure 2 – Impression of proposed culvert along Clontarf Foreshore

The proposed new outfall is a new box culvert to be constructed under the grassed area of the Clontarf Promenade, from the bus lane of Clontarf Road to the foreshore. The new culvert is to be located alongside the existing underground Wad River Culvert. Its aim is to increase the carrying capacity of this section of the Wad network and thus reduce flooding upstream.

Drawings and Information

- Foreshore Licence for Wad River - 1:500 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Foreshore%20Licence%20for%20Wad%20River%201-500.pdf)
- Foreshore Licence for Wad River – 1:10,560 (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Foreshore%20Licence%20for%20Wad%20River%201-10,560.pdf)
- Lease Area (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Lease%20Area.pdf)
- Levels and Cross Section (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Levels%20and%20Cross%20Section.pdf)
- Cross Section (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Cross%20Section.pdf)
- Consultant's Drawing 20446-30 Rev A (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Consultants%20drawing%2020446-30%20Rev%20A.pdf)
- Method Statement (/sites/default/files/content//WaterWasteEnvironment/waterprojects/Documents/Method%20Statement.pdf)

Where do we go from here

- Legal wayleave agreements are to be reached with the relevant stakeholders and residents
- Finalise Foreshore Licence
- Construction phase funding in place
- It is expected that construction works will be carried out by the OPW, with works programmed to commence later this year / early next year, subject to way leave agreements.

Information last updated October 2013

For more information

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- Regional Projects & Emergency Management Section,
  floor 4, 68-70 Marrowbone Lane, Dublin 8.

Trending - Water, Waste and Environment

- Find a Recycling Centre (/main-menu-services-water-waste-and-environment-waste-and-recycling/find-recycling-centre)
- Recycling Services (/main-menu-services-water-waste-and-environment-waste-and-recycling/recycling-services)
- Dublin Fire Rescue and Emergency Ambulance Service (/main-menu-services/dublin-fire-brigade-and-ambulance-service)
- Community Bring Centres (/main-menu-services-water-waste-and-environment-waste-and-recycling-recycling-services/community)
- Waste and Recycling (/main-menu-services-water-waste-and-environment/waste-and-recycling)
- WEEE and Householders (/main-menu-services-water-waste-and-environment-waste-and-recycling-recycling-services/weee-and)
- Careers in the Fire Brigade (/main-menu-services-dublin-fire-rescue-and-emergency-ambulance-service/careers-fire-brigade)
- FAQ in relation to Fire Safety Certificates (/main-menu-services-dublin-fire-rescue-and-emergency-ambulance-service-fire-safety-legislation/faq)
- Green Waste Charges (/main-menu-services-water-waste-and-environment-waste-and-recycling-recycling-services/green-waste)
- Civic Amenity Sites(CA Sites) (/main-menu-services-water-waste-and-environment-waste-and-recycling-recycling-services/civic-amenity)

All pages in Water, Waste and Environment

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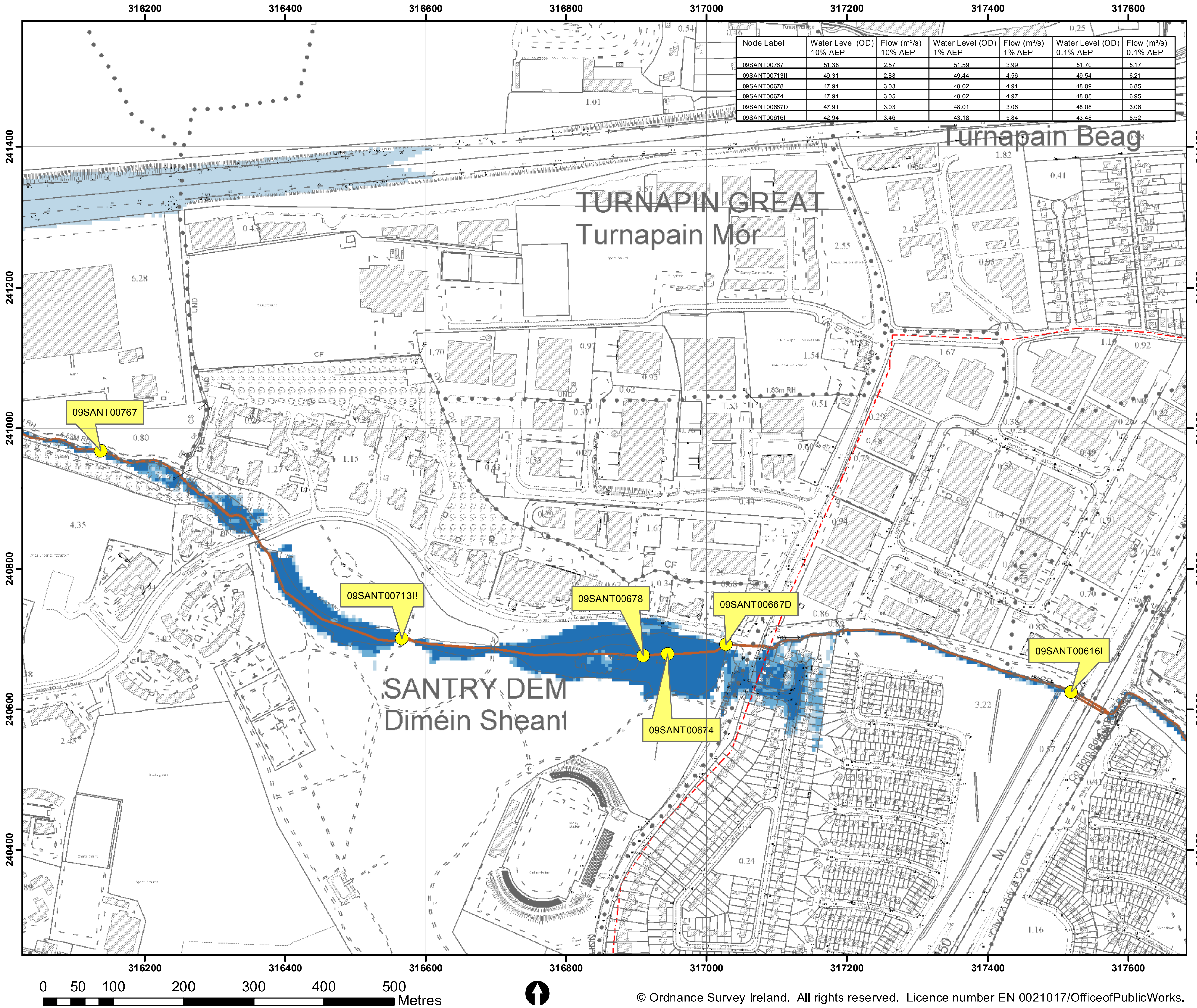

Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
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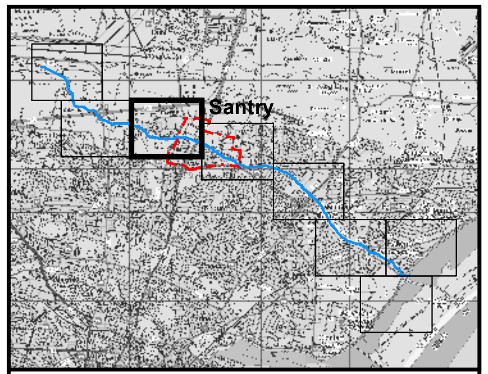
09SANT00713I!	49.31	2.88	49.44	4.56	49.54	6.21
09SANT00678	47.91	3.03	48.02	4.91	48.09	6.85
09SANT00674	47.91	3.05	48.02	4.97	48.08	6.95
09SANT00667D	47.91	3.03	48.01	3.06	48.08	3.06
09SANT00616I	42.94	3.46	43.18	5.84	43.48	8.52



IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

Legend

- 10% Fluvial AEP Event
- 1% Fluvial AEP Event
- 0.1% Fluvial AEP Event
- Modelled River Centreline
- AFA Extents
- Node Point
- Node ID Node Label

FINAL

REV:	NOTE:	DATE:
01	Amendment to flood zones to include Raheny AFA	15/12/17

EASTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

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Map:
Santry Fluvial Flood Extents
Map Type: EXTENT
Source: FLUVIAL
Map Area: HPW
Scenario: CURRENT
Drawn By : C.C. Date : 15 December 2017
Checked By : A.S. Date : 15 December 2017
Approved By : S.P. Date : 15 December 2017
Drawing No. :
E09SAY_EXFCD_F1_03
Map Series : Page 3 of 8
Drawing Scale : 1:5,000 @ A3

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