Bonneagar Iompair Éireann
Transport Infrastructure Ireland

NTA
Údarás Náisiúnta Iompair
National Transport Authority

Luas Finglas

Environmental Impact Assessment Report 2024

Appendix A10.2: Site Specific Flood Risk Assessment

BARRY TRANSPORTATION
egis GROUP
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Project Ireland 2040
Building Ireland's Future

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SECTION 1: Executive Summary

J. B. Barry and Partners was appointed by Transport Infrastructure Ireland to prepare a site-specific Flood Risk Assessment (FRA) to support a planning application for the proposed Luas Finglas project: an extension of the Luas Green Line, transport infrastructure development from Broombridge (Dublin) to new terminus in Charlestown (Finglas).

This FRA is undertaken in accordance with "The Planning System and Flood Risk Management Guidelines for Planning Authorities" published in November 2009, jointly by the Office of Public Works (OPW) and the then Department of Environment, Heritage and Local Government (DoEHLG) and Circular PL 2/2014 (here after known as the Guidelines).

Dublin City has zones prone to fluvial and/or tidal flooding with some significant events occurring in recent years. Various flood investigation studies have been produced for the area; the aim of this report is to analyse the site-specific flood levels in the vicinity of the development. Parts of the development are at risk due to the risk of flooding from the river Tolka and surrounding streams and canals. The risk of pluvial and groundwater flooding to the site is considered moderate and is limited to the construction period.

The Proposed Scheme has an overall length of approximately 4km of transport infrastructure, with 4 new stops, two major bridges, one new Park and Ride (P&R) and a new extension to Broombridge depot stabling area and interfaces with nearby watercourses. The site ground levels vary significantly throughout.

As sections of the Study Area are located within Flood Zones A and B and are deemed vulnerable, a Justification Test for the development was completed as part of the site-specific Flood Risk Assessment (FRA) and it was determined that the development proposal satisfied all the requirements.

The scope of the Proposed Scheme is in keeping with the existing road profile and does not increase the risk of flooding elsewhere. Moreover, surface water management measures including bioretention, rain gardens, filter strips, green trackform, integrated constructed wetland (ICW), SuDS, tree pits are incorporated in the design.

To minimise the risk further, the design for this area ensured access and egress to emergency vehicles is not restricted at all times. Site staff employed during the construction of the Proposed Scheme will maintain awareness of flood and weather forecasts on an ongoing basis as well as receiving warnings from Dublin City Council, Finglas county Council and Met Eireann as appropriate. During operation, motorist, cyclist, and pedestrian users will have sufficient notice through social media and news reports as part of weather warnings to avoid affected areas in advance of a possible flood.

This FRA demonstrated that the risks relating to flooding can be managed to acceptable levels and therefore comply with the Guidelines.

1.1 Introduction

1.1.1 Background

J. B. Barry and Partners was appointed by Transport Infrastructure Ireland to prepare a site-specific Flood Risk Assessment (FRA) to support a planning application for the proposed Luas Finglas project.

This FRA was undertaken in accordance with the 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' published in November 2009, jointly by the Office of Public Works (OPW) and the Department of Environment, Heritage and Local Government (DoEHLG), and Circular PL 2/2014, herein referred to as "the Guidelines". Reference is also made to the Strategic Flood Risk Assessments completed for the Dublin City Development Plan 2022 – 2028 and Fingal Development Plan 2023-2029.

1.1.2 Proposed Scheme

Luas Finglas project (herein referred to as 'the Proposed Scheme') is the proposed extension of the Luas Green Line from its terminus in Broombridge to the north of Finglas in Charlestown, beside the junction of the M50 and N2.

The Proposed Scheme is a public transport priority corridor encompassing pedestrian crossings, upgraded footpaths, and the Luas line from Broombridge stop to Charlestown. The Proposed Scheme is being progressed to enable more sustainable and effective movement in the transport networks in Dublin City, Finglas County, and the wider region.

The Luas Finglas route covers a total length of approximately 4km of transport infrastructure. The route is shown in Figure 1.

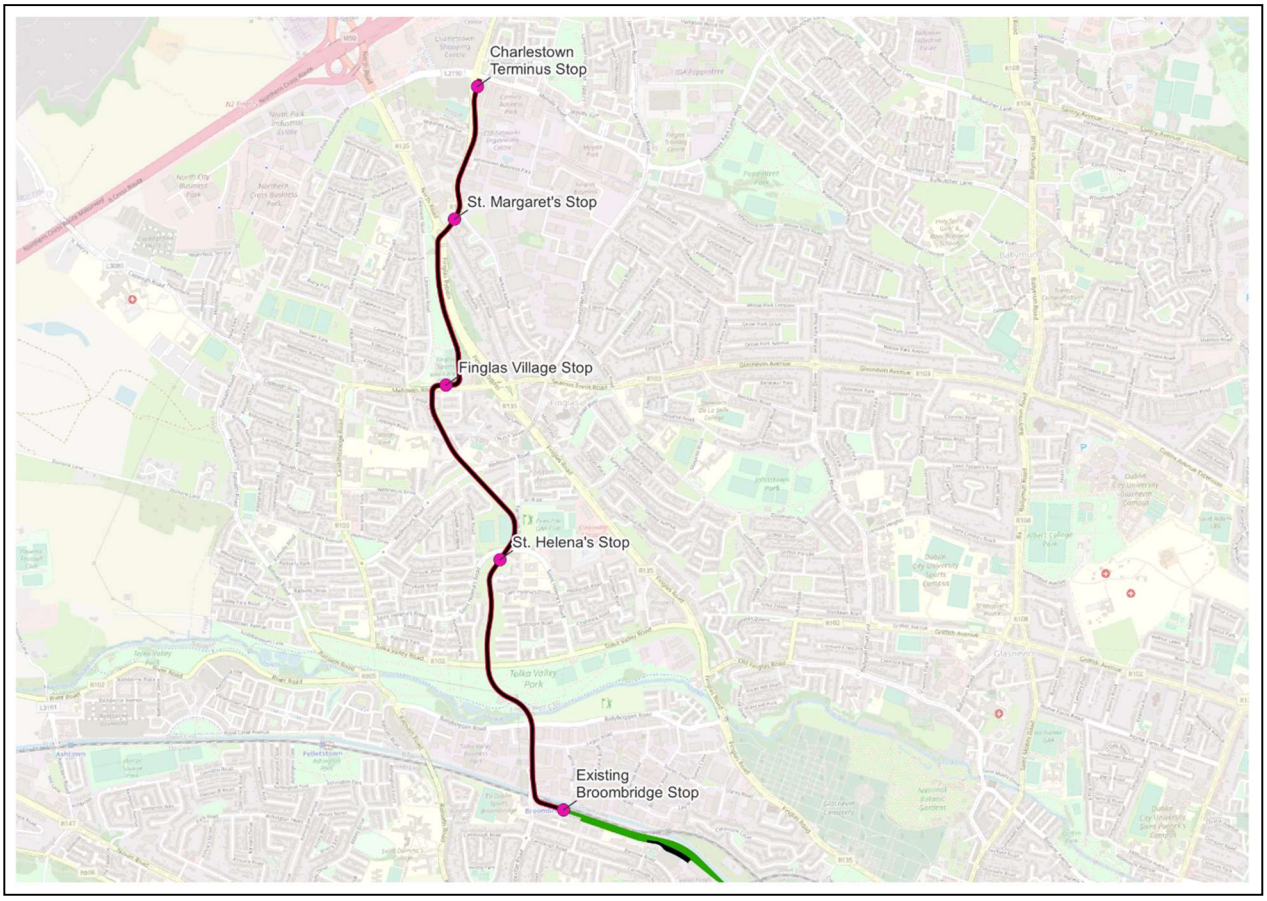


Figure 1.1: Proposed Scheme Layout

The emerging preferred route (EPR) starts the Broombridge Luas Stop (and Irish Rail Broombridge Station), before turning northwards just east of Broom Bridge, crossing the existing Irish Rail line and adjacent Royal Canal, travelling along Broombridge Road towards Tolka Valley Park. Within Tolka Valley Park, the route follows a gentle arc to the west, crossing the Tolka River before straightening and arcing northwards, crossing Tolka Valley Road and St Helena's Road, passing through Farnham Park, before continuing onwards along Patrickswell Place. The exact alignment through the Cappagh Road/Mellowes Crescent area is still under review but will broadly follow a northerly direction, entering Mellowes Park in the southeast corner and exiting towards northeast corner, crossing Finglas Road before continuing along St.Margaret's Road, terminating in Charlestown.

A site plan and typical sections of the Proposed Scheme are included in the planning application.

1.1.3 Site Location

The Proposed Scheme is located partially within the Dublin County and partially within Finglas County, extending on the north from the Broombridge stop and Royal Canal junction, travelling through Tolka Valley park and Finglas village centre and extending further north to Charlestown. The location of the Proposed Scheme including Site Compounds is shown in Figure 2.

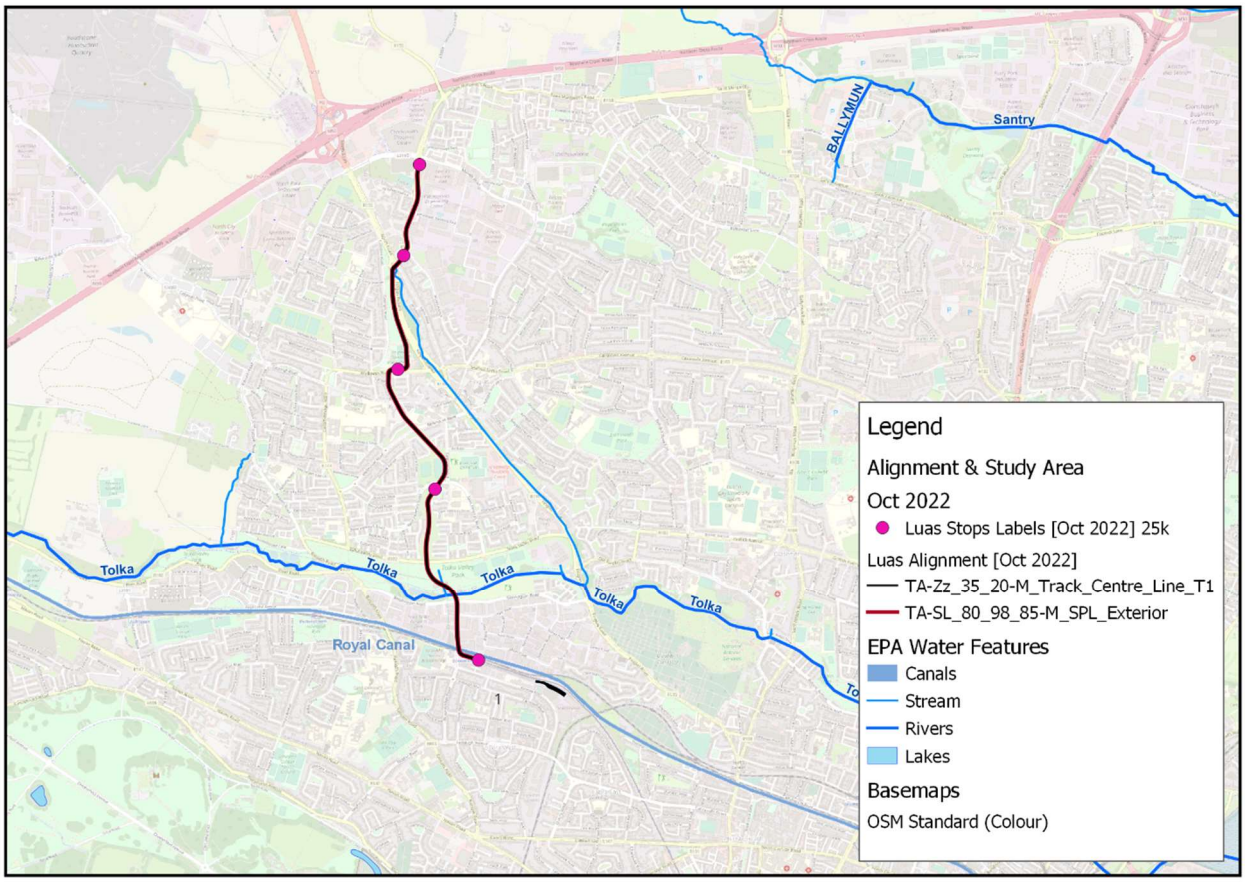


Figure 1.2: Site location (© Open Street Map; annotations by J. B. Barry and Partners)

The proposed line crosses from south to north, the Royal Canal, Tolka River and Bachelor's stream. The line originates from the existing Broombridge stop which is located on the waterfronts of the Royal Canal. The proposed line passes through green areas through the Tolka Valley Park and residential developments, running parallel to the Finglas road up to Finglas village. The proposed line crosses the Finglas Bypass and follows the path of St. Margaret's Road to the final stop at Charlestown shopping centre.

The river Tolka flows in a easterly direction, crossing the proposed line at the Tolka Valley Park.

The site roughly slopes north to south, with the lowest point at the banks of river Tolka and rises again towards the Broombridge stop. The site ground level falling from its highest point of +66.83mOD at Charlestown stop to the lowest points of +19.42mOD at Tolka river basin, +24.97mOD on Tolka riverbank and 35.6mOD at the Broombridge stop.

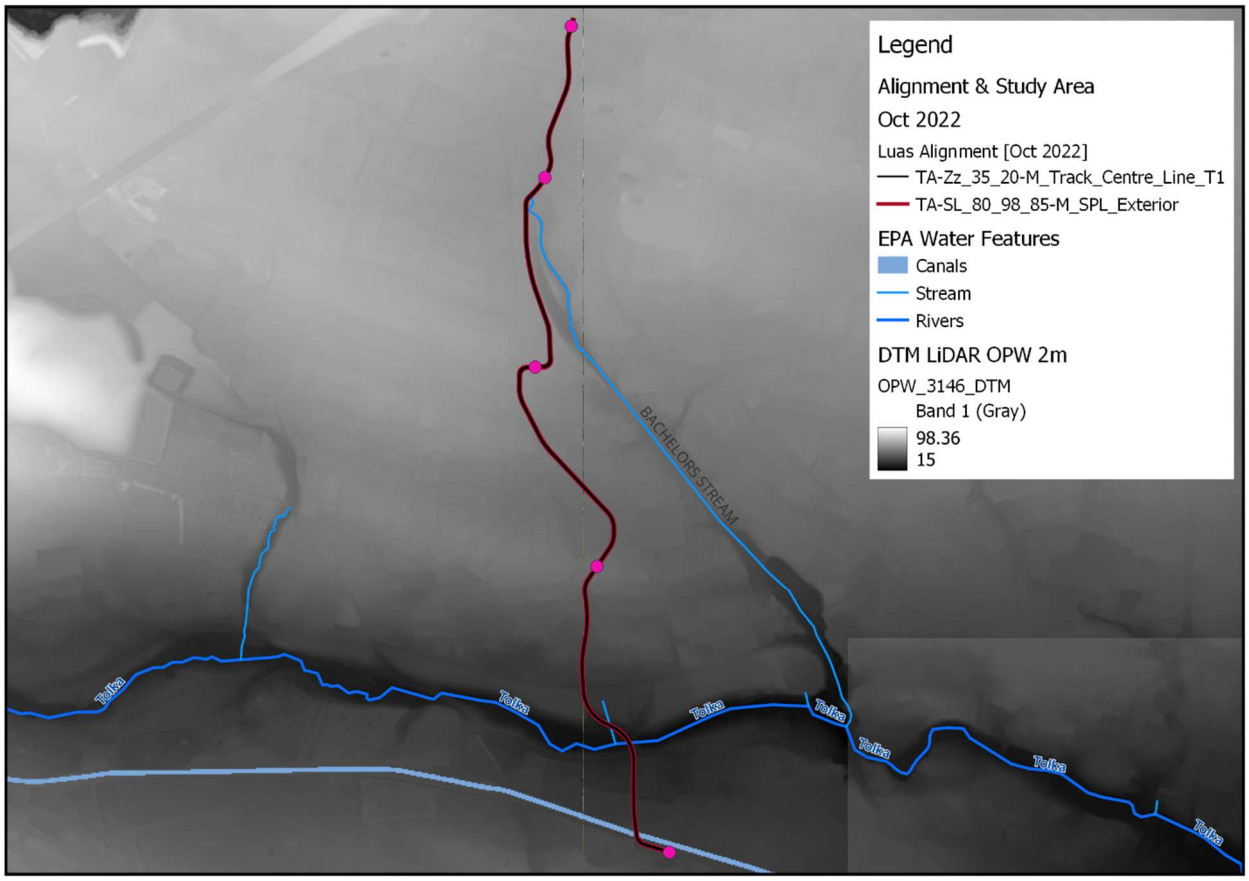


Figure 1.3: Site topography map (Source: LiDAR Coverage Office of Public Works (OPW) National Aerial Survey Contract (NASC) Ireland, annotations by J. B. Barry and Partners

1.1.4 Scope of the Report

This FRA report contains the following information:

- Identification and confirmation of the sources of flooding which may affect the site;
- A qualitative assessment of the risk of flooding from the various sources to the site and to adjacent areas because of construction of the Proposed Scheme;
- Justification Test for Development Management;
- Identification of possible measures which could mitigate the flood risk to acceptable levels; and
- Statement of residual flood risk.

1.1.5 Summary of Data Sources

Data relating to flood risk relevant to the Proposed Scheme and surrounding area has been obtained from the following sources:

- Fingal Development Plan 2023-2029 including its Strategic Flood Risk Assessment;
- Dublin City Development Plan 2022-2028 including its Strategic Flood Risk Assessment;
- Eastern CFRAM Hydrology and Hydraulics Reports and predictive flood mapping (https://www.floodinfo.ie/publications/);
- Fingal East Meath and Eastern CFRAM Catchment Flood Risk Management Plan (https://www.floodinfo.ie/publications/);
- River Tolka and River Wad Flooding Studies (https://www.floodinfo.ie/publications/);
- OPW National Flood Hazard Mapping Website (www.floodinfo.ie);
- Preliminary Flood Risk Assessment (PFRA) mapping produced by the OPW (https://www.floodinfo.ie/publications/);

- Topographical survey of the site; and
- Proposed scheme planning application drawings.

SECTION 2: Flood Risk Assessment Methodology

2.1 Methodology

The methodology used for the flood risk assessment for the proposed development is based on 'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (2009)'. The FRM Guidelines require the planning system at national, regional and local levels to:

- Avoid development in areas at risk of flooding, particularly floodplains, unless there are proven wider sustainability grounds that justify appropriate development;
- Adopt a sequential approach to flood risk management when assessing the location for new development based on avoidance, reduction and then mitigation of flood risk; and
- Incorporate flood risk assessment into the process of making decisions on planning applications and planning appeals.

The sequential approach (see Figure 3.1 of the FRM Guidelines below) in flood risk management requires the following three steps to identify the necessity for the justification test for a development:

- Step 1: Identification of the Flood Zone at the proposed development site (Section 2.23 of the FRM Guidelines);
- Step 2: Identification of the vulnerability of the type of the proposed development (Table 3.1 of the FRM Guidelines); and
- Step 3: Using the matrix of vulnerability versus Flood Zone (Table 3.2 of the FRM Guidelines), identify the necessity for the justification test for the proposed development.

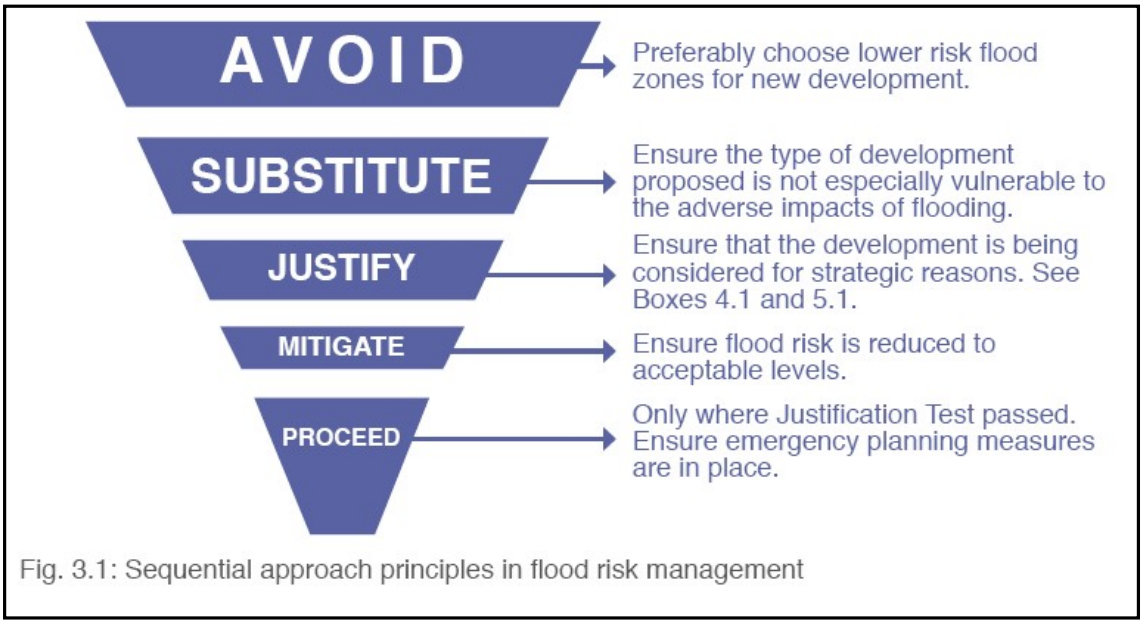


Fig. 3.1: Sequential approach principles in flood risk management

While Figure 3.1 of The FRM Guidelines sets out the broad philosophy underpinning the sequential approach in the flood risk management, Figure 3.2 of the Guidelines (shown below) describes the mechanism of the sequential approach for use in the planning process.

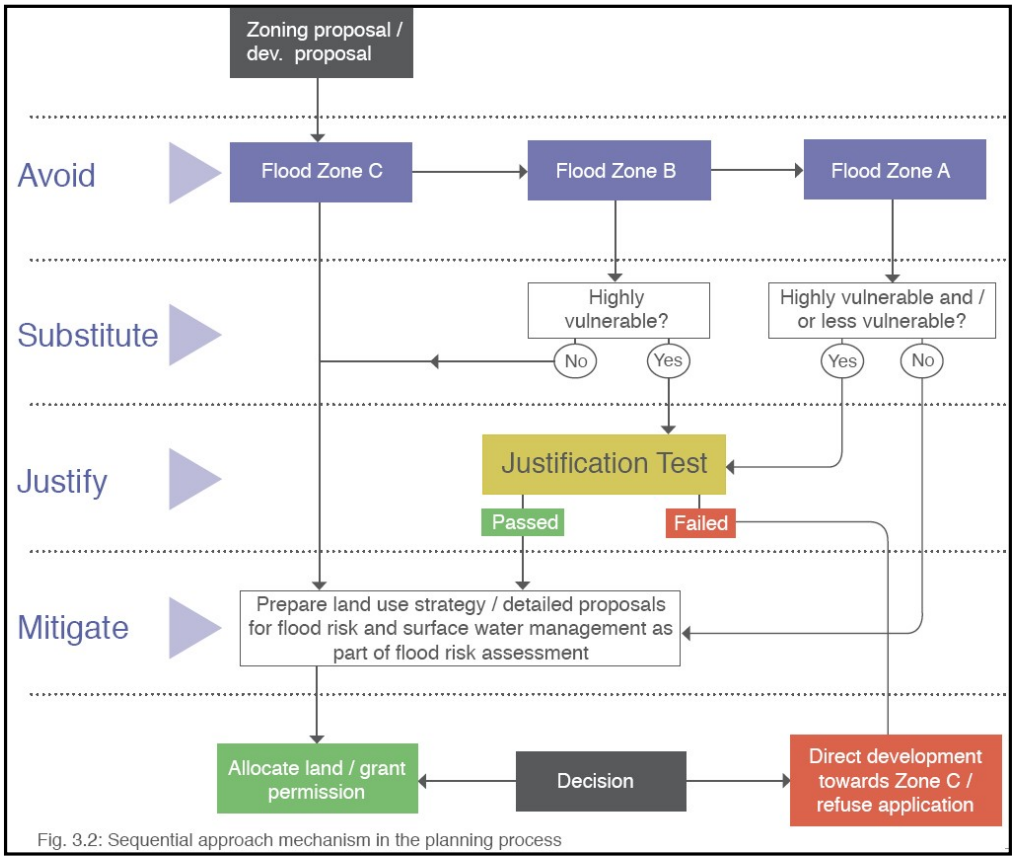


Fig. 3.2: Sequential approach mechanism in the planning process

According to the FRM Guidelines, Flood Zones are graphical areas within which the likelihood of flooding is in a particular range. They are a key tool in flood risk management within the planning process as well as in flood warning and emergency planning. There are three Flood Zones, namely,

Flood Zone A – where the probability of flooding from rivers and the sea is highest (greater than 1% AEP or 1 in 100 year for river flooding or 0.5% or 1 in 200 for coastal flooding);

Flood Zone B – where the probability of flooding from rivers and the sea is moderate (between 0.1% AEP or 1 in 1000 year and 1% AEP or 1 in 100 year for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 year for coastal flooding); and

Flood Zone C – where the probability of flooding from rivers and the sea is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding). Flood Zone C covers all areas of the plan which are not in zones A or B.

Flood Zones A, B and C are based on the current assessment of the 1% AEP and the 0.1% AEP fluvial events and the 0.5% AEP and 0.1% AEP tidal events, without the inclusion of climate change factors. Table 3.1 of the FRM Guidelines (see below) shows the classification of the vulnerability to flooding of different types of development.

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 3.2 of the FRM Guidelines (shown below) identifies the types of development that would be appropriate for each Flood Zone and those that would be required to meet the Justification Test. Since wastewater pumping stations are classified as 'Highly vulnerable development' the section highlighted in Table 3.2 presents the required actions for each flood zone.

	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.

The FRM Guidelines (Chapter 2) outlines the following three stages of flood risk assessment:

Stage 1: Flood risk identification – to identify whether there may be any flooding or surface water management issues relating to the proposed development site that may warrant further investigations.

Stage 2: Initial flood risk assessment – to confirm sources of flooding that may affect the proposed development site, to appraise the adequacy of existing information and to determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. This stage involves the review of existing studies and hydraulic modelling to assess flood risk and to assist with the development of FRM measures.

Stage 3: Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development, of its potential impacts on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model across a wide enough area to appreciate the catchment wide impacts and hydrological process involved.

2.2 Sequential Approach

The Flood Risk Assessment has identified that there is a significant fluvial flood risk to this site. Under the sequential approach identified in the FRM Guidelines a three-step approach is required to confirm the appropriateness of the development in terms of flood risk.

Step 1: Identification of the Flood Zone at the proposed development site

Using the Flood Zone criteria from the FRM Guidelines and as defined in Section 2.1 previously, the flood zones for each of the sites were determined.

Step 2: Identification of the vulnerability of the type of the proposed development (Table 3.1 of the FRM Guidelines)

The different types of proposed infrastructure are then assigned a vulnerability classification according to the definitions in 'Table 3.1 – Classification of vulnerability of different types of development' of the FRM Guidelines.

As described in Section 2.1 above, the proposed development consists of 'primary transport infrastructure' This is classified as 'highly vulnerable development'.

Step 3: Using the matrix of vulnerability versus Flood Zone (Table 3.2 of the FRM Guidelines), identify the necessity for the justification test for the proposed development

If the proposed development is located in Flood Zone A, it is categorised as Highly Vulnerable Development. Table 3.2 of the FRM guidelines– Sequential approach mechanism in the planning process (FRM guidelines) stipulate that a justification test is required for such a development. The Table 3.2 matrix in Section 2.1 highlights the matrix of vulnerability versus flood zone.

SECTION 3: Stage 1 – Flood Risk Identification

3.1 Historic Flooding Maps

The OSI Historic 6" map marks out no flooding vulnerability areas. This indicates that the proposed development has not been subjected to a historic tendency for flooding.

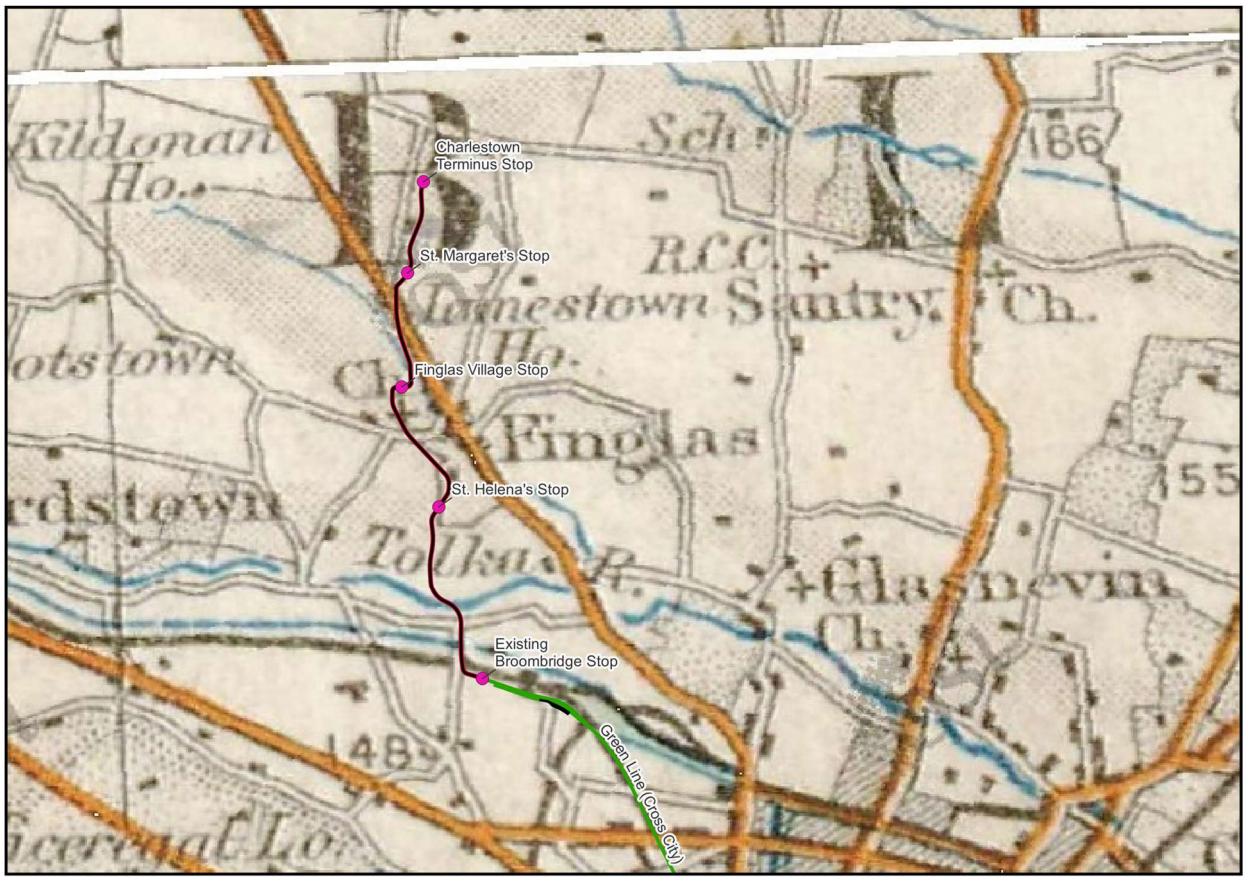


Figure 3.1: OSI Historic 6'' Mapping in the vicinity of proposed development (georeferencing and annotation by J. B. Barry and Partners)

3.2 Past Flood Events

Records of past fluvial and tidal floods were obtained from the OPW National Flood Hazard Mapping website (www.floodmaps.ie) and reports produced as part of the Flood Risk Management Plan for the Liffey & Dublin Bay River Basin. There are no records for pluvial or groundwater flooding available from the above sources.

An extract from the National Flood Hazard Mapping website report summary, indicating the locations of recorded flood events, is shown in Figure 5. The area approximately 400m south of the Proposed Scheme is indicated to have flooded in the past.

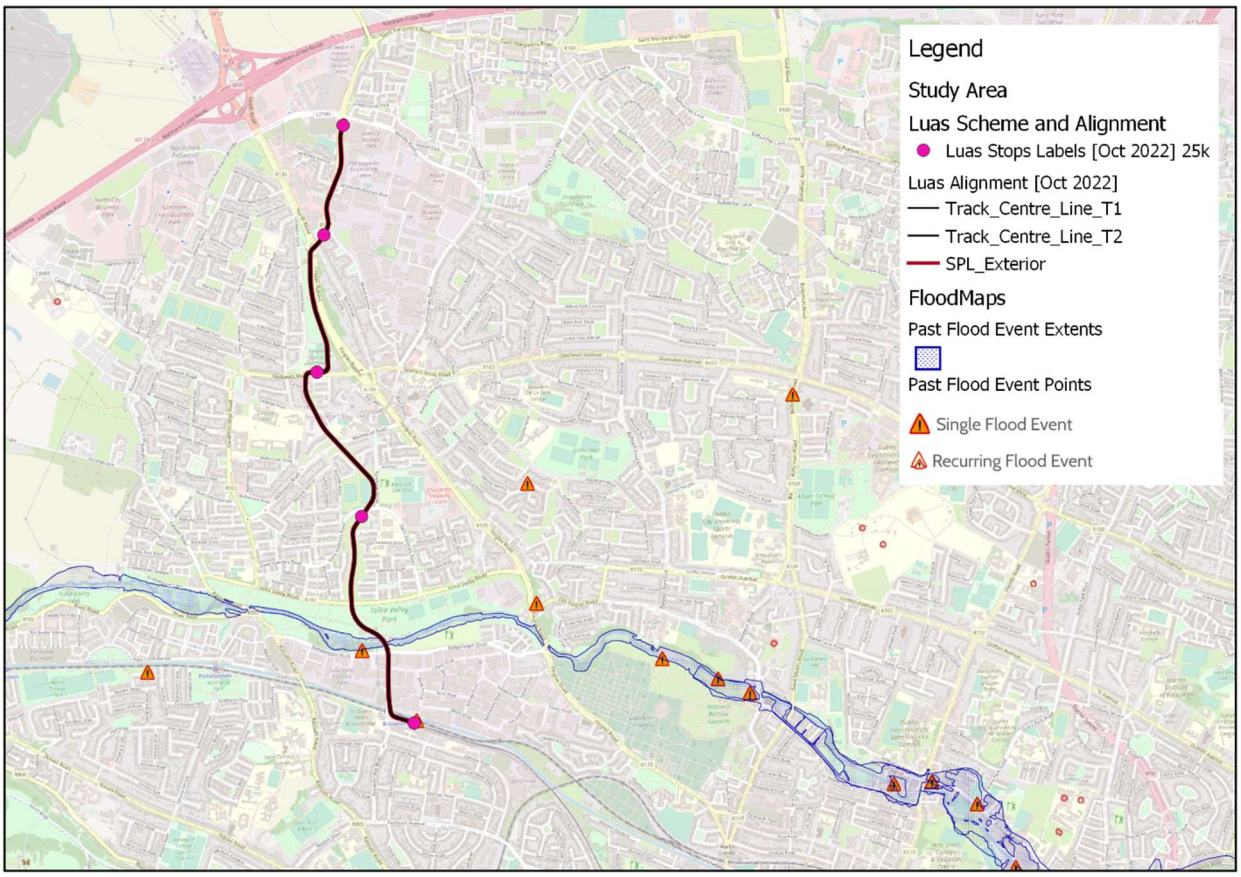


Figure 3.2: Past Flood Events and Point Locations (Source: OPW FloodInfo.ie; annotations by J.B. Barry and Partners)

Tolka River has historically been prone to fluvial and/or tidal flooding with significant events occurring in recent years. A summary of the flood events that have occurred in the past 20 years, near the subject site are listed in Table 1. The most recent recorded flood event which occurred within the boundary of the Proposed Scheme site, was in 2011, due to blockage at Glasnevin according to the OPW report. An extended list of past flood events is available in Appendix 1.

Table 1: Summary of recorded flood events near the subject site in the past 20 years (Source: OPW National Flood Hazard Mapping website).

Date of flood event	Location	Flooding mechanism
23/10/2011	Broombridge Railway Station	Pluvial/Mechanical
23/10/2011	Glendhu Park, Cabra	Pluvial
23/10/2011	Ballygall Crescent and Fairways Green	Pluvial
07/01/2005	Tolka January 2005	Fluvial & Pluvial
13/11/2002	Tolka November 2002	Fluvial & Pluvial

3.3 Existing Flood Studies

3.3.1 River Tolka Flooding Study, 2003

This study was undertaken in 2002, by Dublin City Council in association with Fingal County Council, Meath County Council and the Office of Public Works. The purpose of this study is to address the flooding risk to properties caused by the River Tolka after the significant events that occurred in November 2000. The study defines its objective as, "to describe the comprehensive flood analysis of the River Tolka, Castle Stream and Twin Pinkeen Streams and how it developed, from a modelling perspective." The 2004 flood zone mapping for the River Tolka pre-date major infrastructural changes in the M3 area carried out over the last 15 years. However, the 2003 'River Tolka Flooding Study' has been superseded by the 'River Tolka Flood Study (2022)' commissioned by Fingal County Council as part of the SFRA as described in Section 3.3.2.

This mapping is being used for the Fingal County Development Plan until the completion of the OPW Tolka Review and as such forms the basis of this FRA.

The Eastern CFRAMS Study describes the Tolka Flood Alleviation Scheme, as a response to the November 2002 fluvial flooding. The works under the scheme were completed by 2009, which included flood defence walls, embankments, channel conveyance improvements, a new raised bridge, and a pumping station. The scheme design was incorporated for the 100-year flood.

3.3.2 Dublin City Development Plan 2022 – 2028 – Strategic Flood Risk Assessment

The Plan provides an area-wide assessment of significant flood risk to inform strategic land-use planning decisions. The SFRA has considered various sources of flood data to produce flood maps for the Dublin City region. The Plan states that, "the City Council has increased co-ordination and capacity building and adopted a flood risk prevention (SFRA/ Flood Risk Management Guidelines as framework for forward planning and development management), protection (Flood Relief Schemes), preparedness (Flood Warning / Emergency Response) and resilience approach."

Figure 3.5 presents the flood map generated for the region in the vicinity of the proposed development line. From observation of this map, it can be concluded that a part of the proposed development lies within Flood Zone A. A full SFRA flood map is included in Appendix 2.

3.3.3 CFRAM Study

The OPW undertook the National Catchment-based Flood Risk Assessment and Management (CFRAM) Programme in consultation with the Local Authorities and supported by external engineering consultants. One of the objectives of the CFRAM Programme was identify and map the existing and potential future flood hazard and flood risk in the areas at potentially significant risk from flooding. Where a full detailed hydraulic assessment if an area was not undertaken, indicative flood maps were developed. These maps show the modelled extent of land that might be flooded by rivers during a theoretical or 'design' flood event with an estimated probability of occurrence, rather than information for actual floods that have occurred in the past.

Figure 3.3 overleaf is an extract from the CFRAMS indicative fluvial flood extent map (old version) showing the fluvial flood extent concerning the proposed WWTP development site. The Tolka River area is currently '*Under Review*', as stated by OPW on the floodinfo.ie platform, explaining that "information in this area is under review following an objection, submission and/or further information received". The full CFRAMS indicative flood extent map (old version) showing the flood extent of the Tolka River is included in Appendix 3. Observation of the map shows that the proposed development site is located inside of the 1% and 0.1% AEP fluvial flood events. Therefore, the proposed development line is considered to be within fluvial **Flood Zone A,** where the risk of flooding is highest.

3.4 Fluvial Flood Risk Map

An extract from the CFRAMS indicative fluvial flood extent map is presented in Figure 3.3. The predicted extents for the 1 in 100- and 1000-year fluvial flood events are shown.

The flood map indicates that the area in the Tolka Valley Park lies within the 1 in 100-year fluvial flood extent (Flood Zone A), with the rest of the site is located outside of the 1 in 100-year fluvial flood extent.

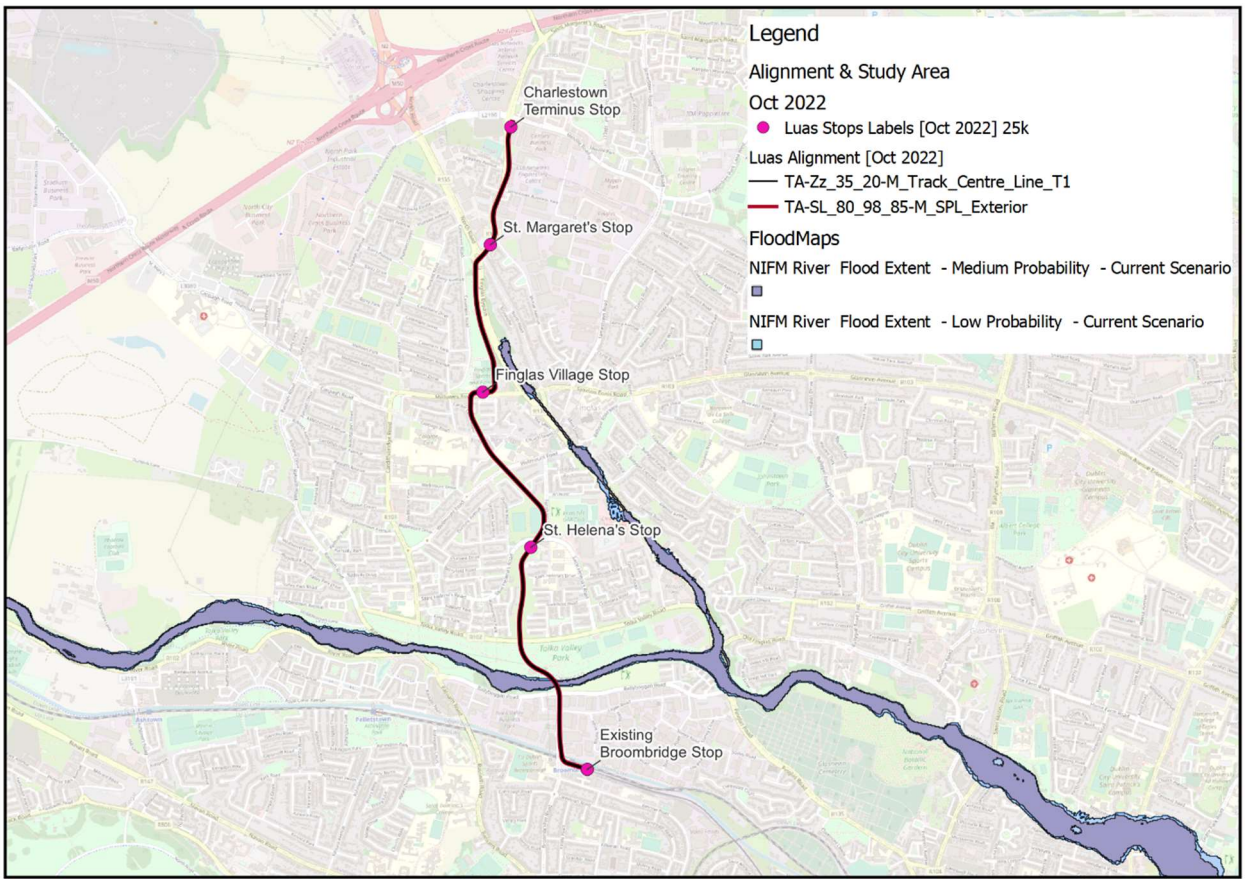


Figure 3.3: NIFM fluvial flood extent map (Source: www.floodinfo.ie, annotations by J. B. Barry and Partners)

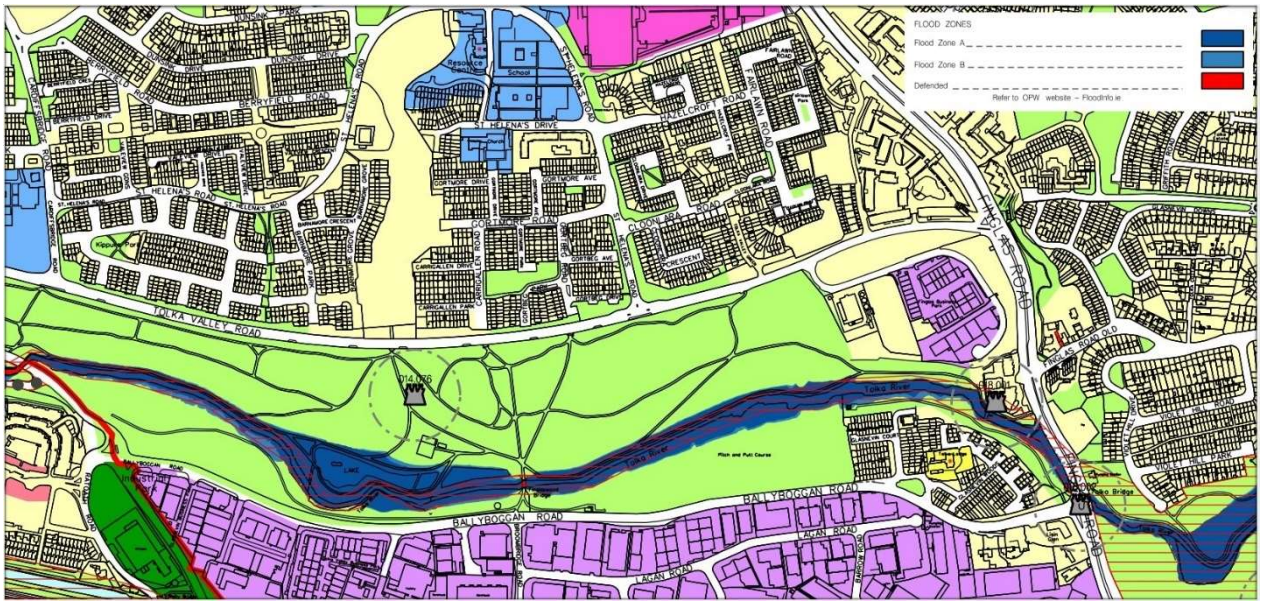


Figure 3.4: Fluvial flood mapping for Tolka River (Source: Dublin City Council Development Plan 2022-28; Strategic Flood Risk Assessment)

3.5 Tidal Flood Risk Map

An extract from the Eastern CFRAMS tidal flood extent map is displayed in Figure 3.5. The predicted extents for three separate return period events of the 1 in 10-, 200- and 1000-year tidal flood events are shown. Nodal points detailing the water level have not been included within the Eastern CFRAM Coastal study.

The flood map indicates that the proposed development is in areas outside the 1 in 1000-year tidal flood extent, categorised as Flood Zone C.

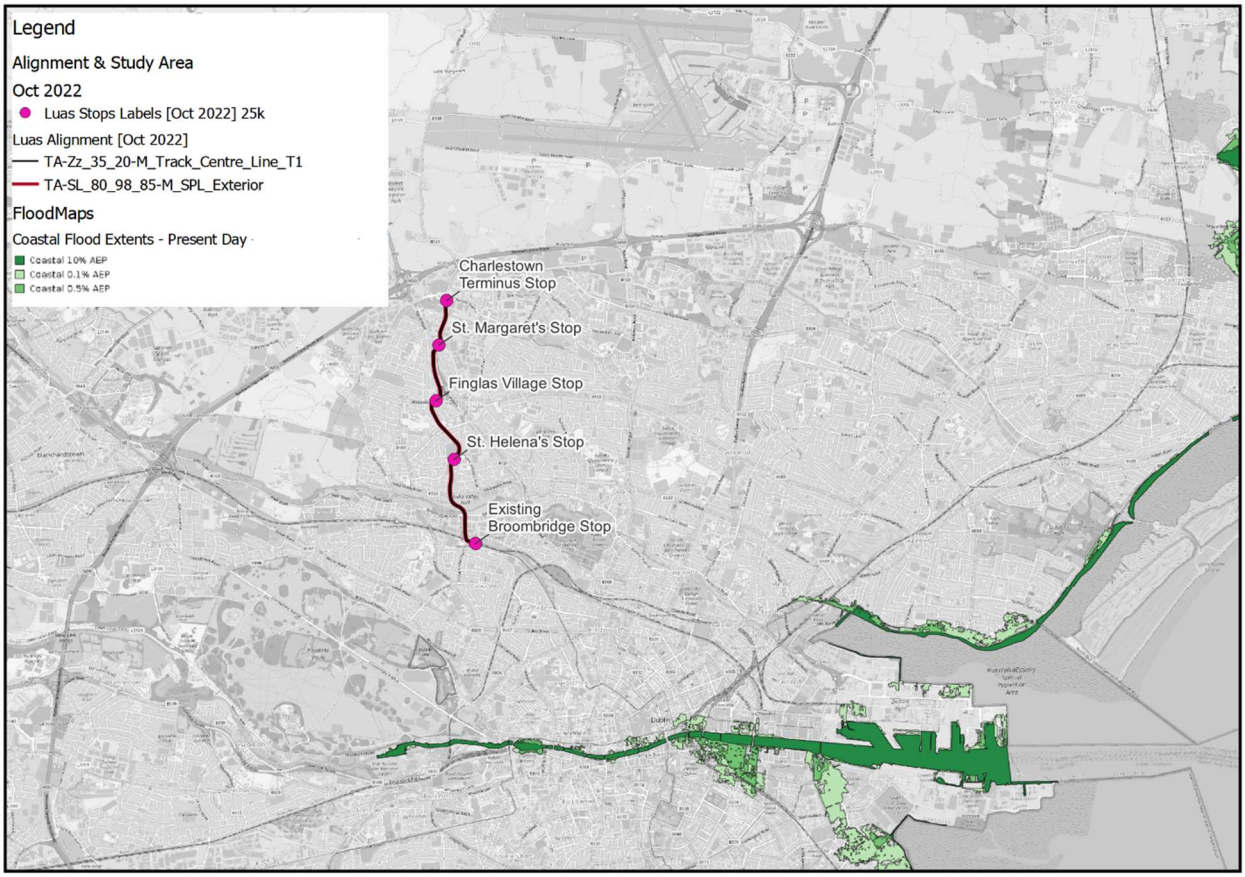


Figure 3.5: CFRAMS coastal flood extents (Source: www.floodinfo.ie, annotations by J.B. Barry and Partners)

3.6 Pluvial Flooding

Pluvial flooding occurs when extreme rainfall overwhelms drainage systems or soil infiltration capacity, causing excess rainwater to pond above ground at low points in the topography. To assess the risk of pluvial flooding to the development, the CFRAMS maps preparedby the OPW was reviewed. Maps indicating the extent of pluvial flooding during the 0.5%, 1.0% and 10% flood events and the associative flood depths are provided in Figures 3.7 and 3.8 respectively.

Figure 3.7 indicates that areas of site and many of the roads in the vicinity of the site are within areas risk of pluvial flooding during the 0.5%, 1% and 10% exceedance events.

It should be noted that the maps are only indicative and are not based on detailed analysis of the numerous variables which contribute to pluvial flooding along the route, i.e, infiltration capacity of soil, capacities of drainage networks and flow routes across the landscape. Whilst the maps would indicate

significant areas that are subject to potential flooding, for the vast majority of these regions there are no recorded flood events on floodinfo.ie. Therefore as part of the Luas Finglas FRA, these maps have been treated with caution, and are considered to significantly overestimate the flood risk along the route. It is considered that the drainage system that will be installed as part of the Luas Finglas will result in a post development improvement to flood conditions along the route. This will be due to the additional subsurface storage volume which will be provided via attenuaton structures, SuDS features, and storwater pipes.

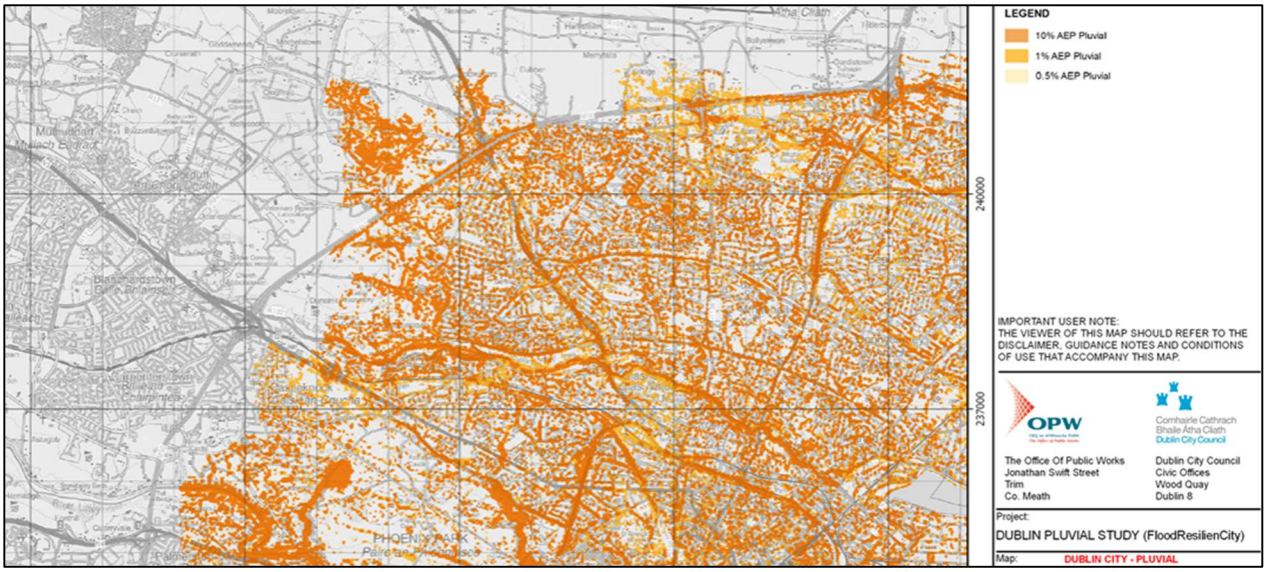


Figure 3.6: Extract from OPW 1% AEP Pluvial Flood depth map (www.floodinfo.ie)

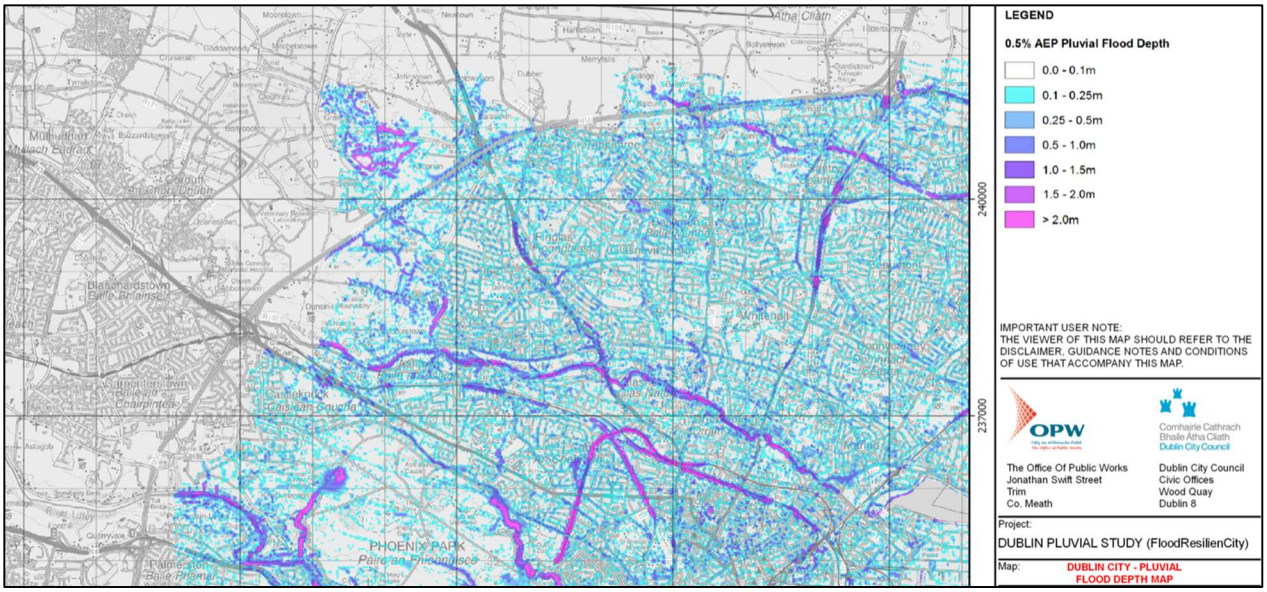


Figure 3.7: Extract from OPW 0.5% AEP fluvial flood depth (www.floodinfo.ie)

3.7 Groundwater Flooding

Groundwater flooding can occur during lengthy periods of heavy rainfall, typically during late winter/early spring when the groundwater table is already high. If the groundwater level rises above ground level, it can pond at local low points and cause periods of flooding.

To assess the risk of groundwater flooding to the site, the Geological Society Ireland (GSI) Groundwater Flooding Data maps were obtained from floodinfo.ie.

An extract of the map is presented in Figure 3.8. It should be noted that the groundwater flooding data maps are only indicative. These maps are developed to indicate areas of high groundwater likelihood.

The map suggests that the site and areas in the vicinity are not identified at risk of groundwater flooding.

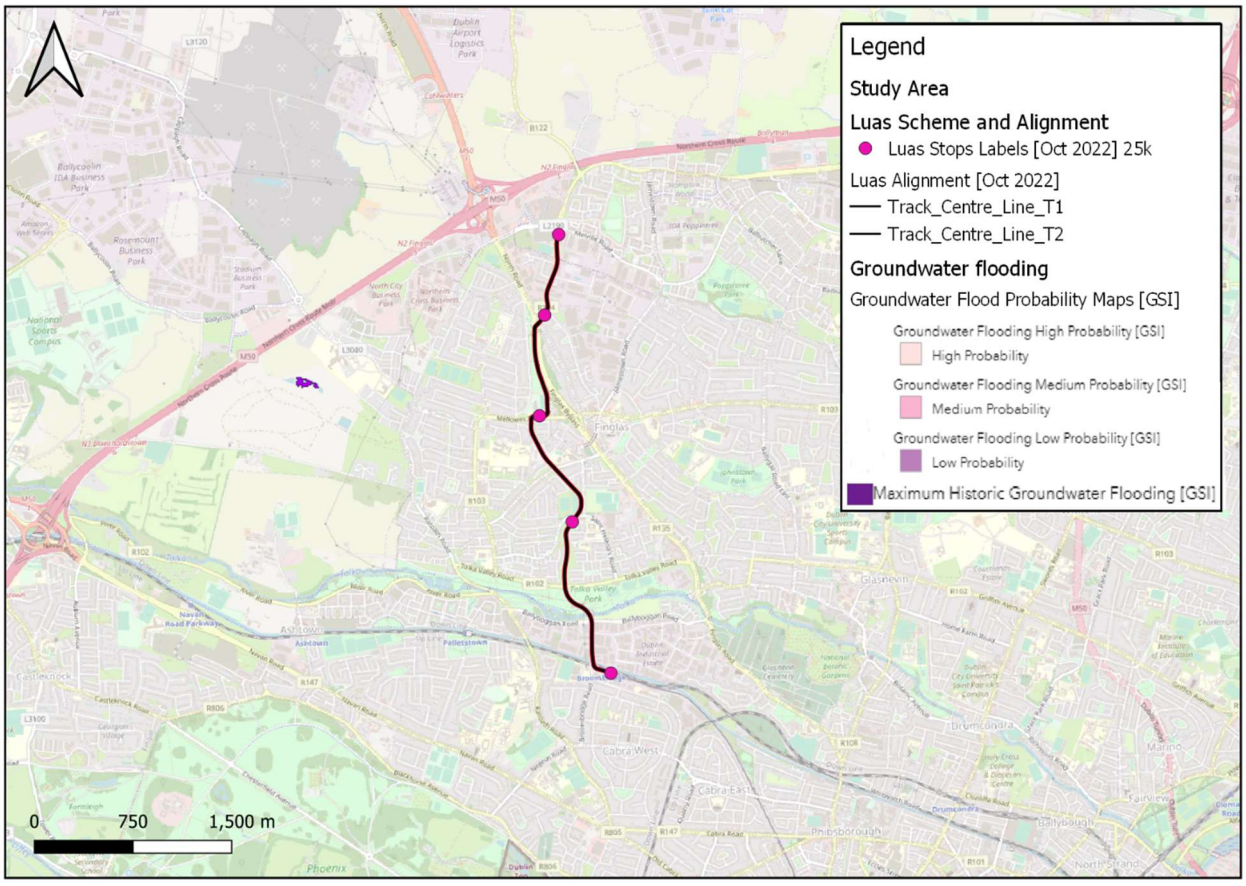


Figure 3.8: Extract from GSI Groundwater Flood Map (floodinfo.ie)

Figure 3.9 presents information on the Geological Survey of Ireland (GSI) groundwater vulnerability at the Proposed Scheme. It can be seen from the figure that the groundwater vulnerability is indicated as high for a large portion of the site, with moderate vulnerability along Finglas Village stop and small areas of extreme vulnerability in the Tolka Valley Park and St. Margaret's stop. This suggests that groundwater levels at the site may be relatively shallow. Additionally, it is known that most of the area at the site consists of made ground.

Therefore, it is likely that the vulnerability rating at the Tolka Valley Park is indicative of a relatively shallow water table due to the site's proximity to the River Tolka and surrounding canals and waterways. As there are no recorded flood events due to groundwater flooding along the scheme, it is considered the risk from groundwater flooding is low.

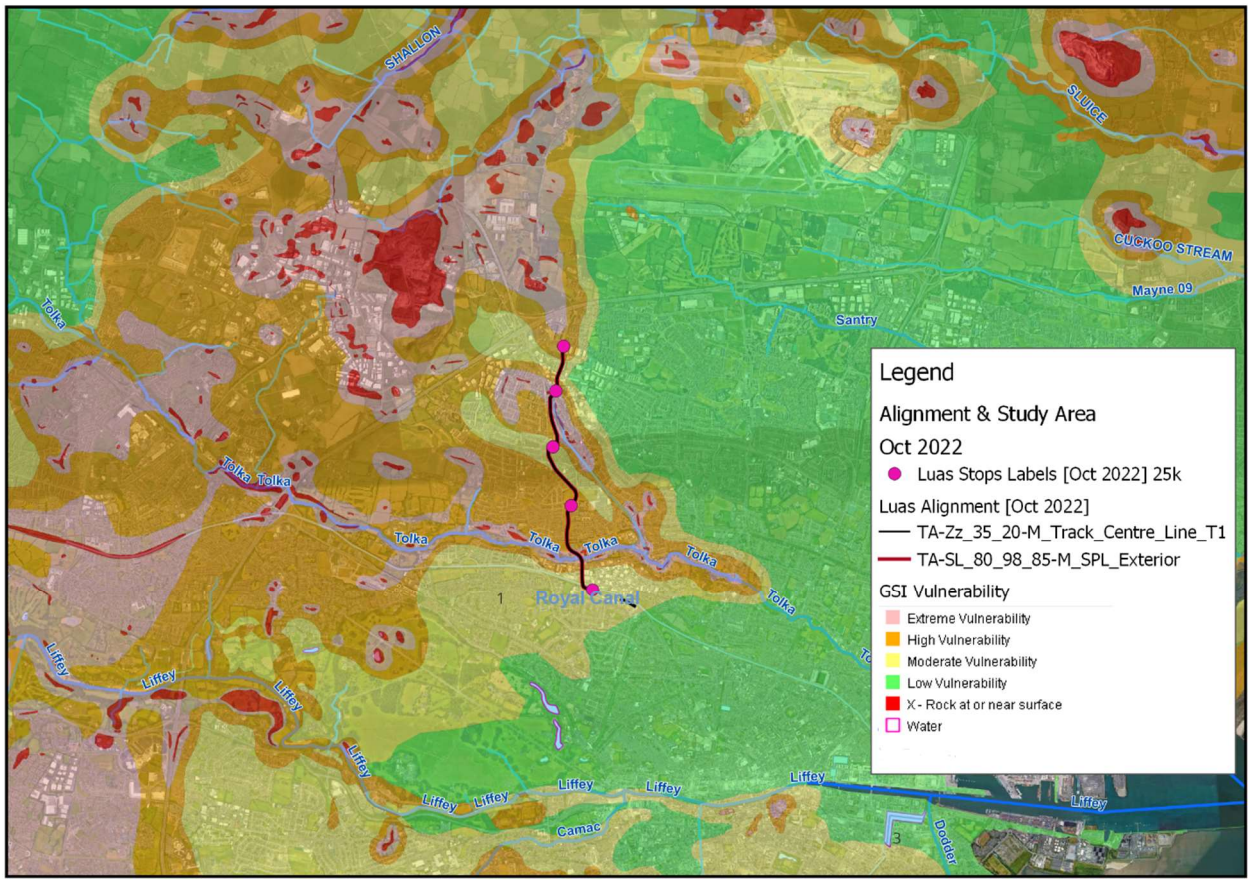


Figure 3.9:Extract from GSI spatial resources Groundwater Vulnerability Mapping

3.8 Mechanical/Operational Failure

There are several bridges on River Tolka and other waterways which may fail or block due to mechanical error, deterioration, and operational problems.

Of these, the Royal Canal constitutes a significant source of flooding to the Study Area. The Royal canal is known to have burst its banks in the past under storm surge. The OPW report of this incident (Appendix 4) indicated the reason for the surge being possible blockages upstream.

3.9 Summary of Existing Flood Risk

The risk of flooding to the existing site from fluvial, tidal, pluvial and groundwater sources was assessed and is summarised as follows:

- The Tolka Valley Park area has a high risk of fluvial flooding from the Tolka River;
- Parts of Finglas village have a high risk of fluvial flooding from the Bachelors stream;
- The remainder of the site have a low probability of fluvial flooding;
- The Proposed Scheme site has a low probability of tidal flooding;
- A portion of the site is located within fluvial Flood Zones A;
- The risk of pluvial flooding to the site is considered low with the site. As this risk may not be eliminated, appropriate drainage system design will be required to reduce the risk from pluvial flooding to acceptable level during construction;
- The risk of groundwater flooding to the site is considered moderate and limited to construction stage; and
- The Royal Canal have been identified as the main sources of flooding due to mechanical or operational failure.

3.10 Conclusion of Stage 1 - FRA

The various sources of flooding were assessed and was determined that the site, at least in part, is at risk of flooding from fluvial and groundwater sources. Therefore, the flood risk assessment progressed to Stage 2: Initial Flood Risk Assessment.

SECTION 4: Stage 2 – Initial Flood Risk Assessment

4.1 General

For Stage 2: Initial Flood Risk Assessment, the Proposed Scheme is divided into 10no. distinct areas of works to better understand the risk of flooding from all sources and identify management options for each area. Flood risk to each of these sections is detailed below.

4.2 Broombridge Road

Along Broombridge Road (starting from Broombridge stop continuing along the royal canal crossing and further towards Tolka Valley Park), the proposed Scheme Works will involve creating cycle track connectivity, tie in existing roadways network, new vehicular access for Colorman to Broombridge road and relocation of bus lane after crossing the royal canal junction.

Figure 4.1: Broombridge Road Section of Works

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C. Previously there was a flood event where the waters from the Royal Canal flooded onto the track adjacent Broombridge Railway Station(Refer to Figure 4.2 below) The event occurred on the 24th of October 2011 and has flood reference ID-11744 on the OPW website floodinfo.ie It is understood this was caused by a blockage in the Royal Canal at Glasnevein.It is considered that Luas Bridge Crossing of the Royal Canal which are to be constructed as part of the Luas Finglas Project will not result in a likelihood of this flood event occurring, or a worsening of the existing situation.

Fig 4.2: Flooding of Irish Rail Tracks adjacent Broombridge Station.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Management of the groundwater may be required during construction.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.3 Tolka Valley Park

Towards the north, going up from the Ballyboggan road, through the Tolka Valley Park the Works involve the Luas line, which exits the Park and crosses the Tolka valley road. This section creates a curved track through the Tolka Valley Park, following the contours of the existing pathways.

Figure 4.2: Tolka Valley Park section of works

Fluvial Flooding

The area of development is within the 1% AEP extent as depicted under the National Indicative Fluvial Mapping and is therefore classified as Flood Zone A.

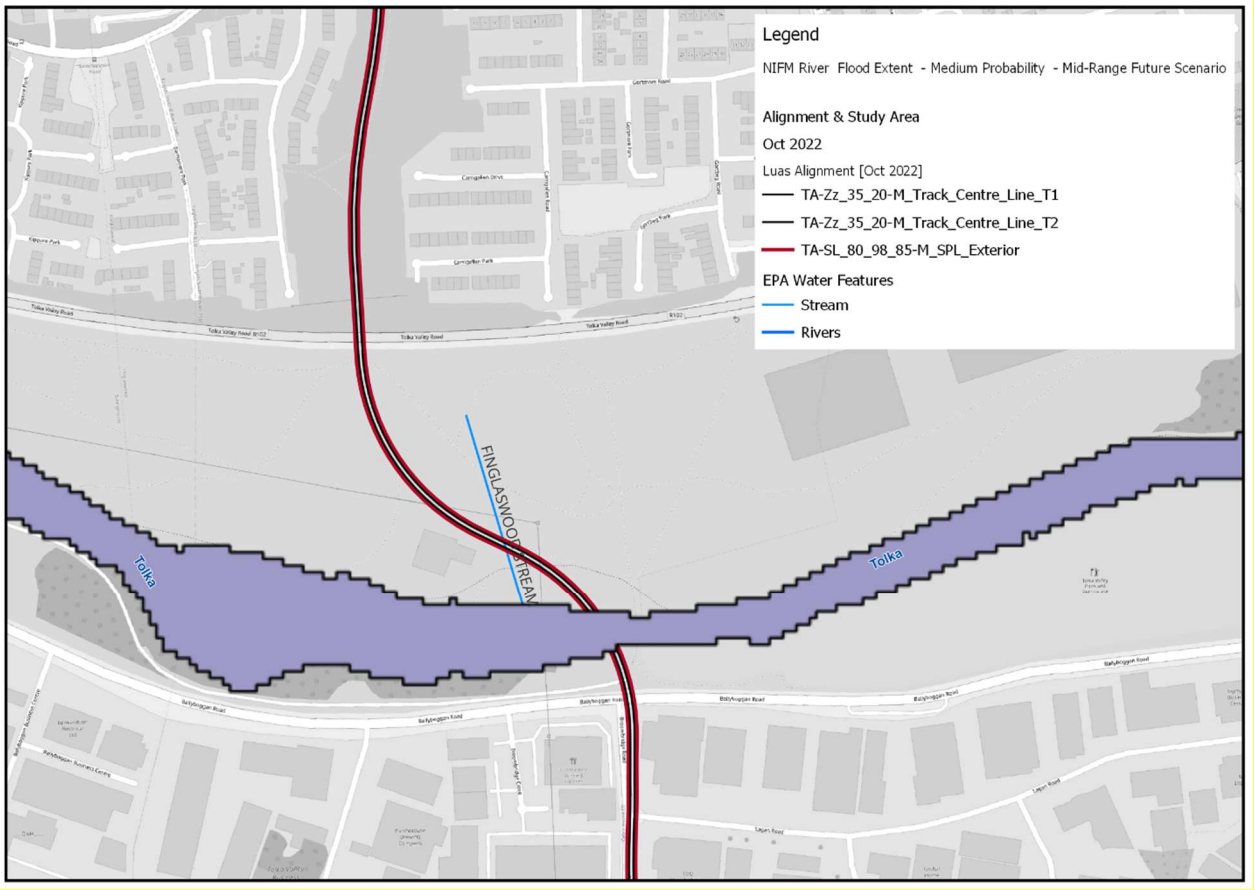


Figure 4.3: Tolka Valley Park Fluvial flooding (Source: NIFM FloodInfo.ie; annotations by J. B. Barry and Partners)

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low, as depicted in Figure 3.7.

4.4 St Helena's Rd

The Works will proceed with the line towards north, passing between the Barnamore Grove and Gortmore Dr. The line will arrive at its first junction beyond this, at the St. Helena's stop.

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.5 St Helena's Stop

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.6 Farnham and Patrickswell

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.7 Ravens Court and Finglas Village Stop

Fluvial Flooding

The area of development is outside the 0.1% and 1% AEP and is therefore classified as Flood Zone C. Figure 4.4 shows that the development boundary lies outside the 0.1% AEP flood zone.

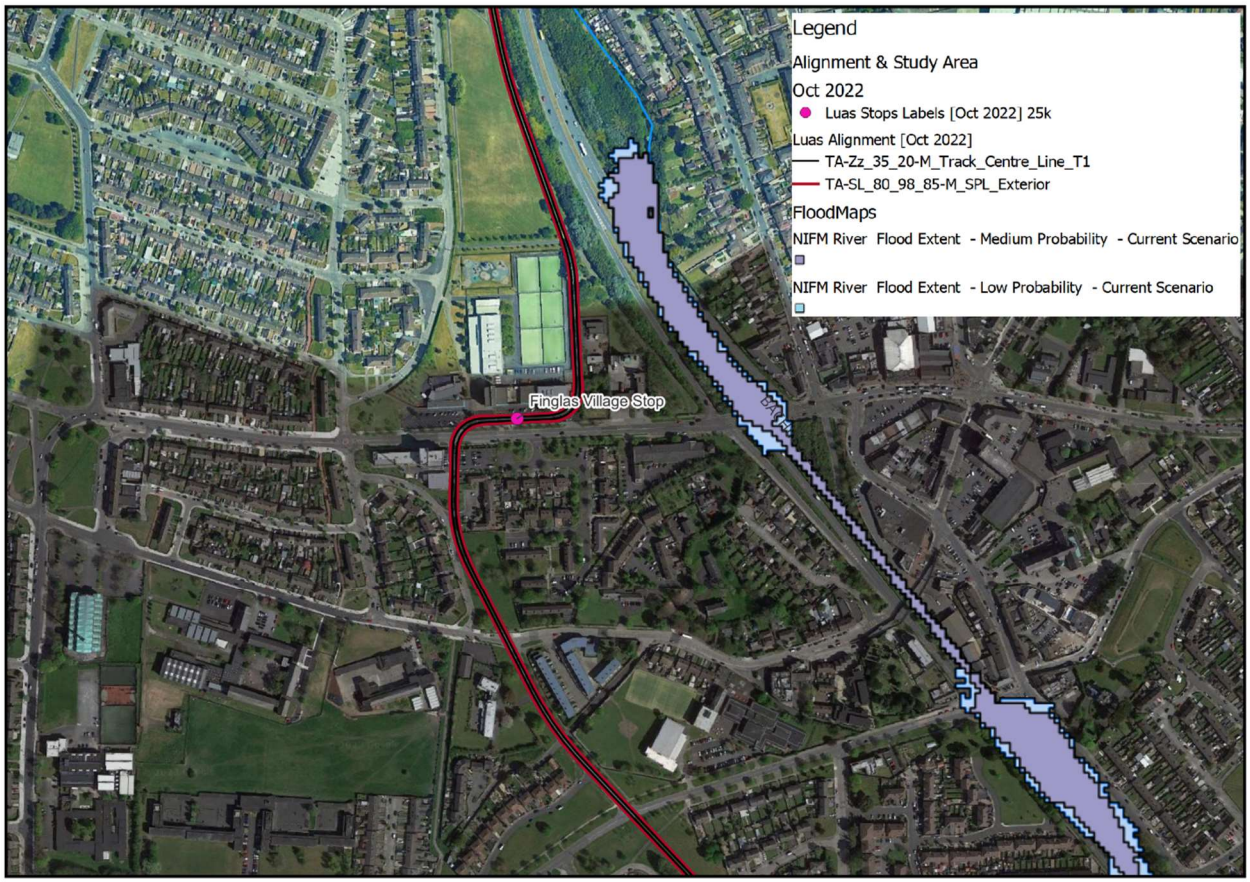


Figure 4.4: Finglas Village stop Fluvial flooding.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.8 Mellowes Park

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.9 St Margaret's Stop

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.10 St Margaret's road

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.11 Charlestown Stop

Fluvial Flooding

The area of development is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The area of development is outside of the 0.5%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater was not indicated in this area by the GSI Groundwater Flood Map,Figure 3.8 The area is noted as high groundwater vulnerability as per Figure 3.9. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Tolka and adjoining canal.

Pluvial Flooding

Pluvial flood depth in this area is minimal in the CFRAMS map and therefore the risk is deemed to be low.

4.12 Summary of Flood Risk

Table 2: Summary of flood risk to the Work Areas

Location	Source of Flooding				
	Fluvial	Tidal	Groundwater	Pluvial	Mechanical
Broombridge Luas Stop	Low	Low	Low	Moderate	Moderate
Broombridge Road	Low	Low	Moderate	Low	Low
Tolka Valley Park	High	Low	Low	Low	Low
St. Helena's Road	Low	Low	Moderate	Low	Low
St. Helena's stop	Low	Low	Moderate	Low	Low
Farnham and Patrickswell	Low	Low	Moderate	Low	Low
Ravenscourt and Finglas Village Stop	Low	Low	Moderate	Low	Low
Mellowes Park	Low	Low	Moderate	Low	Low
St Margaret's stop	Low	Low	Moderate	Low	Low
St. Margaret's Road	Low	Low	Moderate	Low	Low
Charlestown stop	Low	Low	Low	Low	Low

4.13 Conclusion of Stage 2 - FRA

As summarised in Table 2, the location defined in Section 4.3 – Tolka Valley Park is at high risk of flooding (Flood Zone A) from fluvial sources in the Proposed Scheme area. Areas at Tolka Valley Park are in Flood Zone A due to fluvial flooding risk from the Tolka River.

Risk from groundwater sources is low which is likely due to the soil permeability which ranges from moderate to low and groundwater vulnerability. This indicates a shallow water table and may require dewatering during construction. The fluvial/mechanical flood risk at Royal Canal is only a historic event and is due to undersized drainage pipe or blockage of the system as per the OPW event report.

The risk of flooding in the Tolka Valley Park area suggests the need to proceed for a justification test. As outlined in the preceding sections, if the work areas are within Flood Zone A or B and the development being classed a "Highly Vulnerable", a Justification Test is required to be passed for the development proposal to go ahead.

According to the FRM Guidelines, the Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in areas of moderate or high flood risk (Flood Zones A and B; respectively).

SECTION 5: Justification Test

The FRM Guidelines outlines in Box 5.1 (shown in the five criteria, namely Criterion 1, 2(i), 2(ii), 2(iii), and 2(iv), all of which must be satisfied under the Justification Test as it applies to development management. These justification criteria have been addressed in the following paragraphs.

Box 5.1 Justification Test for development management (to be submitted by the applicant)

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
   - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
   - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
   - (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
   - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

Figure 5.1: Box 5.1 extract from the FRM Guidelines

A Justification Test is completed in accordance with the guidelines. This was to ensure the development proposal is not at risk of flooding itself or does not increase the risk elsewhere. Considering, not all parts of the development are considered at risk as they are outside of Flood Zone A or B, the Justification Test was applied for the development area identified in Stage 2.

Table 5.1: Justification Test Table for the Proposed scheme

No.	Criteria	Response	Criteria Satisfied?
1	The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.	The subject transport corridor is an extension to an existing route of the Luas. The Dublin City Development Plan 2022-2028 specifies, "*This policy approach promotes the integration of land use and transportation, improved public transport and active travel infrastructure".* The Fingal Development Plan 2023 – 2029 plans to, "*promote ease of movement throughout Fingal by integrating and enhancing existing developed areas and those areas identified for growth, with high quality connectivity through the delivery of footpaths, segregated cycling facilities, public transport systems, and roads*." This development achieves these objectives by providing enhanced public transport network to Dublin City and Finglas region.	Yes

2	The proposal has been subject to an appropriate flood risk assessment that demonstrates: (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk; (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible; (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.	To satisfy the four sub-criteria (namely 2(i), 2(ii), 2(iii), 2(iv)) under this criterion, as set out in Box 5.1 of the FRM Guidelines, a detailed flood risk assessment has been undertaken. A detailed and appropriate flood risk assessment has been undertaken for the region of the development in the Tolka valley Park, under the four sub-criteria of Criterion 2 of the Justification Test, as described below: ▪ Sub-criterion 2 (i) – Detailed flood risk assessment ▪ Sub-criterion 2 (ii) – Flood risk mitigation measures ▪ Sub-criterion 2 (iii) – Residual risks ▪ Sub-criterion 2 (iv) – Wider planning objectives Each sub criterion is outlined in the following sections.	Yes

5.1 Sub Criterion 2(i) – Detailed Flood Risk Assessment

As mentioned above, a portion of the proposed development lies within the 1% and 0.1% AEP floodplain of the Tolka River. Development on a floodplain has the potential to increase flood risk elsewhere by:

- Increasing the rate and volume of runoff from reduced permeable areas; and
- A decrease in the volume of available flood storage.

The Dublin City Development Plan 2022-2028 undertook an SFRA (Strategic Flood Risk Assessment) which provides an area-wide assessment of significant flood risk to inform strategic land-use planning decisions. The SFRA enables Dublin City Council (DCC) to apply the sequential approach, including the Justification Test for Development Plans.

The SFRA conducts a Justification test for 32 areas which includes the region of the Tolka Valley Park. The Tolka River SFRA has been divided into 5 areas for the purpose of the SFRA. Our area of concern has been covered in 'Area: 23 – Tolka Finglas Road to City Boundary'. The SFRA for Area 23 has been included in Appendix 5, the flood map presented in Figure 5.2.

Area: 23. Tolka: Finglas Road – City Boundary

For Land Use Zoning Maps Overlaid with Flood Zones see Dublin City Council Development Plan 2022 - 2028, Flood Map A.

Area Description	This area on the Tolka River goes from Finglas Road Bridge through the Tolka Valley Park to the city boundary. It runs adjacent to Ballyboggan Road and Rivermount. It also includes the Finglas Stream. Development in this area is parkland with some residential to the south. The park is a natural flood plain.

Figure 5.2: Dublin City Development Plan 2022-28, SFRA Flood Zone A map for Area 23

As noted in the Dublin City Development Plan SFRA, "*Most of the flood cells are in parkland flood plains which must be retained, only water compatible development should be allowed here.*".

The proposed development in the Tolka Valley Park region consists of a bridge Crossing over Tolka River, which is located in the Flood Zone A. Therefore, a more detailed flood risk assessment including modelling was necessary for the area defined in Section 4.3.

A detailed topographical survey of the Tolka River was completed to obtain the geometric data for the river.

River Tolka Bridge Crossing Hydrology and Hydraulics

There has been two significant reports done on the River Tolka previously; the findings of these reports assisted in the determination of the design flows for the proposed Tolka River Bridge. The reports entitled 'River Tolka Flooding Study 2002' and 'River Tolka Flood Study: Hydrology and Hydraulics Summary Report 2022' were prepared by RPS and MyCloy Consulting respectively. In addition, an analysis of the design flows for the subject site was undertaken by using the FSU Method . This was achieved with the use of the

OPW Web Portal which provides information on the catchment characteristics and pivotal sites for ungauged rivers.

The McCloy Consulting and the RPS reports provide estimates for the 1% Annual Exceedance Probability event. The location of the 1% AEP within the McCloy Consulting report is at the Botanic Gardens while for the RPS report the location of the 1% AEP estimate is further downstream, at the East Business Park. These 1% AEP events were utilised to estimate the flow at the location of the Tolka River Bridge by the use of scale factors. This was carried out by comparing QMED Urban values and Catchment Areas between these locations and the location of the proposed bridge.

Table 5.2 below summarises the estimated 1% AEP flows at the Proposed Bridge when scaling down the flows at the Botanic Gardens and at the East Business Park and when applying the FSU Method.

Table 5.2: Flow Estimations

Method	1% AEP at Proposed Bridge(m^3/s)	1%AEP +20%(CC) at Proposed Bridge(m^3/s)
Botanic Gardens .Scaling Factor from QMED Urban method.	84.68	101.62
East Business Park. Scaling Factor from QMED Urban method.	71.53	85.84
Botanic Gardens. Scaling Factor from Catchment Area method.	86.09	103.31
East Business Park. Scaling Factor from Catchment Area method.	76.31	91.57
FSU Method	81.43	97.71

The flow of **103.31** m^3/s is the highest of all the flows estimated and was chosen as the design flow. The flow is a result of comparing the catchments between the Botanic Gardens and the site of the Tolka River Bridge. This figure includes Climate Change of 20%. and is approximately 6 m_3/s higher than the flows derived using the FSU method. Refer to Tolka River Bridge: Section 50 Application LDD101-BEV-GN-GB40-XX-RP-CD-00001 for more details on the calculations of the design flow.

This flow data was utilised along with geometric data obtained by topographical and river surveying to develop a hydraulic model of the reach using HEC-RAS modelling software. HEC-RAS is a software package that allows one-dimensional river analysis, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modelling that can be utilised to simulate flow regimes within waterbodies. The software package features the component of steady flow water surface profiles that can be used to visualise and analyse the output. The basic computational procedure is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is used in situations where the water surface profile is rapidly varied. For example, hydraulics of bridges, and evaluating profiles at river confluences (stream junctions), etc.

The primary outputs of one-dimensional steady flow analysis include the graphical visualisation using X-Y plot of the river system schematic, cross-sections, profiles, rating curves, hydrographs, and inundation mapping. Tabular output is also produced which was used for the purpose of generating the analysis in this report.

To determine the flood levels at the site under consideration, a reach of length 1424 meters was modelled, that included the Tolka River and 3 No. bridge crossings. The model was used to perform a comparative assessment of two scenarios; pre-development and post-development of the proposed bridge crossing. The results of the analysis can be seen in the following tables and figures. A Third Party checker ; Fluvio LTD was involved in the checking of the Hydraulic Model.

River Station	Q Total (m3/s)	Water Surface Elevation (m)		Water Surface Elevation Difference (m)
		Existing Scenario	Post-Development Scenario	
848.44	103.31	23.27	23.29	0.02
830.26	103.31	23.21	23.23	0.02
812.08	103.31	23.16	23.18	0.02
793.90	103.31	23.10	23.13	0.03
776.40	103.31	23.06	23.09	0.03
758.90	103.31	23.02	23.05	0.03
741.40	103.31	22.99	23.03	0.04
723.90	103.31	22.99	23.03	0.04
706.40	103.31	23.01	23.05	0.04
688.90	103.31	23.03	23.06	0.03
669.75	103.31	23.01	23.05	0.04
650.60	103.31	23.00	23.04	0.04
631.45	103.31	22.98	23.02	0.04
612.30	103.31	22.96	23.00	0.04
593.15	103.31	22.95	22.99	0.04
574.00	103.31	22.95	22.99	0.04
556.83	103.31	22.93	22.97	0.04
539.67	103.31	22.91	22.96	0.05
522.50	103.31	22.90	22.94	0.04
505.33	103.31	22.87	22.92	0.05
488.17	103.31	22.85	22.90	0.05
471.00	103.31	22.84	22.89	0.05
454.48	103.31	22.82	22.87	0.05
437.96	103.31	22.74	22.80	0.06
421.44	103.31	22.70	22.77	0.07
404.92	103.31	22.66	22.73	0.07
388.40	103.31	22.61	22.69	0.08
381.10	103.31	22.62	22.64	0.02
368.00	103.31	-	Proposed Bridge	
353.10	103.31	22.36	22.30	-0.06
342.70	103.31	22.28	22.28	0
339.70	103.31	22.26	22.26	0
332.70	103.31	21.76	21.76	0

Figure 5.3: Tabulated results of the hydraulic model representing Flood Levels for Existing and Post-Development Scenarios

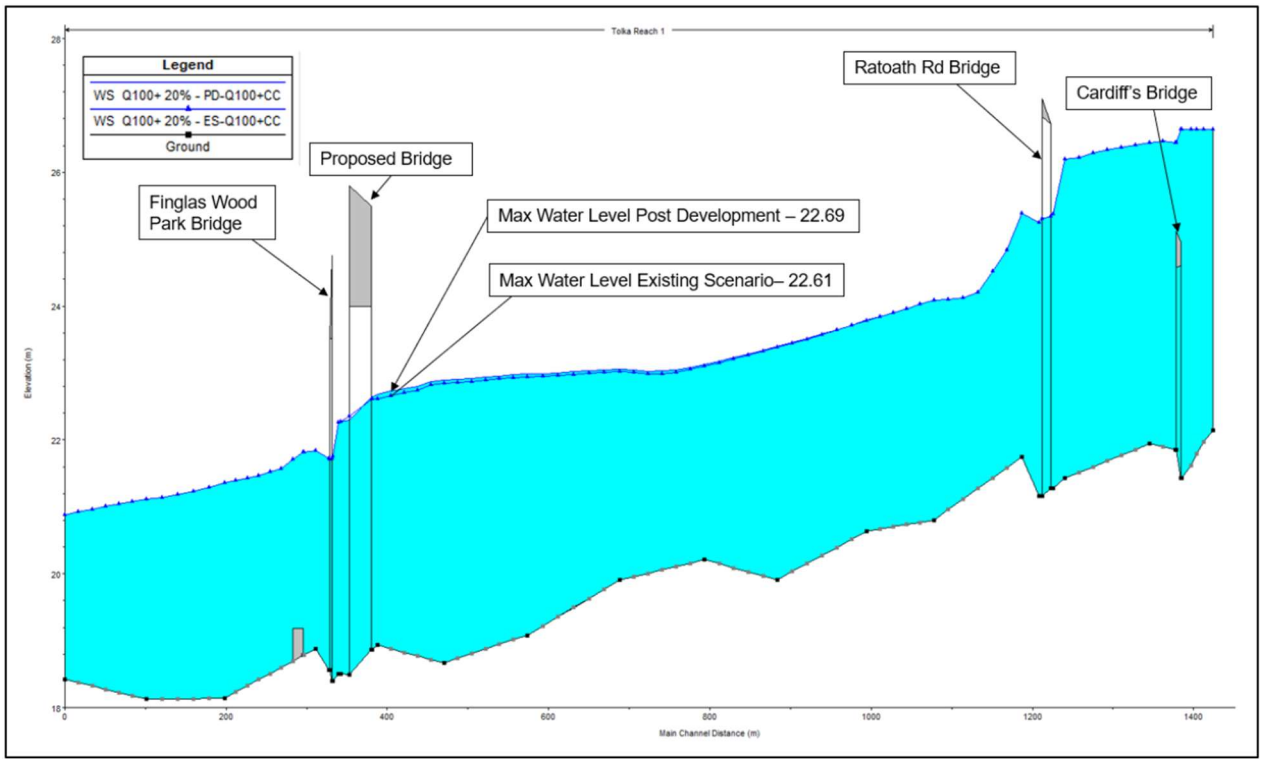


Figure 5.4: Longitudinal profile comparing water surface elevations

Figure 5.5 shows the location of modelled River Stations included in the results table in Figure 5.3. Figure 5.6 shows the stretch of river that was modelled for this assessment.

Figure 5.5: River Stations in the vicinity of the Proposed Bridge

Figure 5.6: Stretch of river extents modelled and location of the river stations.

Refer to below Figure 5.7, which depicts the extents of Flood Zone A. The proposed development alignment is indicated using the grey polygon with black outline, this is indicative of the bridge crossing over the Tolka River. It has been observed that the flood extents for the post development scenario are overlapping the pre -development flood extents. This indicates that the proposed development which id the bridge crossing will not result in a loss of floodplain elsewhere.

Whilst the bridge is at skew, it has been presented as a perpendicular crossing, but with the soffits levels of the proposed bridge projected onto the faces of the rectangular bridge structure within the model. This is a conservative approach. This was considered the best way to model the proposed River Tolka Bridge crossing, and was approved by the Third Party checker.

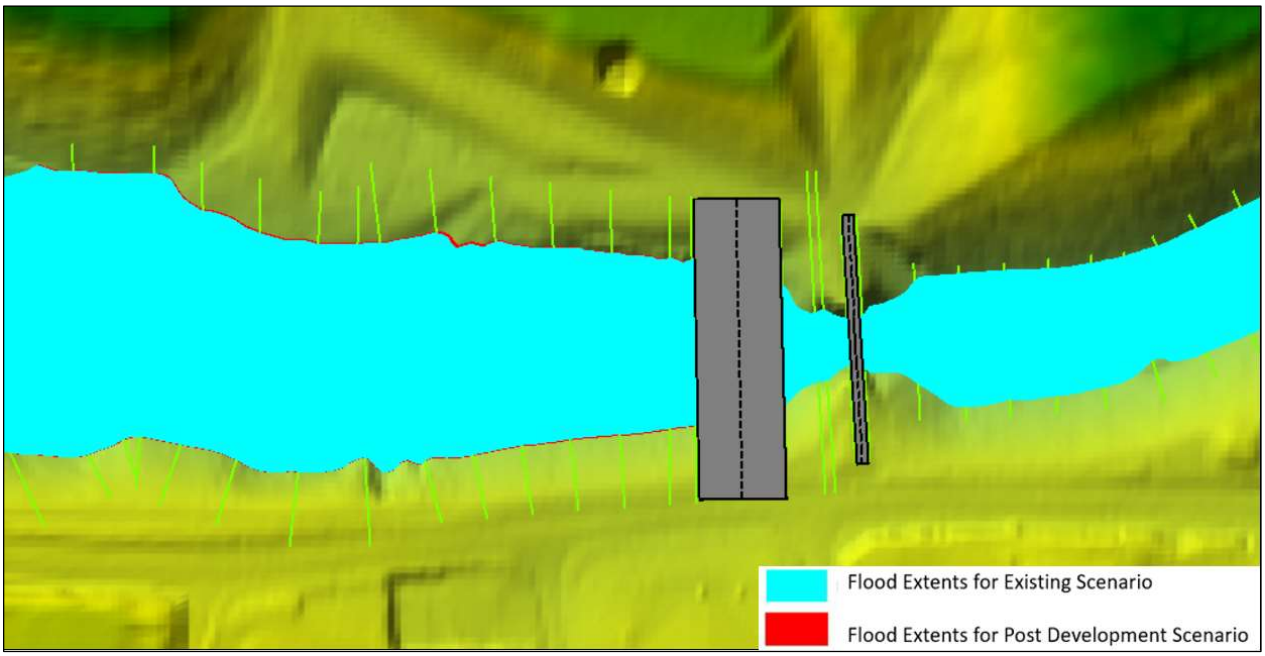


Figure 5.7: Flood extents derived from the model

For the purpose of estimating a safe FFL in this region, the highest flood level recorded, closest to the proposed development bridge crossing (at River Station 388.40), is considered the highest effective flood level during the storm events. This level is **22.69 mOD**, which is the 1% AEP flood level with 20% climate change allowance.

The Figure 5.3 and Figure 5.4 indicate the modelling results which reveal that in the post development scenario which includes the bridge in place, the maximum afflux is 80 mm. Thus, the construction of this bridge will not result in a severe loss of floodplains. The proposed bridge has been shown to convey the design flows which is 1% AEP flow with 20% allowance for climate change without altering the current hydraulic characteristics of the watercourse.

With this, it is considered that the proposed development satisfies sub-criterion 2(i) of the Justification Test.

Further to reviewing the records of flood events in the vicinity, it was found that there Balboggan Road flooded previously in November 2000. The flood report states the road was closed for 1 day, but it is understood only the Balboggan road was flooded, and that no properties were affected. Due to the levels of the road, and out estimated flood levels of the 1%(+20% Climate Change), it does not appear that the flooding of the Balboggan road was caused by inundation from the River Tolka. As there was only a singular instance of flooding in 2000 along Balboggan Road, it would suggest that it was a once off event, perhaps due to a blockage in a drainage network. It is considered that the flooding may have been caused by a failure of the roads drainage system, or overland flow from grassed and paved surfaces. As such it is considered the slight increase in flood levels due to the proposed Luas Bridge Crossing, will not result in any worsening of the existing flood situation.

5.2 Sub Criterion 2(ii) – Flood Risk Mitigation Measures

As discussed in Section 4.2, the main risk of flooding at area considered for this assessment; the Tolka Valley Park Luas line, is from fluvial flooding. It was identified that a portion this track is at risk of flooding due to the 0.1% AEP fluvial flood extent from the adjacent Tolka River.

According to the FRM Guidelines, the minimum road level for a new development should be set above the 1% AEP fluvial flood level and should include an allowance for climate change and freeboard. With a freeboard allowance of **0.3m** and the impact of climate change already incorporated into the flood levels, this gives the minimum required road level of the development as **23mOD**. These levels are based on the flood levels at River Chainage 388.40, which is highest effective flood level in the vicinity of the proposed development.

All new infrastructure should be kept above the level of 23mOD, except the bridge crossing, including structural elements such as piers and abutments, which have been modelled for the comparative assessment undertaken in Section 5.1, for deriving this effective highest flood level. According to the results of the hydrological model developed, the extents of Flood Zone A due to the fluvial flooding of Tolka River are contained within the Tolka Valley Park. The region of Tolka Valley Park is considered as a water-compatible development (Dublin City Development Plan, 2022-28). The Plan recommends, "*The floodplain lands should be retained as their current water compatible uses*." As the model proves in Section 5.1, the proposed bridge crossing exhibits no drastic effects on the existing flood extents or the floodplain. With this, the proposed development satisfies Sub-criterion 2(ii) of the Justification Test.

5.3 Sub Criterion 2(iii) – Residual Risks

With the implementation of flood risk mitigation measures recommended above, it is considered that the risk of flood damage to the proposed infrastructure will be minimal and loss of floodplain due to the proposed development will also be minimal.

The proposed development will have no direct access to any nearby watercourse. It is considered that the proposed development satisfies sub-criterion 2(iii) of the Justification Test.

5.4 Sub Criterion 2(iv) – Wider Planning Objectives

The development will address the above measures in a manner that is compatible with the wider planning objectives in relation to the proposed development. Therefore, it is considered that the development also satisfies Sub-criterion 2(iv) of the Justification Test.

5.5 Conclusion of Justification Test

The Proposed Scheme has been determined to have satisfied all requirements of the justification test as demonstrated in Table 5.1 and the subsequent sections, as per the Flood Risk Management, Guidelines for Planning Authorities' (2009).

As flood risks are present in some areas, measures included in the Proposed Scheme design measures are outlined in Section 6 which were used to complete the Justification Test. Some of the measures include:

- Upgraded road drainage system including SUDs;
- Developed a detailed drainage design report – LDD101-BEV-WE-ROUT-XX-RP-LE-00003;
- New Attenuation storage units in the form of ponds, integrated constructed wetlands (ICWs), tanks, pipes and similar;
- SUDS measures – include embedded trackform, rain gardens, bio retention areas, filter drains, tree pits;
- Routine maintenance plan of the drainage system; and
- Flood risk warning and flood risk awareness system.

Section 6 provides more details of these proposed design measures applied at the areas identified.

SECTION 6: Proposed Scheme Design Measures

6.1 Flood Risk Areas

There was one distinct flood risk area identified along the proposed routes sections of work that spanned from Broombridge stop to the proposed Charlestown stop.

- Area 4.3: Tolka Valley Park

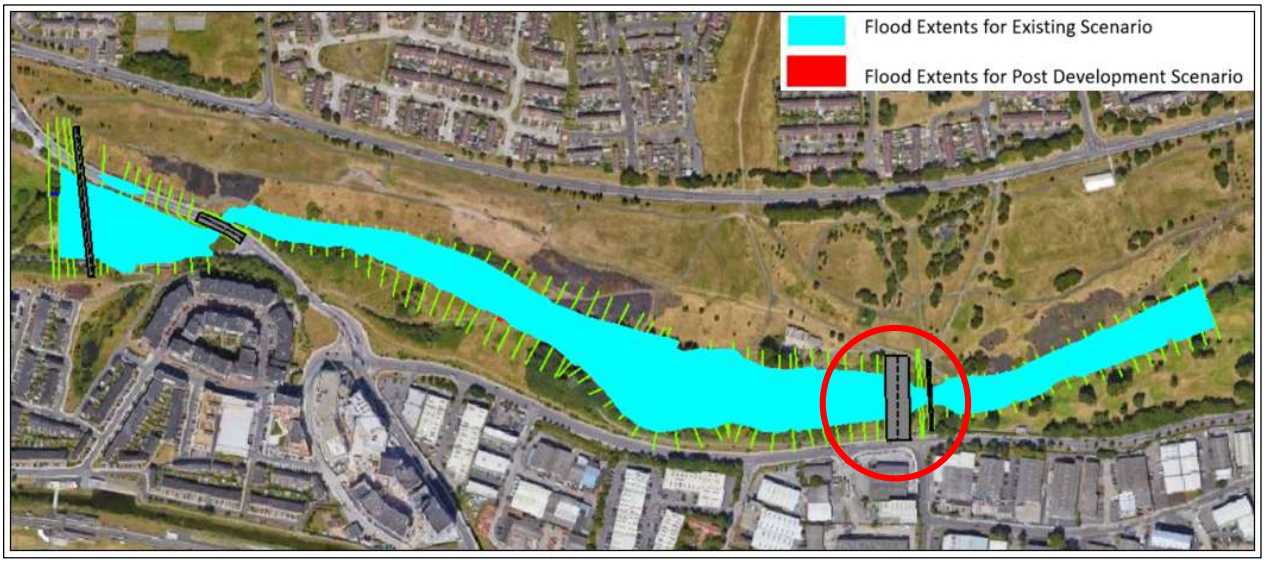


Figure 6.1: Full fluvial flood extents on River Tolka

The detailed drainage design report – LDD101-BEV-WE-ROUT-XX-RP-LE-00003, presents design measures applied to all area outlines in Section 4. The design measures applied to Area 4.3 are outlined below:

6.2 Area 4.3: Tolka Valley Park

The flood extent as an outcome of the hydraulic model developed for the Tolka Valley Park area can be observed in Figure 5.7.

As the model ascertains no significant effects on the floodplain due to the proposed bridge crossing, no change is proposed to the proposed route alignment to mitigate fluvial flood risk. However, the following design solutions are included to mitigate the risk from surface water drainage:

- Infrastructure other than the bridge , to be placed above the 23.20mOD level.
- Abutments are set back a minimum of 5m from the riverbank.
- Drainage Systems – Along the route of the proposed Luas a new drainage system incorporating attenuation in the form of oversized pipes , and SuD features(tree pits, bio-retention areas, and an attenuation pond), will be provided These measure, will result in a significant post development increase in attenuation storage capacity along the route. This will alter the times of concentration within the existing drainage networks(The majority of which discharge to the Tolka) within the region, resulting in a marginal reduction in the peak flow of the Tolka during storm events.

SECTION 7: Conclusion

This FRA was carried out as part of the Planning Application for the proposed Luas Green Line: Extension from Broombridge to Charlestown.

While most areas at low risk of flooding (i.e., Flood Zone C), some sections of the Proposed Scheme site are at moderate to high risk of fluvial flooding. Work areas of the Scheme at moderate/high risk (Flood Zone B or A) of flooding include:

- Area near Tolka River is within Flood Zone A from fluvial source.
- The risk of flooding from groundwater source was determined as low.
- Mechanical/Fluvial Flooding from the Royal Canal is low.
- The abutments will be set at a level of 22.55mOd, and is 23.76mOD.

However, the groundwater flood risk is likely indicative of a shallow water table due to the site's proximity to the sea and hence dewatering may be required during construction.

Therefore, some of the sections of the development are either in fluvial Flood Zone A or B. With the type of development being "essential infrastructure" (i.e., highly vulnerable), a justification test was completed and determined that the proposal satisfied all the requirements.

The scope of the Proposed Scheme is in keeping with the existing profile and does not increase the risk of flooding elsewhere as illustrated in Section 5.1. However, as sections of the area are situated in flood risk zones, the proposal includes drainage design measures including surface water management and SUDS measures including bioretention, rain gardens, filter strips, green trackform, integrated constructed wetland (ICW), SuDS, tree pits are incorporated in the design.

The Contractor will maintain awareness of rainfall event and weather forecasts from Dublin City Council, Finglas County Council and Met Eireann as appropriate during construction, as is standard practice.

In conclusion, this FRA has demonstrated that the risk of fluvial flooding will be managed by constructing the proposed development road level above the recommended level of 23mOD and maintaining the existing floodplain of the Tolka Valley Park region. Also, the risks relating to flooding due to groundwater and pluvial flooding to the Proposed Development are moderate and can be managed during construction and operation of the Proposed Scheme and therefore comply with DoEHLG / OPW.

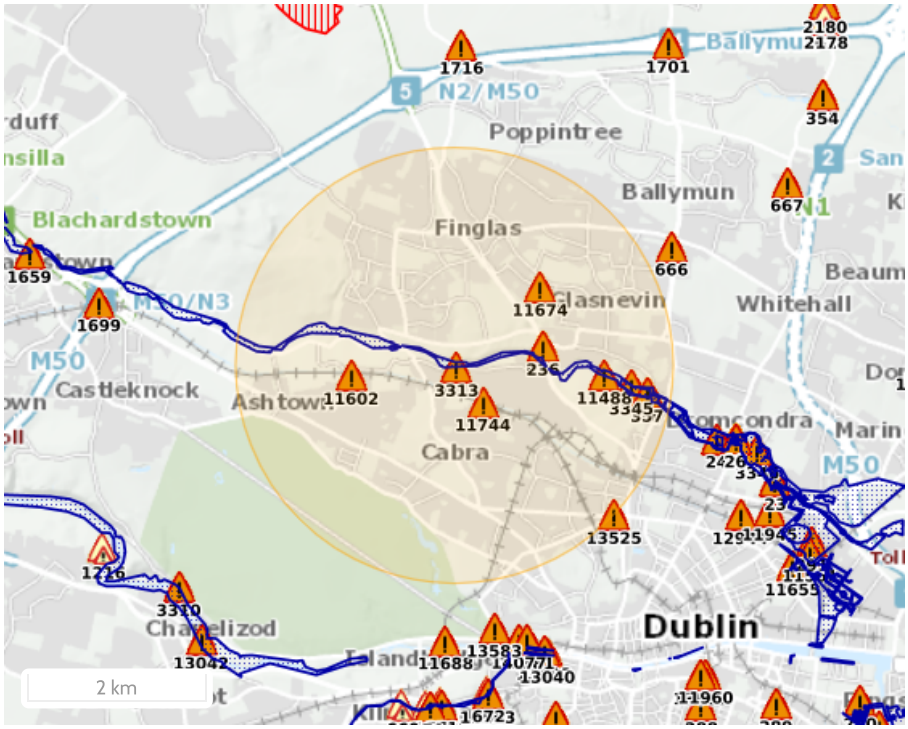
Appendix 1: OPW Summary of Past Flood Events

Past Flood Event Local Area Summary Report

OPW Oifig na nOibreacha Poiblí Office of Public Works

Report Produced: **24/4/2023 15:31**

This Past Flood Event Summary Report summarises all past flood events within 2.5 kilometres of the map centre.



Map Legend

- Single Flood Event
- Recurring Flood Event
- Past Flood Event Extents
- Drainage Districts Benefited Lands*
- Land Commission Benefited Lands*
- Arterial Drainage Schemes Benefited Lands*

* Important: These maps do not indicate flood hazard or flood extent. Their purpose and scope is explained on Floodinfo.ie

13 Results

	Name (Flood_ID)	Start Date	Event Location
1.	Tolka Ballyboggan Road Nov 2000 (ID-3313) **Additional Information:** Reports (1) Press Archive (0)	05/11/2000	Approximate Point
2.	Flooding at Broombridge Railway Station on 24th October 2011 (ID-11744) **Additional Information:** Reports (1) Press Archive (0)	23/10/2011	Exact Point
3.	Tolka River 24th Oct 2011 Botanic Gardens (ID-11488) **Additional Information:** Reports (1) Press Archive (0)	23/10/2011	Approximate Point
4.	Tolka and Finglas Rivers August 1984 (ID-236) **Additional Information:** Reports (2) Press Archive (0)	25/08/1984	Exact Point
5.	Finglas November 1965 (ID-675) **Additional Information:** Reports (1) Press Archive (2)	25/11/1965	Approximate Point
6.	Tolka Glasnevin August 1986 (ID-3345) **Additional Information:** Reports (2) Press Archive (0)	24/08/1986	Approximate Point

	Name (Flood_ID)	Start Date	Event Location
7.	Flooding at Dublin City on 15/06/2016 (ID-13525) **Additional Information:** Reports (0) Press Archive (0)	15/06/2016	Approximate Point
8.	Tolka November 2002 (ID-5) **Additional Information:** Reports (143) Press Archive (13)	13/11/2002	Area
9.	Tolka December 1954 (ID-4) **Additional Information:** Reports (16) Press Archive (9)	08/12/1954	Area
10.	Flooding at Glendhu Park, Cabra, Dublin 7 on 24th Oct 2011 (ID-11602) **Additional Information:** Reports (1) Press Archive (0)	23/10/2011	Approximate Point
11.	Flooding at Ballygall Crescent and Fairways Green, Finglas, Dublin 11 on 24th Oct 2011 (ID-11674) **Additional Information:** Reports (1) Press Archive (0)	23/10/2011	Exact Point
12.	Tolka Jan 2005 (ID-357) **Additional Information:** Reports (1) Press Archive (0)	07/01/2005	Approximate Point
13.	Tolka Nov 1968 (ID-27) **Additional Information:** Reports (5) Press Archive (1)	24/11/1968	Approximate Point

APPENDIX 2: Dublin City Development Plan SFRA Flood Map

Comhairle Cathrach
Bhaile Átha Cliath
Dublin City Council

Dublin City Development Plan 2022-2028

Map A

MAP A	MAP B	MAP C
MAP D	MAP E	MAP F
MAP G	MAP H	

LAND USE ZONING OBJECTIVES[4]

- Zone Z1 Sustainable Residential Neighbourhoods
- Zone Z2 Residential Neighbourhoods (Conservation Areas)
- Zone Z3 Neighbourhood Centres
- Zone Z4 Key Urban Villages / Urban Villages
- Zone Z5 City Centre
- Zone Z6 Employment / Enterprise
- Zone Z7 Employment (Heavy)
- Zone Z8 Georgian Conservation Areas
- Zone Z9 Amenity / Open Space Lands / Green Network
- Zone Z10 Inner Suburban and Inner City Sustainable Mixed-Uses
- Zone Z11 Waterways Protection
- Zone Z12 Institutional Land (Future Development Potential)
- Zone Z14 Strategic Development and Regeneration Areas (SDRAs)
- Zone Z15 Community and Social Infrastructure

SPECIFIC OBJECTIVES

- Conservation Areas
- Architectural Conservation Areas
- Protected Structures. [RPS takes precedence]
- Record of Monuments and Places (RMP) as Established under Section 12 of the National Monuments (Amendment) Act 1994*
- Record of Monuments and Places (RMP) as Established under Section 12 of the National Monuments (Amendment) Act 1994*
- National Monuments*
- COMAH establishments (SEVESO establishments)
- LAP (Local Area Plan) & SDZ (Special Development Zone)
- Dublin Airport Outer Public Safety Zone
- Dublin Airport Noise Zones

ROADS

Roads, Street and Bridge Schemes

FLOOD ZONES

- Flood Zone A
- Flood Zone B
- Defended

Refer to OPW website – FloodInfo.ie

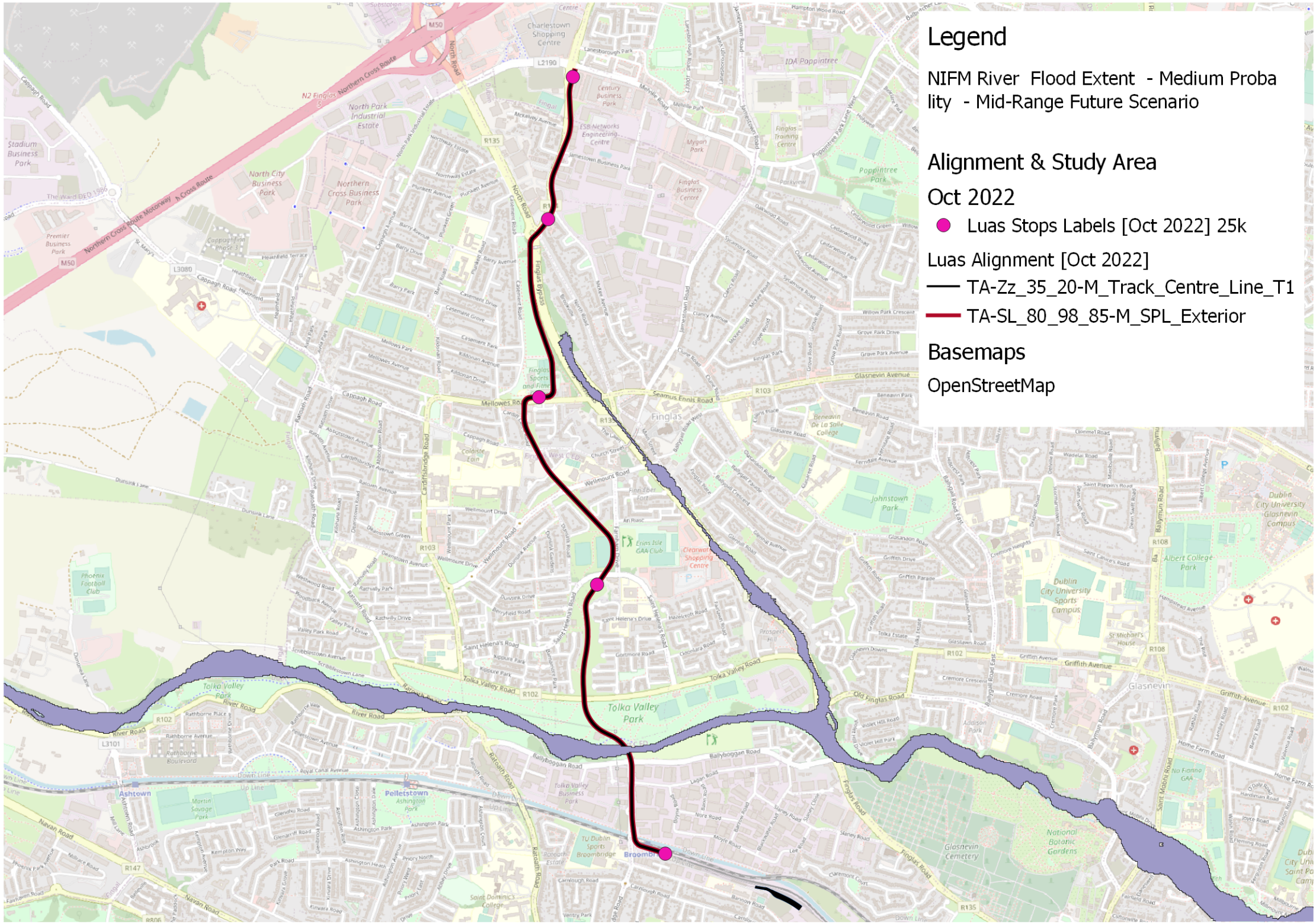
1. Map to be read in conjunction with the written statement
2. Roads objectives are shown diagrammatically
3. *See Record of Monuments and Places (RMP) at https://www.archaeology.ie/publication-forms-lgislation/record-of-monuments-and-places.ie For updated information see the Historic Environment Viewer at https://maps.archaeology.ie/HistoricEnvironment/ The RMP does not include all known archaeological sites and monuments, given that further such sites and monuments are found on an ongoing basis. For that reason, it is very important (in the context of considering proposed development) to take account of all information available on the Historic Environment Viewer (HEV)
4. See written statement (Chapter 14) for full zoning text

City Boundary

Scale: 0 100 200 300 400 500 metres

John O'Hara
Dublin City Planner

APPENDIX 3: NIFM Fluvial Flood Extent Map


Legend
NIFM River Flood Extent - Medium Probability - Mid-Range Future Scenario
Alignment & Study Area
Oct 2022
Luas Stops Labels [Oct 2022] 25k
Luas Alignment [Oct 2022]
TA-Zz_35_20-M_Track_Centre_Line_T1
TA-SL_80_98_85-M_SPL_Exterior
Basemaps
OpenStreetMap

APPENDIX 4: OPW Flood Event Reports

Flooding at Broombridge Railway Station, Cabra, Dublin 7. 24th October 2011

The information contained in this report has been extracted from information submitted to The Office Of Public Works (OPW) by Iarnród Éireann/Irish Rail.

- **Location and date of flood event:**

Location: Broombridge Railway Station, Cabra, Dublin 7.

Irish Grid Co-ordinates – 313,365 237,1222

This flooding event started on the 24th October 2011.

- **Source and cause:**

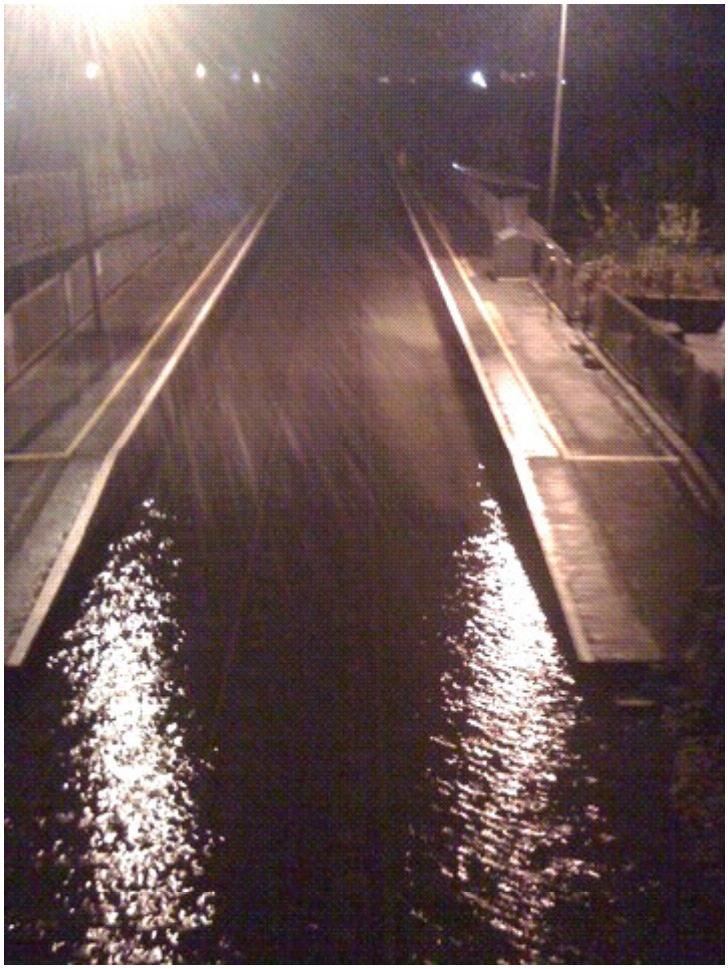
The canal overflowed which may have been due to a blockage at Glasnevin. The drainage on the road was blocked or was unable to cope with the volume of water and it flowed in to the station. The drains from the local housing estates are in the direction of the railway, which may have impacted on the flood.

- **Impacts of flooding event:**

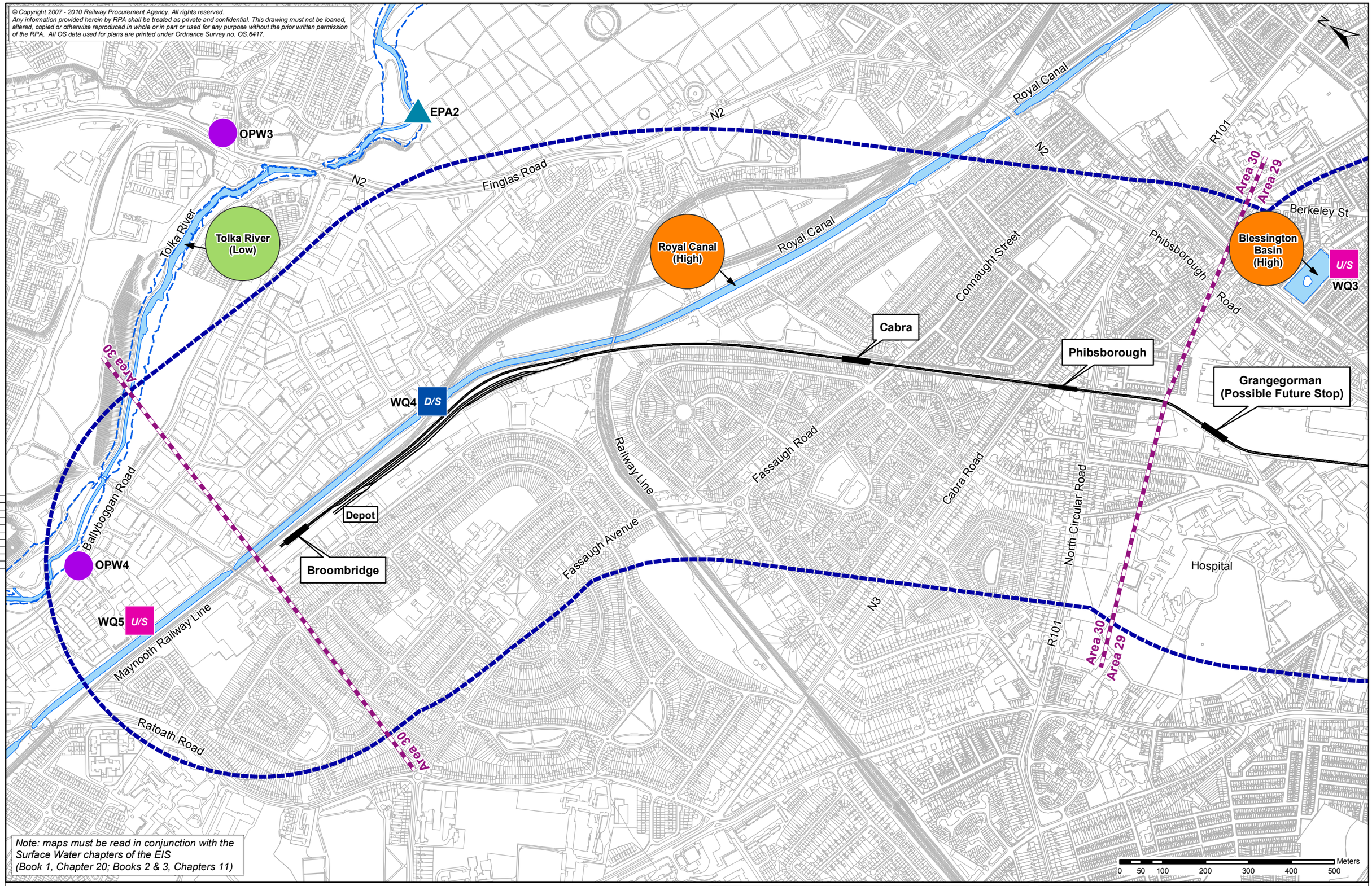
Impacts to transport infrastructure:
Rail – Sligo Intercity and Maynooth commuter services were suspended due to flooding at Broombridge Station.

- **Additional information:**

A photograph of the flood and a map of the area are attached.



Broombridge Station – October 2011



Note: maps must be read in conjunction with the Surface Water chapters of the EIS (Book 1, Chapter 20; Books 2 & 3, Chapters 11)

- Proposed Alignment
- Proposed Stops
- Study Area
- Area Divides (Area 29, Area 30)
- Luas Green Line
- Luas Red Line
- Waterbody
- EPA Monitoring Station
- Upstream Monitoring Location (U/S)
- Downstream Monitoring Location (D/S)
- OPW Flood Points
- OPW Flood Zones

Baseline Rating

- Very Low (VL)
- Low (L)
- Medium (M)
- High (H)
- Very High (VH)

RPA Railway Procurement Agency
Gníomhaireacht Um Fháil Iarnród
Parkgate Business Centre, Parkgate Street, Dublin 8, Ireland.
Phone +353 1 646 3400
Fax +353 1 646 3401
www.rpa.ie

LUAS

FEHILY TIMONEY & COMPANY

PREPARED: SOR	REVIEWED: DB	APPROVED: BG
	CHECKED: DB	DATE: April 2010
		SCALE: 1:8,500

LOCATION: Former Broadstone railway cutting to Broombridge
Sheet 2 to 2

SPECIALIST TOPIC:
Surface Water Baseline

AREA NO.	PLAN NO.	SUBJECT.
Area 30	BXD - EIS Book 4	EIS

Report to
Department of the Environment & Local Government,
Fire Services and Emergency Planning Section,
Dated 10th November 2000

Prepared by Office of Deputy City Engineer Operations,
Dublin Corporation.

RE: Report on response to severe weather conditions – Dublin City 4th November 2000 to 7th November 2000.

Introduction

This report has been prepared by Dublin Corporation in order to give a general briefing on events, which took place from 4th November to 7th November 2000.

Cause of problem

The incident arose as a result of significant falls of rainfall in the Dublin Area and throughout the Country. This rainfall was of a persistent nature and in the South City was recorded as 135 mm over 24 hours (a months rain fell in a single day).

General Chronology:

TIME	LEVEL OF ACTIVITY
12.00 Saturday 4th November to 12.00 Sunday 5th November 2000	Normal deployment of emergency response crews as required to deal with complaints in relation to consequences of high persistent rainfall.
Sunday 12.00 to Monday 12.00	Escalation of level of response and resources deployed to meet exceptionally high rainfall of a persistent nature. Crisis management team in place within Dublin Corporation
Monday 12.00 to Tuesday 12.00	Major Emergency Phase activation (see note).
Tuesday 12.00 to Wednesday 12.00	Scale down of resources and clean up phase.

Road Closures

Generally the city was not badly affected by actual road closures. The City has over 1200 Km. of roads and 2400 Km. of footpaths

List of closures included:

- Rock Road at Merrion Gates for 4-5 hours.
- Knockmaroon Hill, Chapelizod closed completely and just reopened.
- Botanic Avenue, Drumcondra closed for 2 days.
- Ballyboggan Road closed for 1 day.
- Clonsaugh Road near southbound on ramp to M1 (6-10 hours).

Other than that some standing water was evident due to inability of blocked gullies to clear drainage. These did not render the roads in any way impassable. Report from Traffic Control Centre indicated that traffic movement was very light and free throughout the city.

Property affected

As far as properties are concerned less than a dozen houses were actually flooded and these are detailed in the table below. Please note however that the definition of flooding can vary and a person with a flooded garden may use the term flooded. The information is to be taken as best available not necessarily definitive.

LOCATION	**PROPERTY AFFECTED**
Richmond Road	c. 4 houses flooded low-lying location have flooded in the past.
Drumcondra	1 property (Prison officer club) flooded.
Dodder Cottages	c. 1 house flooded.
Dodder area	Dropping Well pub – car park flooded (close to building)
Chapelizod	1 House flooded St. Martins row (flooded also in the past, close to River Liffey). 1 garage flooded.
Poddle Park	Very close to houses– Gardens flooded.
Sherriff Street	Liberty trust – previous history.
Abbey Street	Pub basement affected.

Sandbags deployed

About 6000 sandbags were deployed during the incident. Sandbags were principally deployed at:

- Botanic Avenue, Drumcondra.
- St. Martins Row, Chapelizod.
- Liffey Boardwalk – openings in quay wall.

- Clontarf Road.

Depots at Bannow Road, Cabra and Marrowbone Lane were used for sandbag filling and a significant number of personal callers were given sandbags for their own use.

Evacuation

Less than 20 people were evacuated from Botanic Avenue as a result of a risk from the River Tolka. These were evacuated to the prepared evacuation point at St. Patrick's College in Drumcondra. They remained for a small number of hours and returned by their own decision to their houses. They considered that their houses would not actually be flooded and this proved to be the case. No water or sewage plants were either affected or damaged by the flood waters. Gardai were stationed Mon. night/early hours of Tue. In case of reoccurrence.

Overview of risks faced by the City

The reason for the emergency response was heavy and persistent rainfall over an extended period of time. Figures for 24 hours on the Sunday show in the Dodder Catchment approximately 130 mm of rainfall falling in a 24-hour period. The primarily areas of risk therefore centered around the rivers of Dublin and their interface with the coastal environment where tidal rise and fall was an additional influencing potential risk factor.

The following section gives a brief overview of the issues pertaining to each river.

The **River Tolka** rose to a very high level and escaped from its watercourse in the Botanic Avenue area. Water flowed from the river across a grassed area and flooded the road. Houses were at risk but not flooded. In the Richmond Road area, slightly downstream of that location, 4 houses were flooded and these were at a low-lying location. Mindful of previous flooding in the river Tolka and the interface with the high tides this was an area where significant resources were deployed to clean gullies, clean drainage systems, place sandbags, place on site monitoring and control teams, locate an evacuation centre very close to that point of risk.

River Liffey: The river Liffey rose to a very high level and flooded a house at the village of Chapelizod. The house was somewhat low-lying and may have experienced flooding in the past. The road at the base of Knockmaroon Hill was closed due to risks associated with the high river level and concerns over a wall separating the road from the river which subsequently partially collapsed.

Information presented was unable to provide significant additional information for the Co-Ordination Group who had to put in place around the clock monitoring of the river Liffey in its lowest reaches to identify any potential location for severe flooding. A number of low-lying developments at Chapelizod, Islandbridge, City centre were presented as possible risks requiring evacuation. These were constantly monitored. In the event no problem arose. However possibility of basement nightclubs, low-lying commercial centres and hotels requiring evacuation was, for a period of time, one of the major action lines being considered by the Co-Ordination Group. Action now being pursued with E.S.B. to consider options for the future.

River Poddle: This river is culverted over a large section of its length and has a limited carrying capacity for floodwaters. Flood plains are located along its length and these came into action at Poddle Park. Houses came close to being flooded but the response of the combined emergency services insured a safe outcome.

River Dodder: The river is characterised by flash flooding of an exceptionally high intensity. This catchment suffered considerable distress during the flooding associated with hurricane Charlie in 1986. Sections of the river around Mount Carmel Hospital can escape their banks and flood onto low-lying roads. In the upper catchment however, the risk is greatest where man made dams at Bohernabreena are located. In the event of severe persistent rainfall of a very high intensity the risk factors associated with dam failure increase. It should be noted that plans are with the Department of the Environment & Local Government awaiting approval for construction works which will reduce this level of risk to an acceptable level. It is anticipated that these construction works, which have had to go through a planning process/public sector procurement process, etc. should be constructed fully within 2 years.

Dublin Corporation has introduced a new stormwater policy for new developments to reduce high runoff leading to flooding.

In conclusion, the City was not badly affected, the activation of the normal emergency planning arrangements and the Major Emergency Plan worked very well and the success was due to the skill and dedication and effort of over 2000 people who worked as an integrated team.

_____

Deputy City Engineer.

APPENDIX 5: SFRA for Area 23

Area: 23. Tolka: Finglas Road – City Boundary	
	
For Land Use Zoning Maps Overlaid with Flood Zones see Dublin City Council Development Plan 2022 - 2028, Flood Map A.	
Area Description	This area on the Tolka River goes from Finglas Road Bridge through the Tolka Valley Park to the city boundary. It runs adjacent to Ballyboggan Road and Rivermount. It also includes the Finglas Stream. Development in this area is parkland with some residential to the south. The park is a natural flood plain.
SDRAs within this Area	N/A
Benefitting from Defences (flood relief scheme works)	None. The park provides a natural flood plain.
Sensitivity to Climate Change	Low – there is little difference between Flood Zones A and B, and is within areas of open space.
Residual Risk	Not applicable.
Historical Flooding	The flood maps attached are consistent with previous flooding of this section of the River Tolka in 1954 and 2002.
Surface Water	Run-off from the parkland is natural and should be retained as such. All developments shall have regard to the Pluvial Flood Maps in their Site Specific Flood Risk Assessment, see FloodResilienCity Project, Volume 2 City Wide Pluvial Flood Risk Assessment at http://www.dublincity.ie/main-menu-services-water-waste-and-environment-drains-sewers-and-waste-water/flood-prevention-plans.

Area: 23. Tolka: Finglas Road – City Boundary
Commentary on Flood Risk: The flood extents indicate flow paths generally coming directly out of the river channel and finding their way back into the river channel slightly downstream. The Finglas Stream flows into the Tolka River near Finglas Road. The flood maps were produced based on the Greater Dublin Strategic Drainage Study and have been verified by the OPW CFRAM Study team as being largely consistent with current methodologies and they have been checked against historic flooding in the area.
Development Options: Most of the flood cells are in parkland flood plains which must be retained, only water compatible development should be allowed here. Community, commercial and residential development (some infill) would be a natural extension of existing development just upstream of Finglas Road. The Core Strategy identifies the Dublin Industrial Estate as a 'Future Development Area' in the City – see section 2.4.5 of the Written Statement. It is the intent of the Council that, following feasibility studies, that these wider industrial lands will be brought forward as regeneration lands during the lifetime of the Development Plan. Any such change would require an amendment to the zoning of the lands and would be subject to a SFRA as part of that process.
Justification Test for Development Plans • The area within Flood Zones A and B is within park land (water compatible) so the Justification Test is not applicable. • The floodplain lands should be retained as their current water compatible uses.
Conclusion: Justification Test <u>Not Applicable</u>

Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Údarás Náisiúnta Iompair
National Transport Authority

BARRY TRANSPORTATION
egis GROUP

egis

Project Ireland 2040
Building Ireland's Future