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Appendix N

Flood Risk Assessment



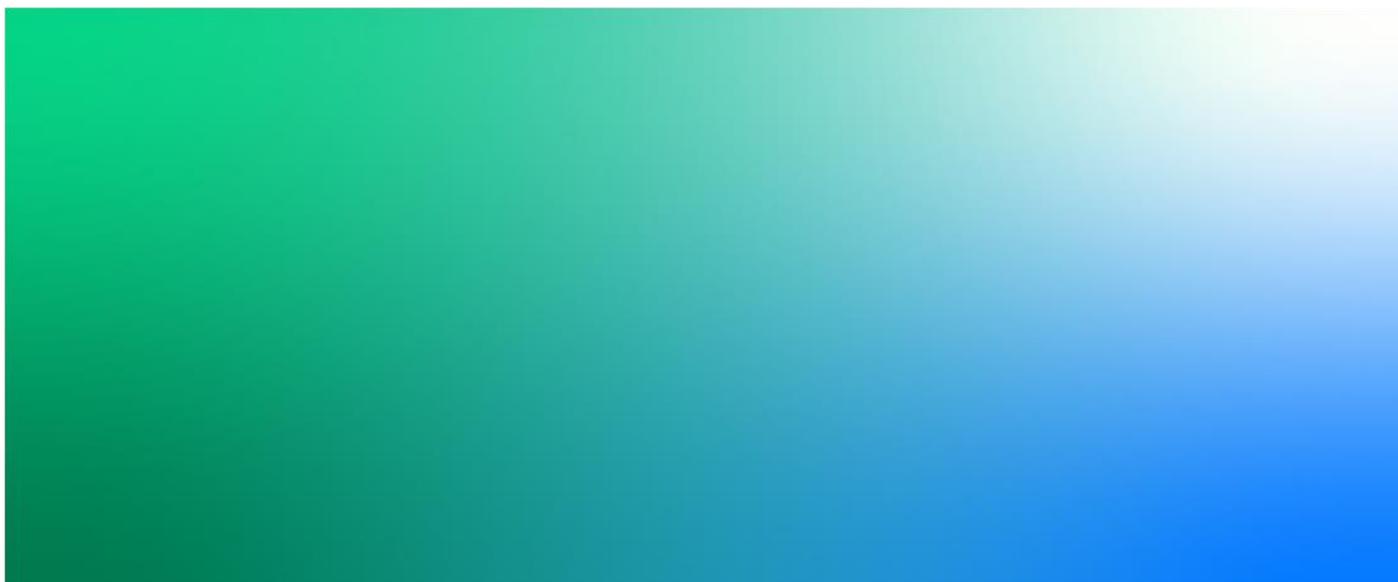
Jacobs

BusConnects Dublin Core Bus Corridor Infrastructure Works – Package B

Route No.7 Liffey Valley to City Centre Flood Risk Assessment

21/06/2022

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Appendix A. Information Sources Checklist

Appendix B. OPW CFRAM Mapping

1. Introduction & Background

1.1 Project Background

In June 2018 the National Transport Authority (NTA) published the Core Bus Corridors Project Report. The report was a discussion document outlining proposals for the delivery of a core bus corridor network across Dublin. It set out the vision for the provision of 230km of dedicated bus lanes and 200km of cycle lanes/tracks on 12 key bus corridors.

The proposed development consists of 12 radial core bus corridors, refer to Figure 1.1.

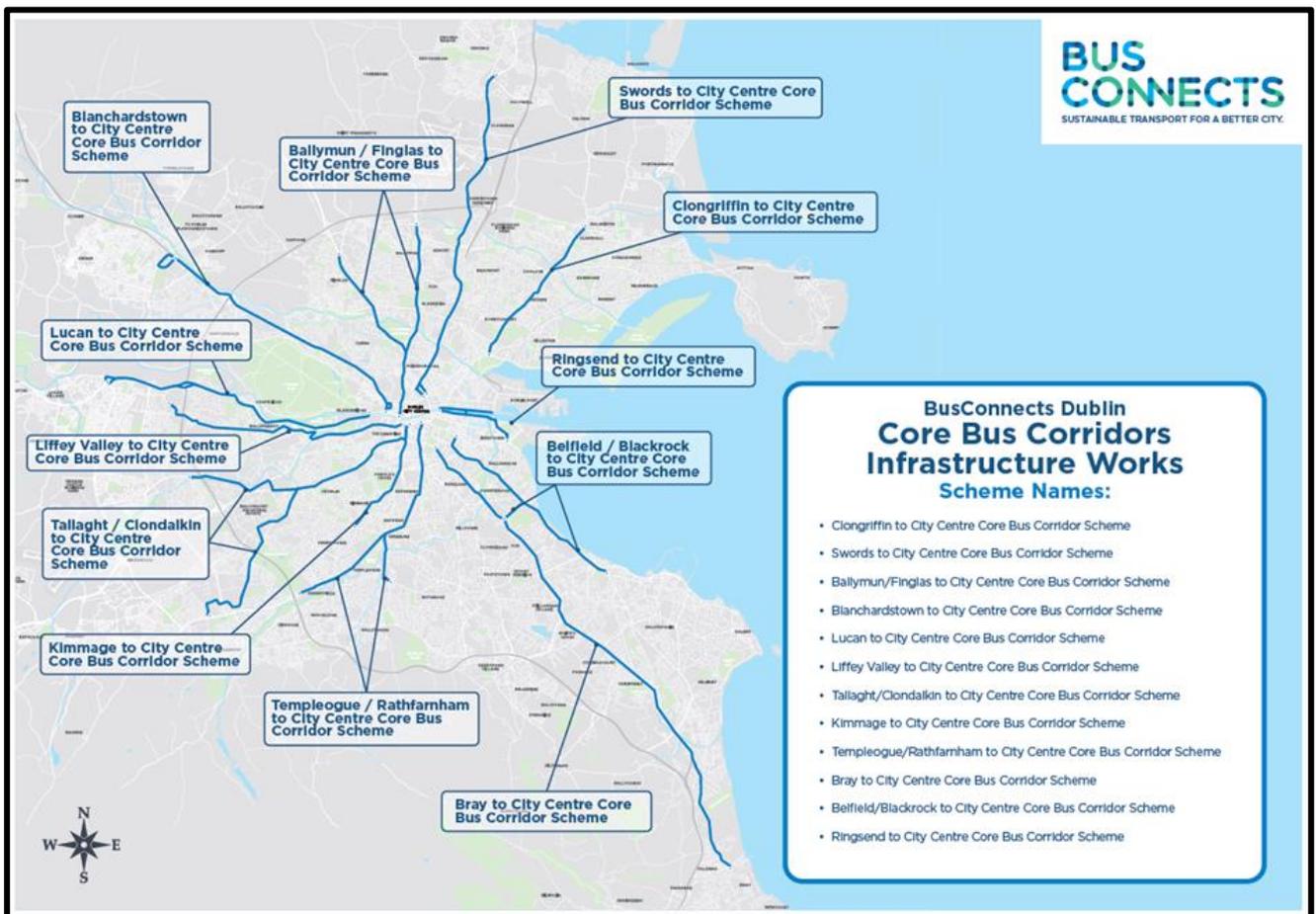


Figure 1.1 Core Bus Corridor Infrastructure

Each bus corridor is subject to an independent flood risk assessment. This flood risk assessment relates specifically to Route No.7: Liffey Valley to City Centre, which is highlighted in Figure 1.1.

The objective of this report is to assess the level of flood risk to the proposed development. The assessment complies with Stage 1 and Stage 2 flood risk assessment as set out in 'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (Office of Public Works, 2009).

As outlined in the report, a Stage 3 flood risk assessment was not considered to be necessary.

1.2 Works Description

The Liffey Valley Core Bus Corridor (CBC) scheme (herein after called the **Proposed Scheme**), refer to Figure 1.2, commences on the Fonthill Road. The route continues along the distributor road to the west and south of Liffey Valley Shopping Centre in a southerly direction towards Coldcut Road. From here it joins the R833 Coldcut Road

and continues to the bridge over the M50, subsequently turning onto the R833 Ballyfermot Road. The Proposed Scheme then travels through Ballyfermot Village and continues onto the Sarsfield Road, whilst city bound general traffic is diverted via Le Fanu Road and Kylemore Road back to Ballyfermot Road.

The Proposed Scheme continues along Ballyfermot Road and Sarsfield Road, turning right at the junction with Con Colbert Road before turning right again onto Grattan Crescent. At the intersection of Grattan Crescent and Emmet Road the Proposed Scheme travels along Emmet Road, Old Kilmainham, Mount Brown and James’s Street. From here the Proposed Scheme joins Thomas Street, Cornmarket and along High Street to the junction with Nicholas Street and Winetavern Street where it will join the existing traffic management regime in the City Centre and terminates at the end of High Street.

Priority for buses is provided along the entire route, consisting primarily of dedicated bus lanes in both directions with alternative measures proposed at particularly constrained locations. Refer to the general arrangement drawings for the Proposed Scheme.

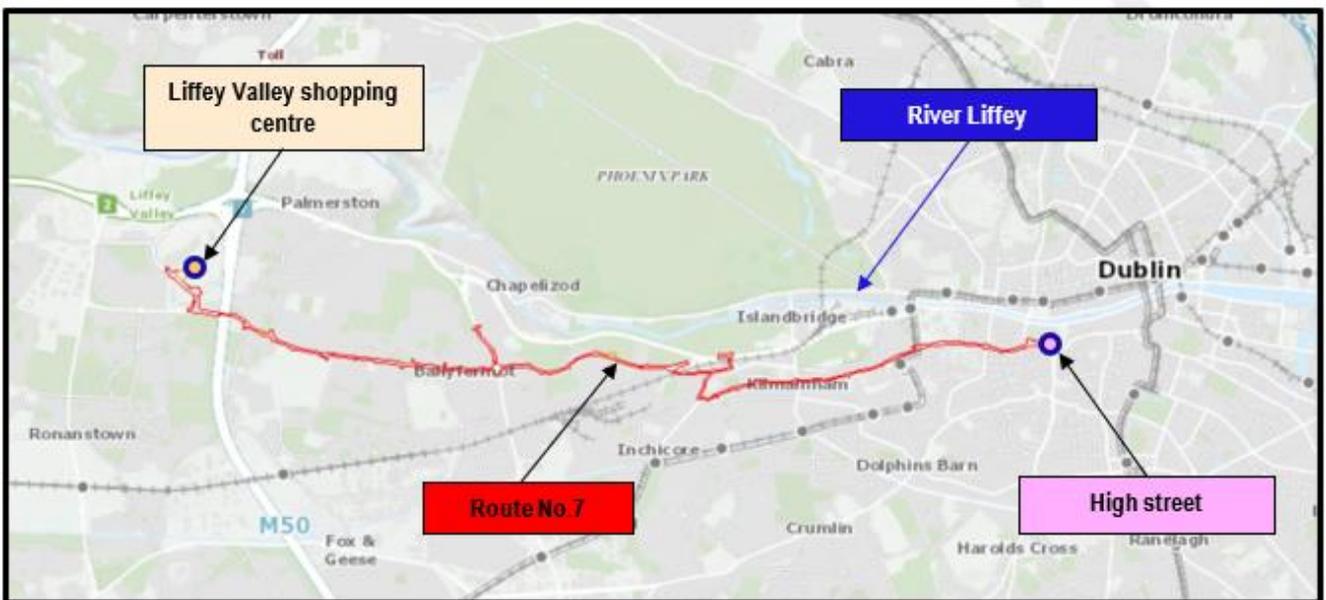


Figure 1.2 Location Map of Route No.7: Liffey Valley to City Centre

The Core Bus Corridor is split into five sections which are shown in Figure 1.3 and described below.

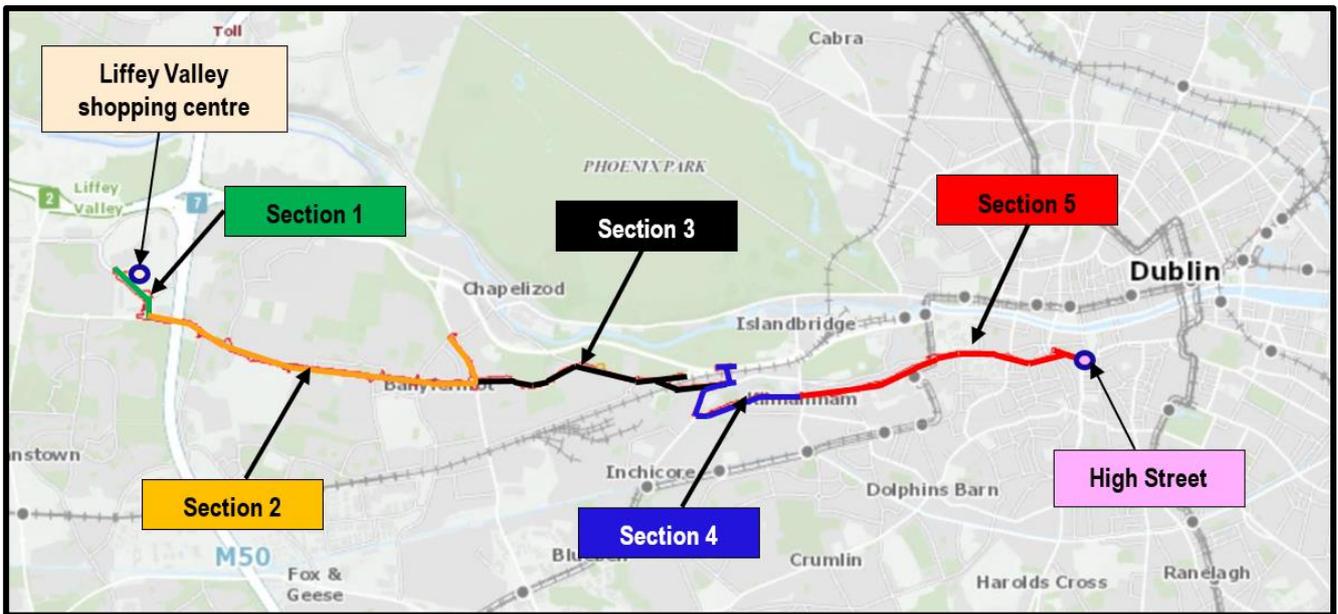


Figure 1.3 Route No.7: Liffey Valley to City Centre. Sections

1.2.1 Section 1: Liffey Valley Shopping Centre to Coldcut Road Junction

It is proposed to commence the Proposed Scheme on Fonthill Road at the tie in with the Liffey Valley Shopping Centre Bus Interchange and Road Improvement Scheme. Between Fonthill Road and the junction with Coldcut Road, it is proposed to provide a continuous bus lane in each direction. Cycle tracks can be accommodated in both directions through dedicated cycle tracks. These proposals can be provided by widening into the central median, modifying the existing junctions and utilising existing green space adjacent to the road. The existing roundabout, one where Coldcut Road meets Fonthill Road and another heading towards Liffey Valley Shopping Centre on Fonthill Road are to be developed into signalised junctions and provide improved infrastructure for cyclists and pedestrians.

1.2.2 Section 2: Coldcut Road Junction to Kylemore Road Junction

It is proposed to modify the Coldcut Road / Liffey Valley Entrance Road to accommodate the following lanes:

- 2 no. bus lanes on Coldcut Road (westbound and eastbound);
- 3 no. general traffic lanes (westbound, eastbound, and right turn lane for accessing Liffey Valley); and
- Cycle tracks and footways in both directions.

As Coldcut Road crosses over the M50, the carriageway width is restricted. To overcome this restriction and maintain bus priority over this section, it is proposed to provide Signal Controlled Bus Priority on both sides of the bridge crossing. The traffic signals at this location will be sequenced to ensure bus priority. To accommodate these changes, it is proposed to encroach on the green space to the east of the existing structure.

Between this bridge crossing and the junction with Ballyfermot Road, it is intended to maintain a single bus lane and general traffic lane in both directions. It is proposed to modify the Cloverhill Road and Kennelsfort Road junctions to provide improved facilities for cyclists and pedestrians. To accommodate these changes, it is proposed to utilise limited land take along the green space adjacent to Palmers Walk, Palmers Court and Palmers Drive area.

On Ballyfermot Road, it is proposed to maintain one single bus lane, one general traffic lane, and a cycle track in both directions. To accommodate this improved infrastructure, it may be necessary to acquire limited land take at the following locations:

- Cherry Orchard Industrial Estate;
- Cherry Orchard Hospital;
- Entrance Cherry Orchard Filling Station; and
- At junction with Le Fanu Road.

It is also proposed to amalgamate the main Ballyfermot Road and the access roads. This would provide sufficient space to improve the existing public transport infrastructure. Public Realm works, additional tree planting and provision for parallel parking are proposed where the access road will be modified.

At the Le Fanu Road junction, it is proposed to divert city bound traffic on to Le Fanu Road. The section of Ballyfermot Road between Le Fanu Road and Kylemore Junction will be restricted to one bus lane in both directions and one outbound general traffic lane. Local access on Ballyfermot Road between La Fanu Road and Colepark Road has been maintained. City bound traffic will be redirected up Le Fanu Road and down Kylemore Road. It is intended to provide a cycle track in both directions on this section of the Ballyfermot Road and on Kylemore Road. Eastbound local access will still be permitted on Ballyfermot Road up to the junction with Colepark Avenue.

1.2.3 Section 3: Kylemore Road Junction to Inchicore Road Junction

It is proposed to upgrade the existing roundabout junction on Kylemore Road / Ballyfermot Road to a signalised junction and provide improved infrastructure for cyclists and pedestrians. Between Kylemore Road and Markiewicz Park, it is proposed to maintain one bus lane, one general traffic lane and one cycle track in both directions. To accommodate this modified cross section, it is anticipated that limited land take will be required at the following locations:

- Limited green space from St. Raphael's and St. Gabriel's Primary School; and
- Limited green space from the former De La Salle National School/ Mount La Salle.

To reduce the impact on Markiewicz Park and the adjacent residential properties, it is proposed to provide Signal Controlled Bus Priority for citybound buses with the traffic signals sequenced to ensure full bus priority. The citybound bus lane would then be reintroduced at St. Laurence's Road. To accommodate the revised arrangements, it is intended to close the junction of O'Hogan Road and Ballyfermot Road as part of the implementation of the Signal Controlled Bus Priority on Ballyfermot Road. O'Hogan Road can still be accessed via Garryowen Road and Decies Road. The proposals will require land take at the following locations:

- Limited land take at Markiewicz Park;
- Boundary lands at the Steeples Estate;
- Private frontages between O'Hogan Road and St. Laurence's Road;
- Boundary lands on Longmeadows Pitch and Putt / Longmeadow Park; and
- Private frontages between First Avenue and Saint Mary's Avenue West.

Between Sarsfield Road and Chapelizod Bypass it is proposed to extend the proposed cycle track to tie into the proposed cycle infrastructure that forms part of the Lucan to City Centre Core Bus Corridor Scheme. If the cycling infrastructure proposed as part of the Lucan to City Centre Core Bus Corridor Scheme was delayed, cyclist have an alternative route to the City Centre via Sarsfield Road, Inchicore Road, Kilmainham Lane and Bow Lane where they will re-join the route and continue along James's St and Thomas Street.

1.2.4 Section 4: Inchicore Road Junction to South Circular Road Junction

It is proposed to change Memorial Road from one way to two way for general traffic. Traffic will also be able to turn right from the Chapelizod Bypass to Memorial Road. It is intended to provide cycle track in both directions on Memorial Road. On Inchicore Road, between Memorial Road and Grattan Crescent, it is proposed to retain the existing lane configuration.

On Grattan Crescent, it is proposed to provide bus lanes in both directions and one general traffic lane in a southbound direction. Northbound traffic will be permitted up to the junction with the CIE Inchicore Works to maintain local access. It is anticipated that the existing footway will be widened, and a new crossing will be provided between Grattan Crescent Park and Inchicore National School. Several of the car parking spaces adjacent to the entrance to Grattan Park will be retained. This design revision has been implemented due to feedback received as part of the Public Consultation carried out on the EPR published in January 2019.

At the junction of Emmet Road and Tyrconnell Road, general traffic turning right from Emmet Road to Grattan Crescent will be for access to Inchicore Works only.

Between St. Vincent's Street West and South Circular Road, Emmet Road is proposed to be reconfigured to provide a bus lane and general traffic lane in both directions. To facilitate this wider road configuration some local on-street parking will need to be removed, but a focus has been to retain as much as possible.

1.2.5 Section 5: South Circular Road Junction to High Street

To maintain bus priority on Old Kilmainham / Mount Brown, it is proposed to provide a staggered bus gate which will operate in the AM and PM peaks. This bus gate would prevent general through-traffic using Old Kilmainham/Mount Brown; however, it will not impact access to the Children's Hospital, St James's Adult Hospital or the locals area.

Between the St. James' Adult Hospital Entrance and the Junction with Bow Lane West, it is proposed to retain the existing road layout. From Bow Lane West to High Street, it is intended to provide continuous cycle tracks, a bus lane where possible and general traffic lane in both directions. Bus priority is provided via a combinations of bus lanes, signals controlled priority and by the reduction in general traffic in the area as a result of the bus gate in Mount Brown.

At the Cornmarket junction the priority has been changed from High Street / Thomas Street to High Street / Bridge Street Upper. The Proposed Scheme will join the prevailing City Centre traffic management regime at the junction with Nicholas Street and Winetavern Street.

1.3 Report Structure

The flood risk assessment is structured as follows:

- Chapter 2 sets out the Planning Guidelines considered;
- Chapter 3 sets out the Flood Risk Assessment Methodology;
- Chapter 4 outlines the findings of the Stage 1 flood risk assessment;
- Chapter 5 presents the findings of the Stage 2 flood risk assessment;
- Chapter 6 details the potential flood risk implications arising from the work and the proposed mitigation measures;
- Chapter 7 assesses the proposed works in accordance with the Justification Test; and
- Chapter 8 presents the conclusions and recommendations.

2. Planning Guidelines

2.1 The Planning System and Flood Risk management Guidelines for Planning Authorities

The Planning System and Flood Risk Management Guidelines for Planning Authorities 'introduce comprehensive mechanisms for the incorporation of flood risk identification, assessment and management into the planning process.'

The Guidelines set out methodology to be used for the flood risk assessment for the proposed development is based on the FRM Guidelines which require the planning system at national, regional and local levels to:

- Avoid development in areas at risk from flooding, particularly floodplains, unless there are proven wider sustainability grounds that justify development. Where this is the case development must be appropriate and flood risks must be effectively managed to reduce the level of risk;
- Adopt a Sequential Approach to flood risk management when assessing the locations for new development based on avoidance, reduction, and mitigation of flood risk; and
- Incorporate flood risk assessment into planning application decisions and appeals.

2.2 Dublin City Development Plan – Strategic Flood Risk Assessment (2016-2022)

The Strategic Flood Risk Assessment (SFRA) provides 'an area wide assessment of all types of significant flood risk to inform strategic land use planning decisions.

The assessment presents the key flood management policies and objectives that must be followed by all new developments. It also identifies 30 sites within flood zones A and B and covers acceptable grounds for justification tests for development plans within each site. Where the proposed development is within or proximate to these sites, further detail is provided within this report.

The proposed development will need to demonstrate compliance with the overarching objectives and recommendations of the SFRA stated in Table 2.1.

Table 2.1 Objectives and recommendations of the SFRA

Dublin City Development Plan SFRA Objective	Proposed Scheme Approach to Compliance
Section 4.5 of the SFRA covers major developments within flood zone A and B. It is not appropriate for new highly vulnerable development to be located on greenfield land within flood zone A or B. Regeneration of already urbanised areas within zones A and B may be justified.	Proposed Scheme comprises extension to and/or modification of the existing highway to accommodate improved bus, cycle and pedestrian routes. Extension of the road onto adjacent greenfield land is only undertaken where the works cannot be accommodated within the existing highway extent or for the provision of Sustainable Drainage Measures
Section 4.6 of the SFRA covers highly vulnerable development in Flood Zone A and B. It states that "Proposals for development that results in a loss of fluvial floodplain within undefended flood zone A must also demonstrate that compensatory storage can be provided on a level for level basis."	No works are undertaken that result in a change in ground level leading to a loss of functional floodplain. Sustainable Drainage Measures are also implemented to ensure no increase in existing runoff rates
Section 4.10 of the SFRA covers climate change. It states that "For most development...the medium-range future scenario (20% increase in flows and/or 0.5m increase in sea level and/or 20% increase in rainfall depth) is an appropriate consideration."	The impacts to and arising from the Proposed Scheme are assessed against the medium range future scenario for climate change

2.3 South Dublin County Council Development Plan – Strategic Flood Risk Assessment (2016-2022)

The Strategic Flood Risk Assessment (SFRA) provides 'an area wide assessment of all types of significant flood risk to inform strategic land use planning decisions.

The assessment presents the key flood management policies and objectives that must be followed by all new developments. It also identifies 16 sites within flood zones A and B and covers acceptable grounds for justification tests for development plans within each site. Where the proposed development is within or proximate to these sites, further detail is provided within this report.

The proposed development will need to demonstrate compliance with the objective set out in section 4.4.3 of the SFRA. SDCC states that no proposals for highly vulnerable developments should be considered in flood risk areas. Any applications should be supplemented by an appropriately detailed FRA and meets the criteria of the Development Management Justification Test. A Justification Test has therefore been developed for the Proposed Scheme as it crosses Flood Zone A and B lands.

2.4 Greater Dublin Strategic Drainage Study (April 2005)

The Greater Dublin Strategic Drainage Study (GSDSDS) was commissioned in 2001 to analyse existing foul and surface water drainage systems in the local authority areas of Dublin City, Fingal, South Dublin, Dun Laoghaire – Rathdown and the adjacent catchments in Counties Meath, Kildare and Wicklow. With respect to the Proposed Scheme the applicable objectives of the study can be summarised as follow:

- To develop an environmentally sustainable drainage strategy for the region consistent with the EU Water Framework Directive;
- To provide a consistent policy framework and standards which will apply throughout the region;
- To develop tools for the effective management of the drainage systems including Geographical Information Systems (GIS), network models and digital mapping; and
- To develop the optimum drainage solution from a range of alternative scenarios having regard to the whole-life cost and environmental performance, the solution to be broken down into a set of implementation projects which can be prioritised and put in place.

An overarching Drainage Strategy was developed for the overall BusConnects project which was applied to the design of the Proposed Scheme. This incorporated the recommendations of the GSDSDS specifically in relation to the design of sustainable drainage measures and minimum drainage design standards.

3. Flood Risk Assessment Methodology

The document *Planning System and Flood Risk Management: Guidelines for Planning Authorities* published by the OPW (referred to hereafter as the FRM Guidelines) outlines the key principles that should be used for assessing flood risk to proposed development sites. It recommends that a staged approach should be adopted. The stages of appraisal and assessment are as follows:

- **Stage 1: Flood risk identification** – This stage identifies any issues (flooding or surface water management) related to the Proposed Scheme;
- **Stage 2: Initial flood risk assessment** – This stage seeks to confirm the sources of flooding identified in Stage 1. All existing information is reviewed in detail and extent of the flood risk associated with the Proposed Scheme established; and
- **Stage 3: Detailed flood risk assessment** – Where required, this stage will 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.

Owing to the nature and design of the Proposed Scheme, a Stage 3 assessment was not considered to be required. This because no works are being undertaken to modify any existing river culverts. No works are also undertaken that would result in a change in ground levels in such way as they would impact on flood risk. As noted, the works are being undertaken to modify an existing highway and it is not practicable to modify the design of the highway to reduce the existing level of flood risk within the existing site constraints.

3.1 Flood Zones

The FRM Guidelines define the following three flood zones:

- **Flood Zone A** – 'Where the probability of flooding from rivers and the sea is highest (greater than 1% annually or 1 in 100 years for river flooding or 0.5% annually or 1 in 200 years for coastal flooding)';
- **Flood Zone B** - 'Where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 years and 1% annually or 1 in 100 for river flooding and between 0.1% annually or 1 in 1000 years and 0.5% annually or 1 in 200 for coastal flooding)'; and
- **Flood Zone C** – 'Where the probability of flooding from rivers and the sea is low (less than 0.1% annually or 1 in 100 years for both river and coastal flooding (Flood Zone C covers all areas of the plan that are not in zones A or B))'.

These flood zones are used to assess the suitability of the location for a proposed development with respect to its vulnerability to flooding.

3.2 Vulnerability of BusConnects Route No.7 Corridor

In summary, the Proposed Scheme development comprises extension and/or realignment of the existing highway to accommodate improved bus, cycle and pedestrian infrastructure. Junction upgrades, new bus stops and street furniture will also be provided.

With reference to Table 3.1 of the Planning System and Flood Risk Management Guidelines for Planning Authorities, the Proposed Scheme works are assessed as "essential infrastructure such as primary transport" and therefore classed as a "highly vulnerable development". Whilst the Proposed Scheme will principally serve areas in South Dublin CC and Dublin CC, its strategic importance and potential catchment area are assessed to elevate it above the criteria of local transport infrastructure.

The FRM Guidelines require that a Justification Test be completed for any highly vulnerable developments that are located within Flood Zone A or Flood Zone B.

Document reference PL 2/2014 issued by the Department of Housing, Local Government and Heritage (9th March 2021), sought to provide clarification on the use of Flood Mapping in planning applications and application of flood zones within older developed areas of towns and cities. Document PL 2/2014 noted that where developments concern the extension to existing assets, the sequential approach cannot be used to locate them in lower areas of flood risk. The Justification Test will therefore not apply, however a commensurate assessment of the risk of flooding from the development to ensure no adverse impacts.

Given the scale and strategic importance of the Proposed Scheme to transport provision in Dublin and classification as a “highly vulnerable” development in accordance with the FRM, whilst it might not strictly be required based on PL 2/2014, an assessment of the proposed scheme against the justification test was undertaken as appropriate.

4. Stage 1 Flood Risk Identification

4.1 General

The Stage 1 Flood Risk Assessment assesses the existing flood risk to the proposed development. This is carried out as a desktop study using existing information from a number of sources. The objective is to identify whether there are potential flooding or surface water management issues for the site that require further investigation.

4.2 OPW Preliminary Flood Risk Assessment Mapping

The OPW Preliminary Flood Risk Assessment (PFRA) Maps were prepared for the purpose of initial flood risk assessment at a national level. The mapping is not considered to be suitable for assessment of flood risk to the Proposed Scheme and particularly where they have been superseded by the Catchment Flood Risk Assessment and Management ('CFRAM') Studies (see section 4.4). PFRA mapping is therefore not used in this assessment.

4.3 Historic Flood Events

The OPW National Flood Hazard Mapping website (www.floodinfo.ie) was used to identify historical flooding along the Proposed Scheme, refer to Figure 4.1.



Figure 4.1 Past flood events in close proximity to Route No.7

Five flood events were identified on or immediately adjacent to the Proposed Scheme. Further details of these flood events are provided in Table 4.1 and Figures 4.2 and 4.3 below.

Table 4.1 Flood events identified on or immediately adjacent to the Route No.7: Liffey Valley Core Bus Corridor

Location	Type	Date	Description
Turvey Avenue	River – Camac River	October 2011/ Recurring	Refer to Figure 4.2. October 2011 flood event and subsequent occasions flooding occurred due to the overtopping of Camac River. Usually caused by intense rainfall. Has resulted in damage to several properties in the area, with an apartment carpark being flooded to an estimated depth of in excess of 2m during the October 2011 flood event. Area is also susceptible to pluvial flooding during intense rainfall events. There are currently no flood defence schemes in this area
Carrickfoyle Terrace	River – Camac River	October 2011 / Recurring	Refer to Figure 4.2. October 2011 flood event and subsequent occasions flooding occurred due to the overtopping of Camac River. Usually caused by intense rainfall. Residential properties flooded. There are currently no flood defence schemes in this area.
Kearns Place	River – Camac River	October 2011 (recurring)	Refer to Figure 4.2. October 2011 flood event and subsequent occasions flooding occurred due to overtopping of Camac River. Approximately eleven residential properties were affected, and the ground floor of Kearns Court and the basement of Old Camac Court Apartments were flooded in 2011 event. Flood waters also spilled on to the road at Kearns Place for approximately 100 metres. Flooding thought to be partly due to restriction of flow at Kearns Place Bridge. There are currently no flood defences in this area.
Lady's Lane	River – Camac River	October 2011	Refer to Figure 4.2. Collapse of flood wall at this location led to Camac River overtopping its banks. Approximately twenty-nine properties were flooded. Following this, an engineered flood wall was installed by Dublin City Council at this location to provide protection against a 1% AEP event, i.e. an annual exceedance probability of 1%.
Bow Bridge	River – Camac River	October 2011 (recurring)	Refer to Figure 4.3. October 2011 flood event and subsequent occasions flooding occurred due to the overtopping of Camac River. Bowbridge Dock and Bowbridge House Apartments were reported as being flooded in the 2011 event. Flooding thought to be partly due to restriction of flow at Bow Bridge.

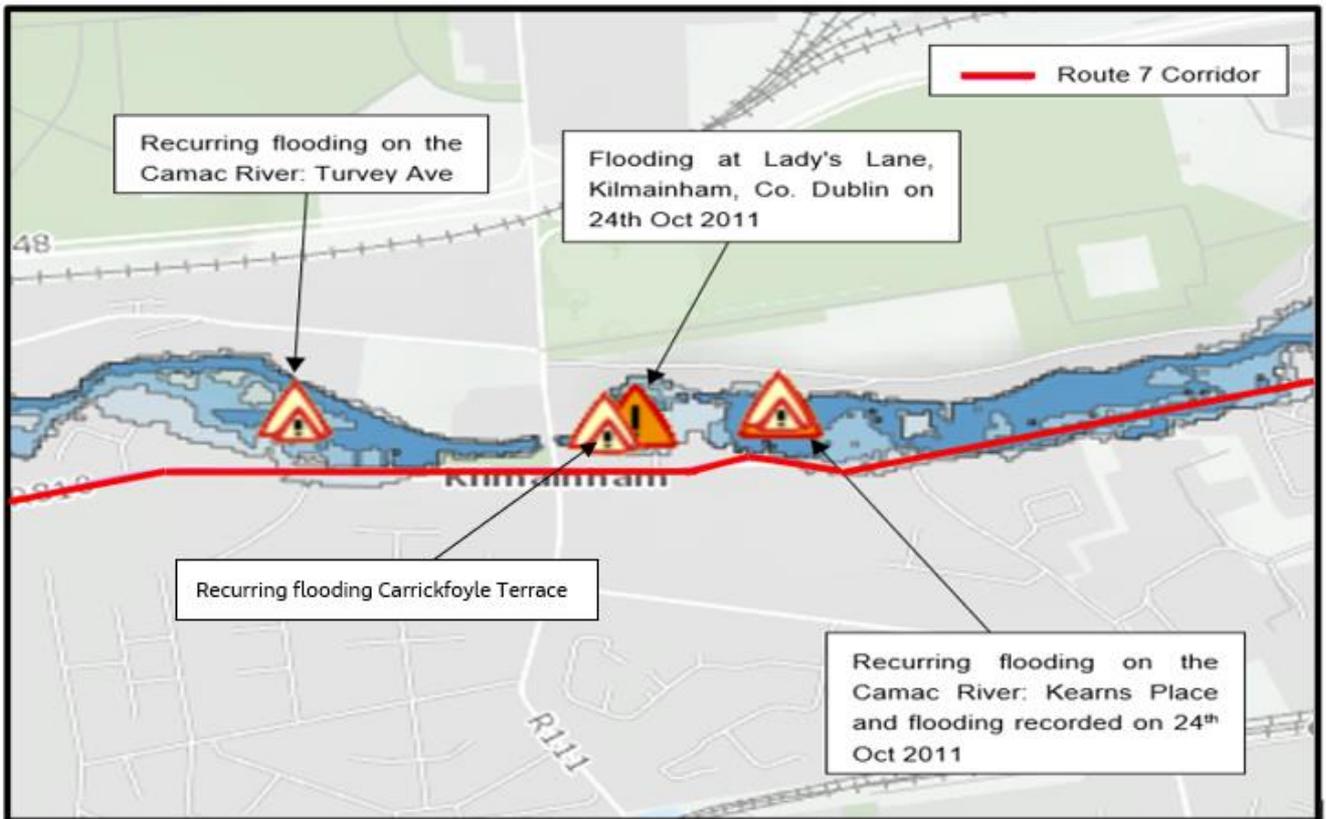


Figure 4.2 Locations of historic flooding near Emmet Road/Old Kilmainham Road

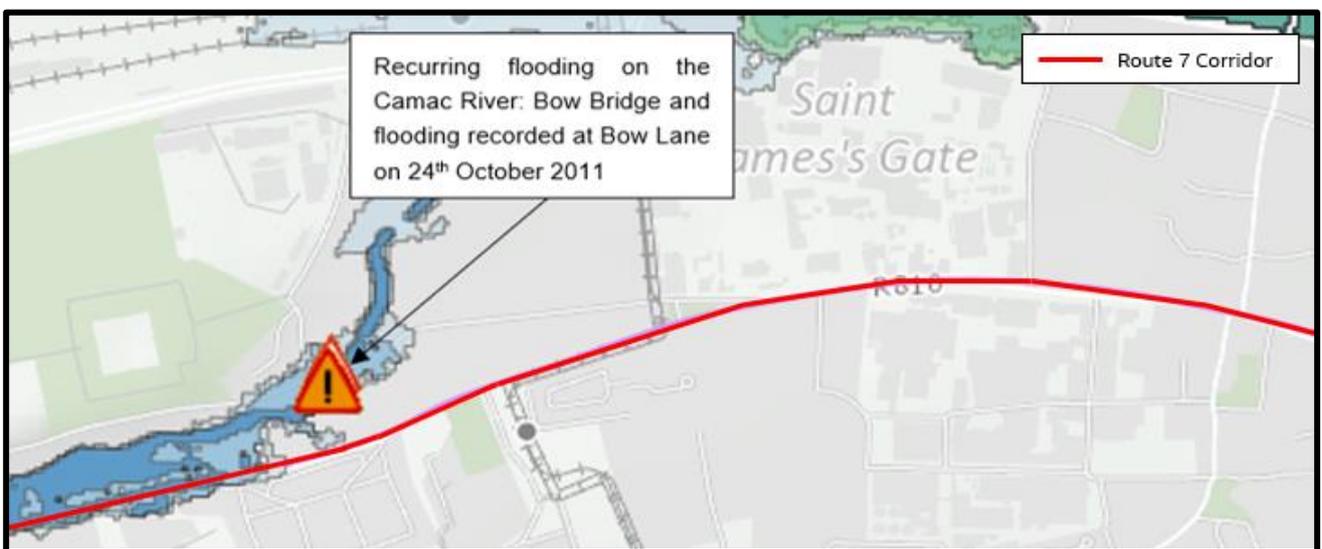


Figure 4.3 Locations of historic flooding near Old Kilmainham Road

4.4 OPW CFRAM Study Mapping

Flood risk along Proposed Scheme was assessed as part of the OPW Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study. The predicted flood extents for the Carmac River from the CFRAM study are presented in full in Appendix B, with extracts showing the predicted coastal and fluvial flood extents in Figure 4.4. This shows that the proposed route is not at risk of coastal flooding however parts of the route are at risk of fluvial flooding in the 0.1%, 1% and 10% AEP floods. Further details on the fluvial flood risk are outlined in Section 4.4.1 and its associated sub-sections.

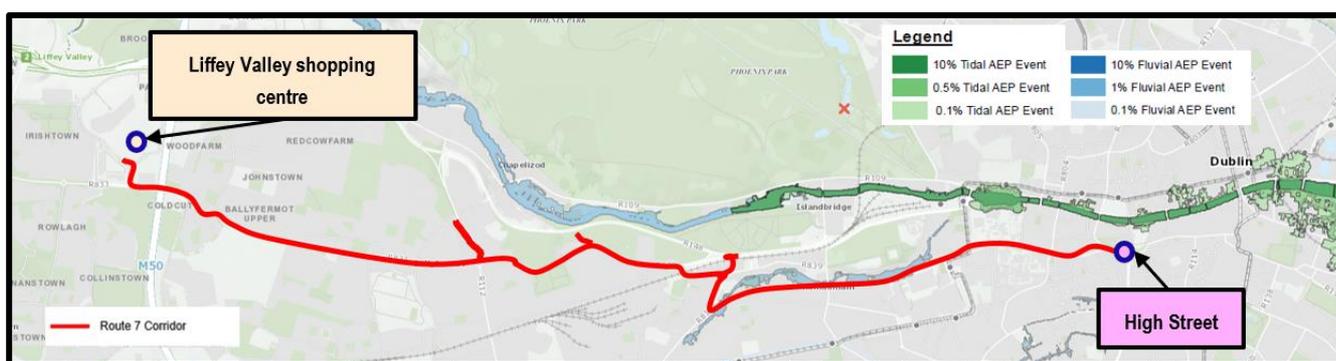


Figure 4.4 Extract of Coastal and fluvial flood mapping from Eastern CFRAM study for the Scheme 7

4.4.1 Fluvial Flood Extents

The Proposed Scheme crosses the Camac River at Emmet Road and then runs parallel to the watercourse as it passes through the Kilmainham area of the city. Sections 4.4.2 to 4.2.2.1.2 highlight the following three locations where the scheme is at risk from flooding from the Camac River:

- Emmet Road, Ch B05+600 – B05+800, refer to Figure 4.5;
- Emmet Road, Ch B06+350 – B06+450, refer to Figure 4.5; and
- Old Kilmainham Road, Ch B06+750 – B07+250, refer to Figure 4.6.

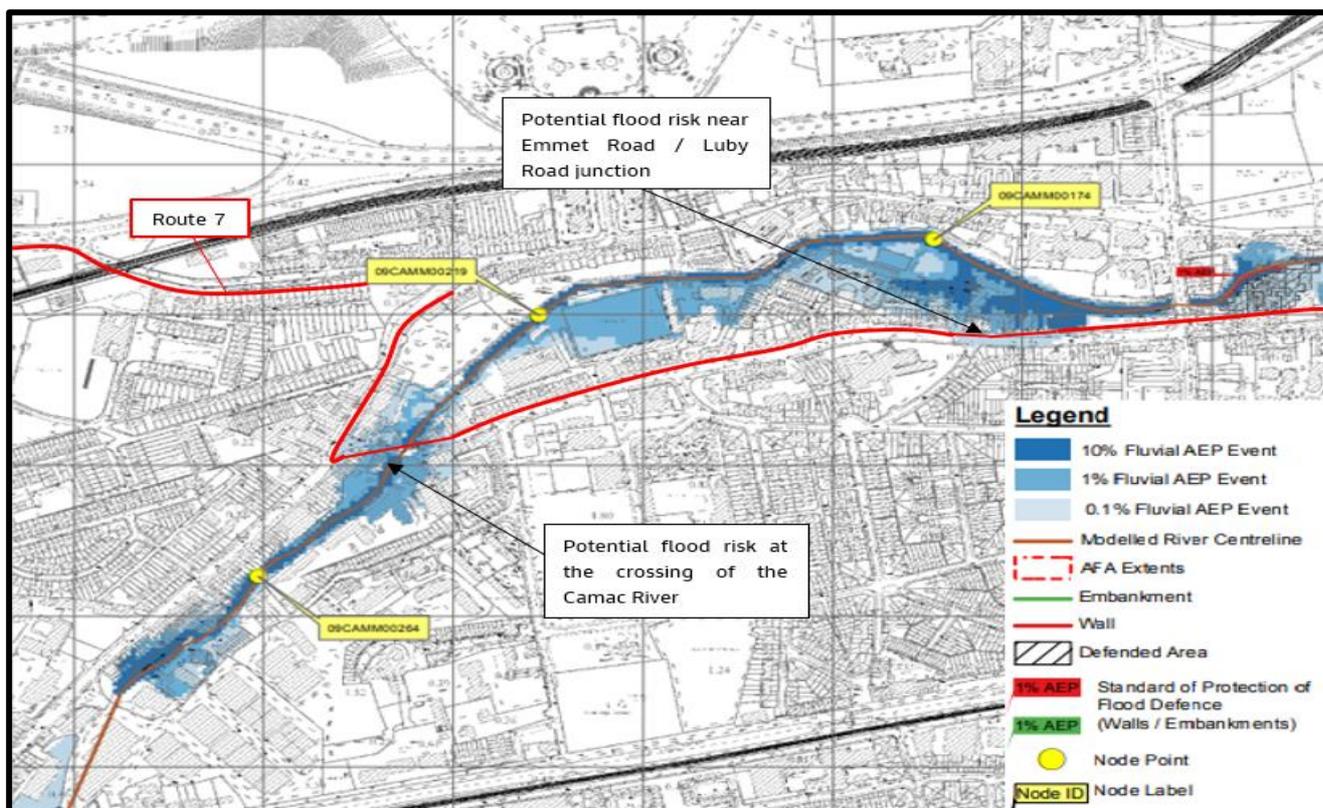


Figure 4.5 Extract of fluvial flood mapping from Eastern CFRAM study Emmet Road area

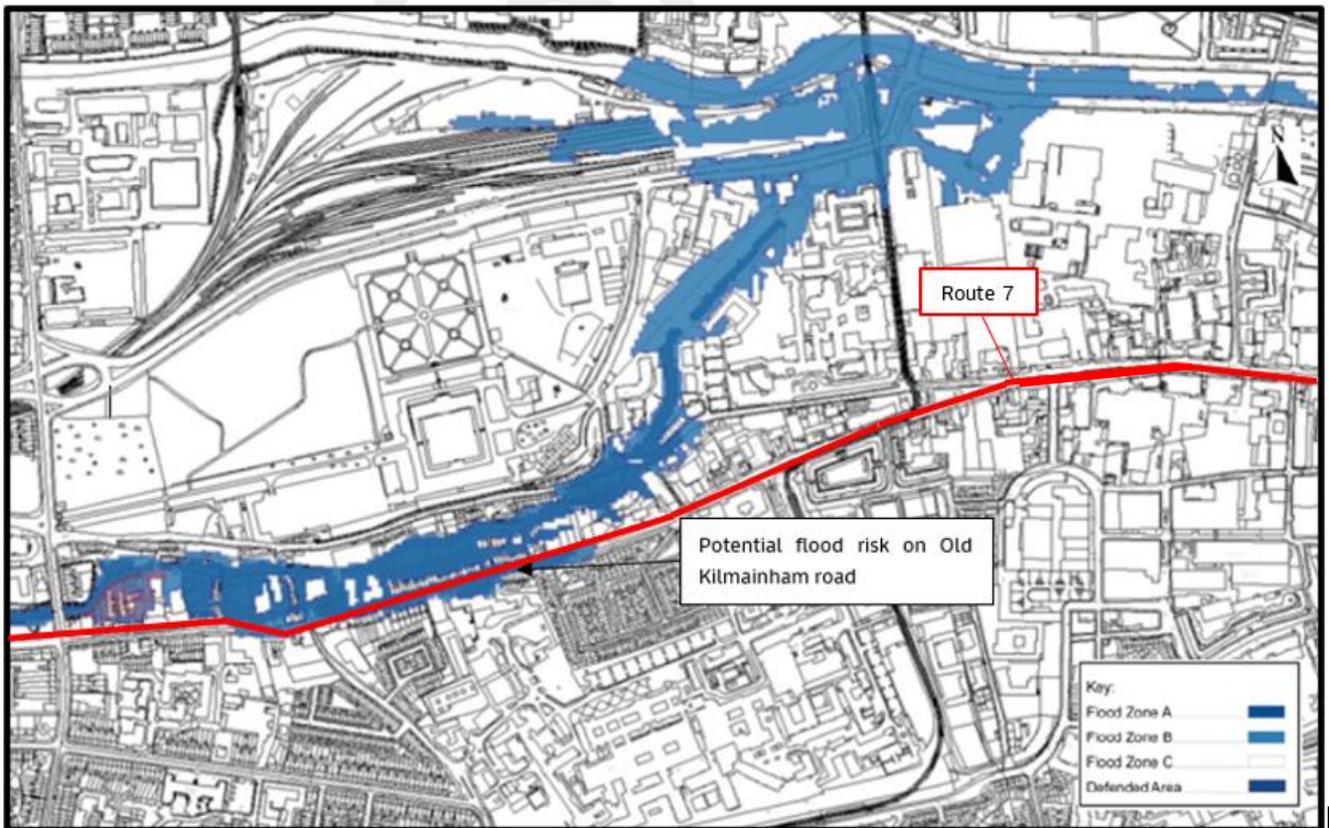


Figure 4.6 Extract of fluvial flood mapping from Eastern CFRAM study Old Kilmainham Road area

4.4.1.1 Bridge Crossing over River Carmac (Ch B05+600 – B05+800)

The proposed bus corridor follows Emmet Road and crosses the Carmac River near Inchicore Village, refer to Figure 4.7. The proposed works are entirely confined to the existing highway extent at this location with no amendment proposed to the existing watercourse crossing.

Figure 4.8 shows that the route is at risk of fluvial flooding in the 10%, 1% and 0.1% AEP floods, where it crosses the Carmac River.

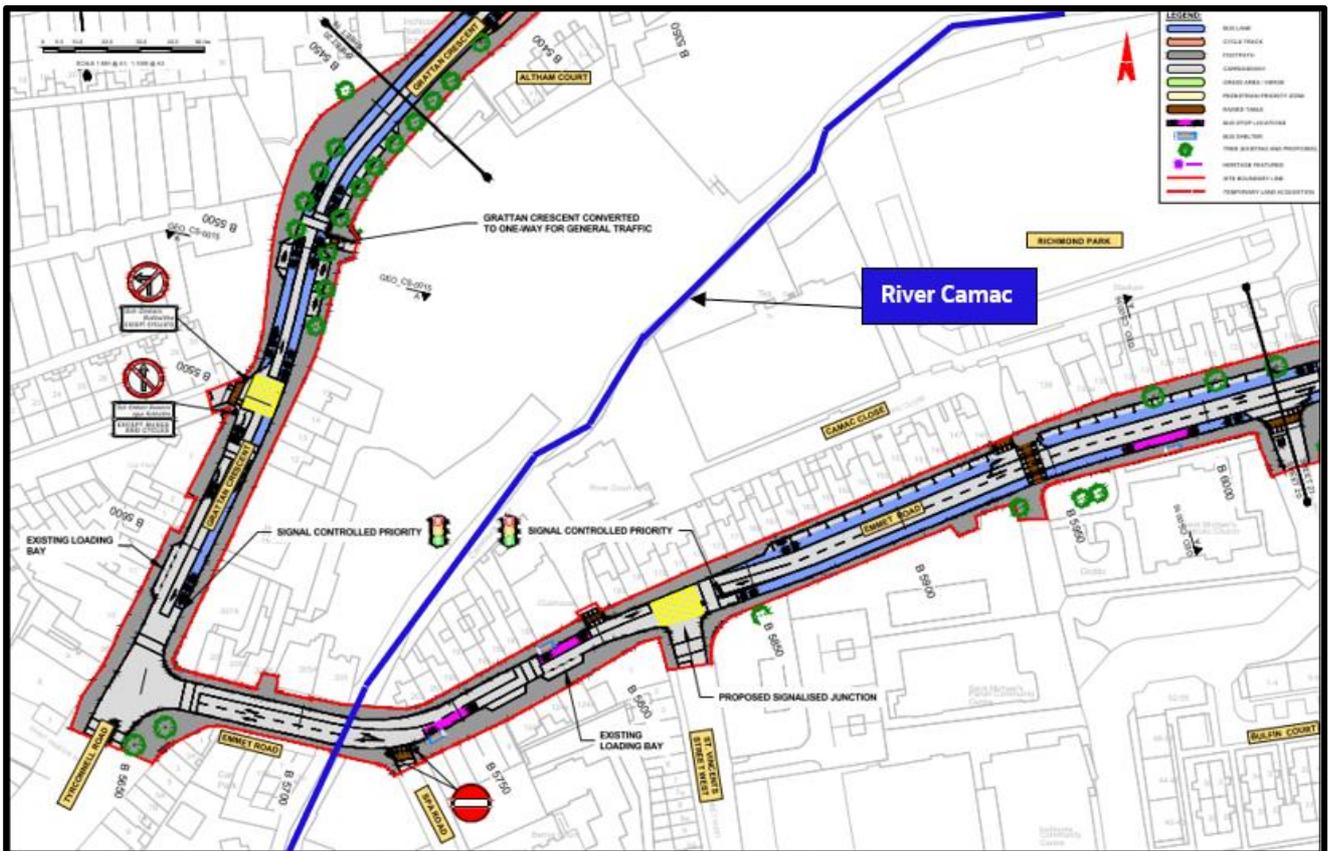


Figure 4.7 Proposed works at Emmet Road, Ch B05+450 – Ch B06+000

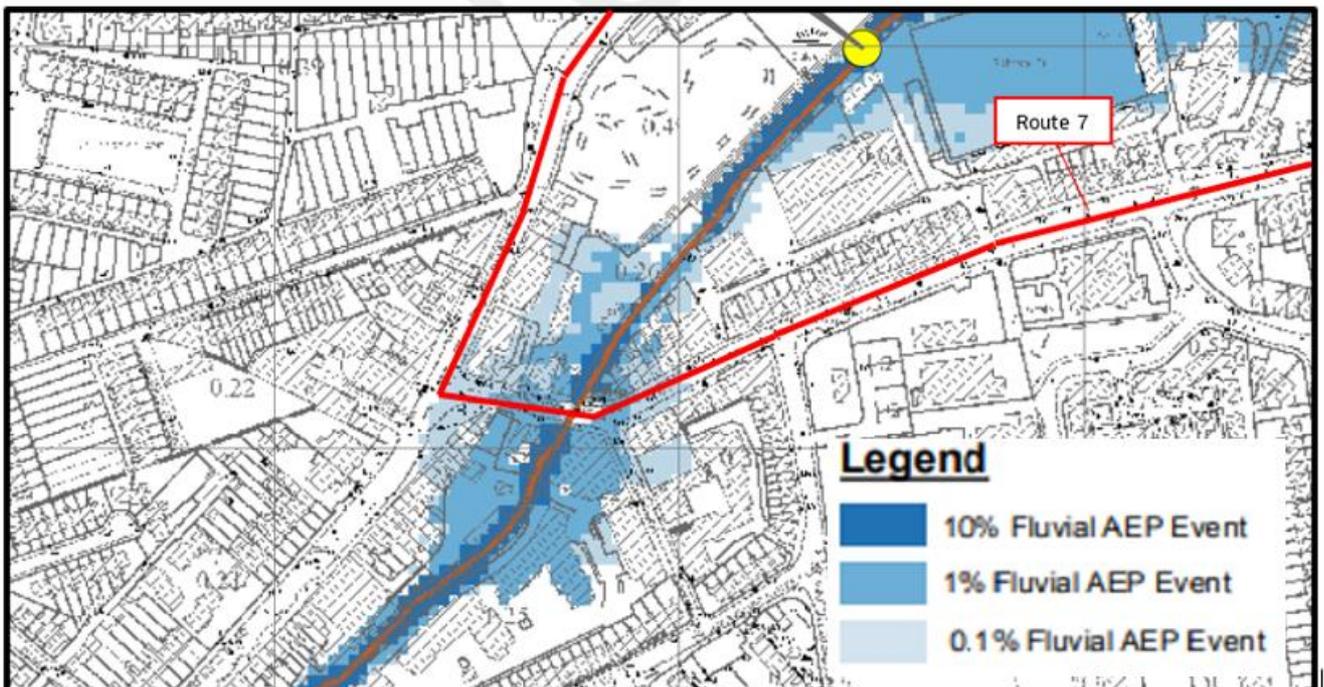


Figure 4.8 Extract of fluvial flood mapping from CFRAM study at Emmet Road, Ch B05+450 – Ch B06+000

4.4.1.2 Emmet Road (Ch B06+350 – B06+450)

Emmet Road also at flood risk from the Camac River near its junction with Luby Road. The proposed works at this location, refer to Figure 4.9, are largely confined to the existing highway extent with land take required on the north side of Emmet Road between the Bulfin Road junction and the Luby Road junction.

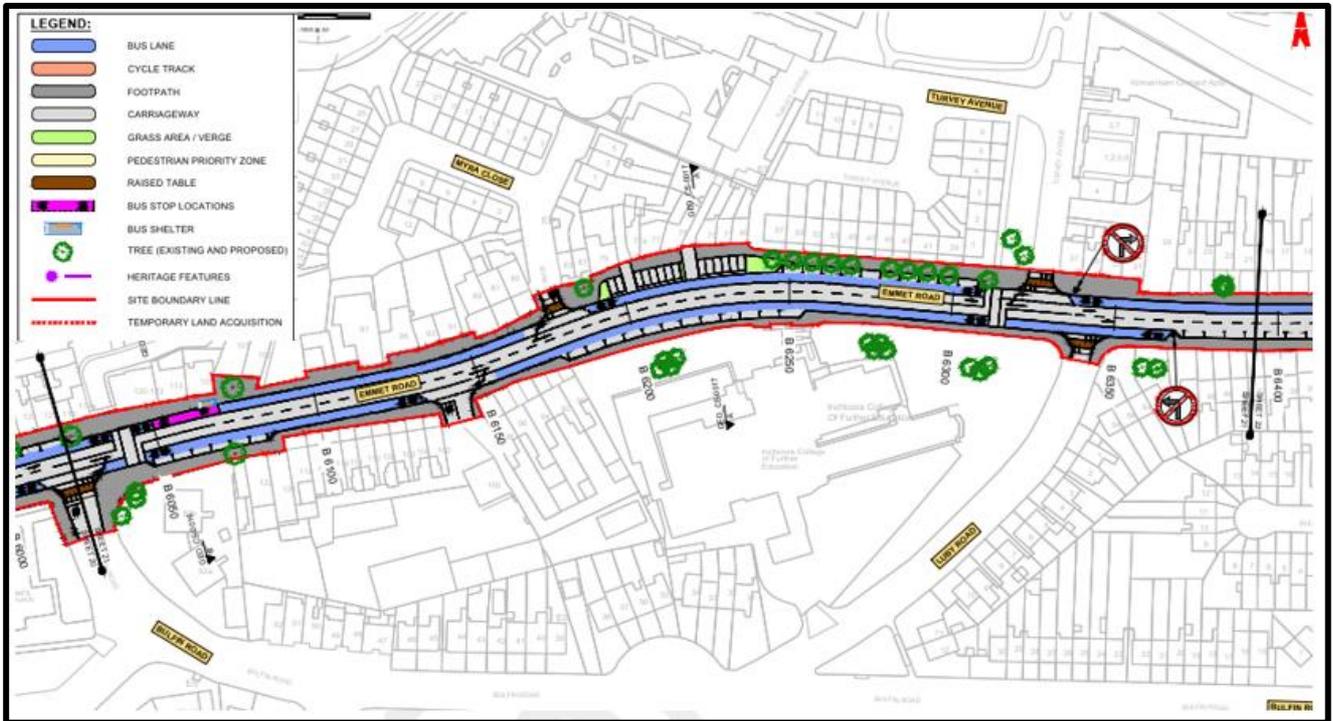


Figure 4.9 Proposed works at Emmet Road, Ch B06+350 – Ch B06+400

Land take is also required for alternative car parking on the north side of Emmet Road before the South Circular Road junction. The existing land at this location consists of greenfield, refer to **Figure 4.10**.

Figure 4.11 shows that the route from Ch B06+050 – Ch B06+400 is at risk of fluvial flooding in the 0.1% AEP flood.

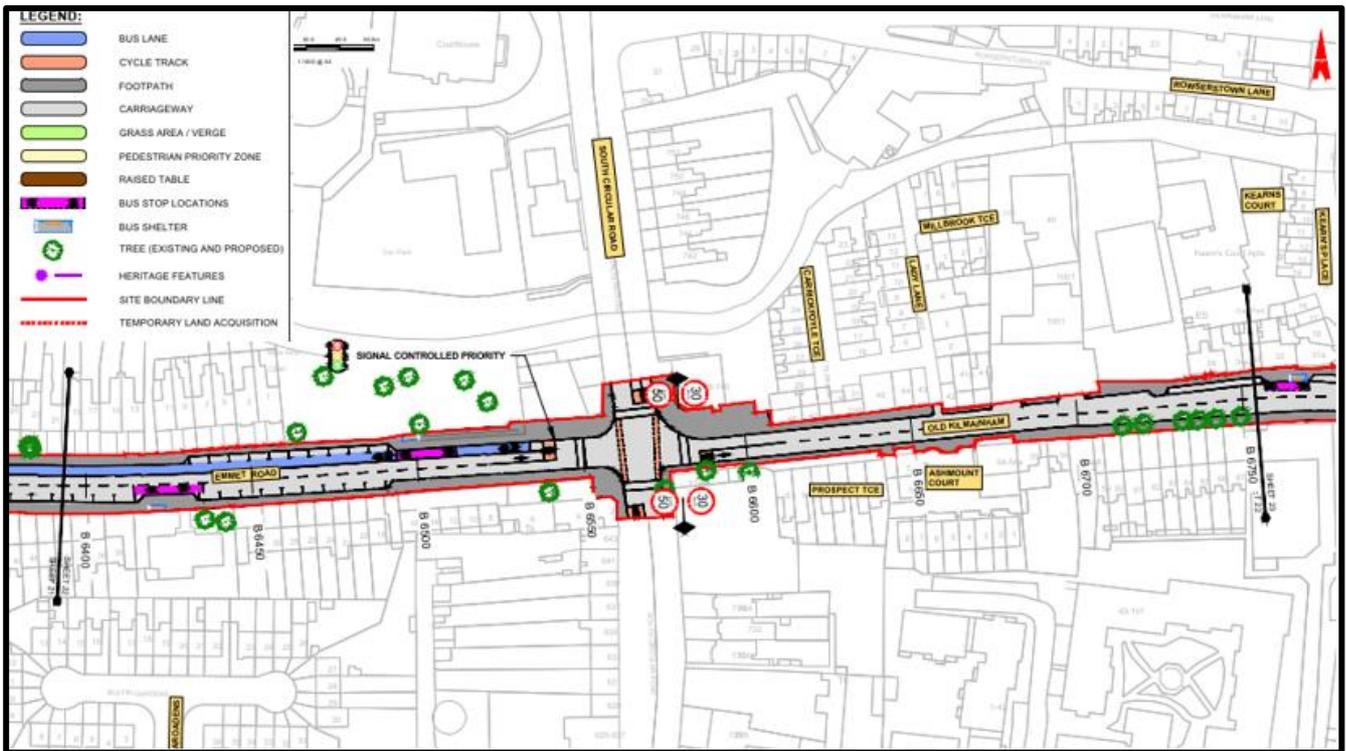


Figure 4.10 Proposed works at Emmet Road, Ch B06+400 – Ch B07+750

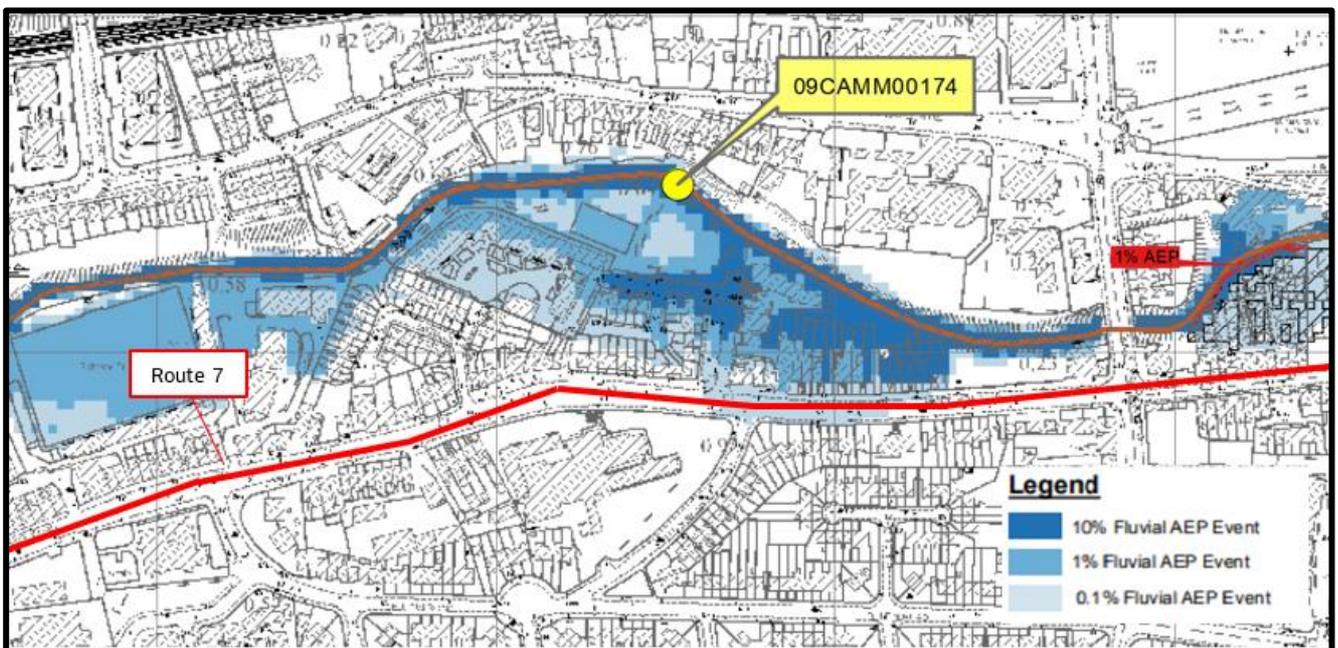


Figure 4.11 Extract of fluvial flood mapping from CFRAM study at Emmet Road, Ch B06+350 – Ch B06+450

4.4.1.3 Old Kilmainham Road (Ch B06+750 – B07+250)

The proposed bus corridor follows Old Kilmainham Road and runs parallel to the Camac River. The proposed works are illustrated in Figure 4.12 and Figure 4.13 and comprise widening on the southern side of the Old Kilmainham Road to accommodate a bus gate. This bus gate location must align with the current National Children Hospital plans.

Figure 4.14 shows that Ch B07+150 – Ch B07+500 of the route is at risk of fluvial flooding in the 10%, 1% and 0.1% AEP floods.

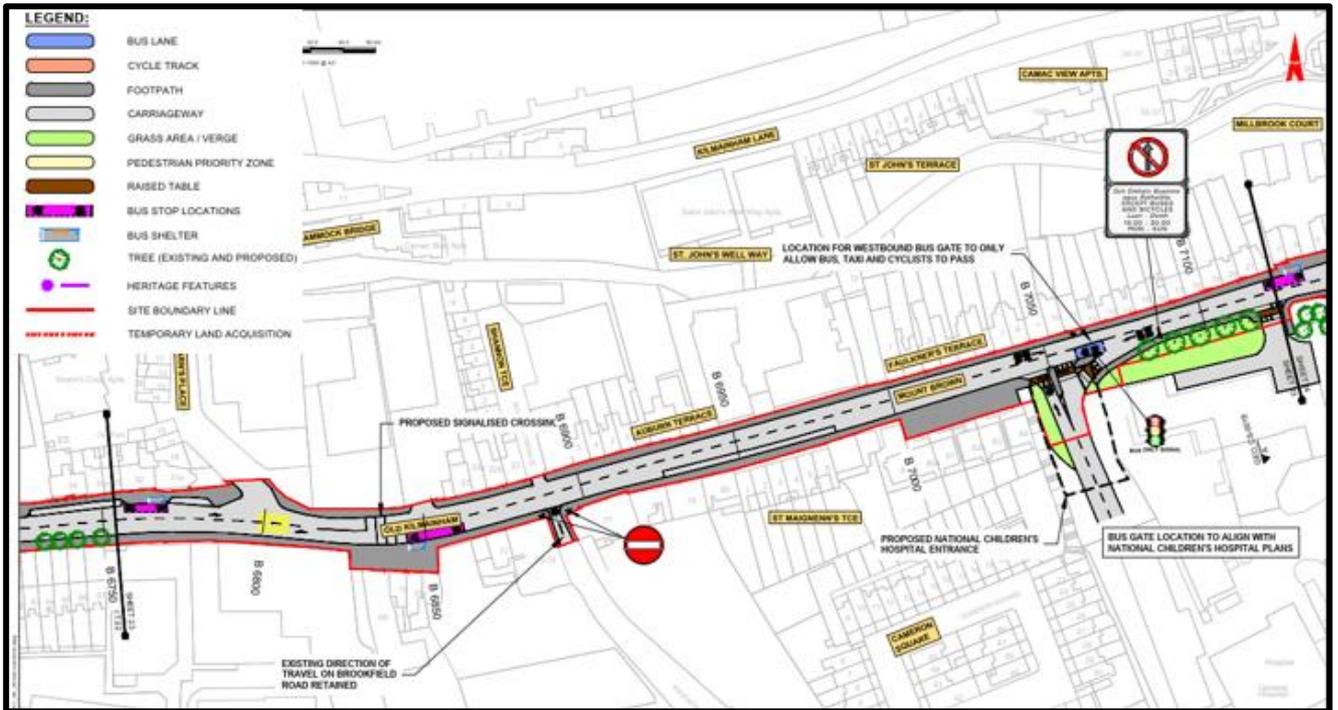


Figure 4.12 Proposed works at Old Kilmainham, Ch B06+750 – Ch B07+100

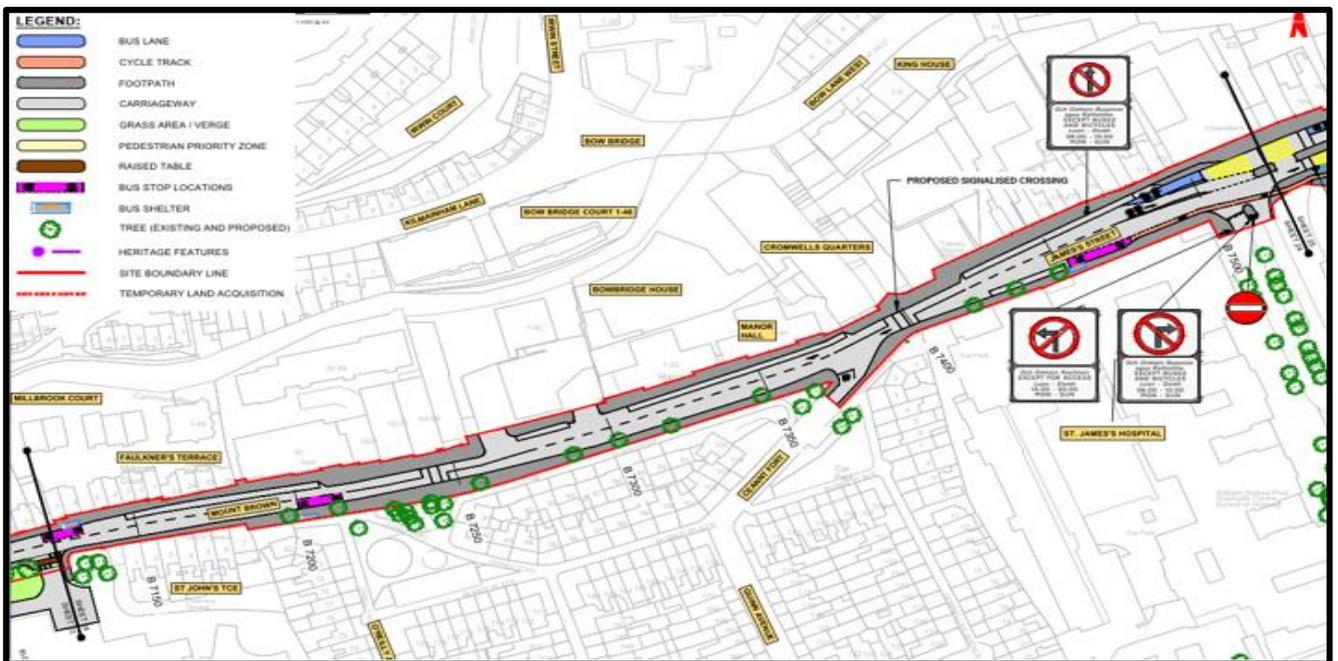


Figure 4.13 Proposed works at Old Kilmainham, Ch B07+150 – Ch B07+500

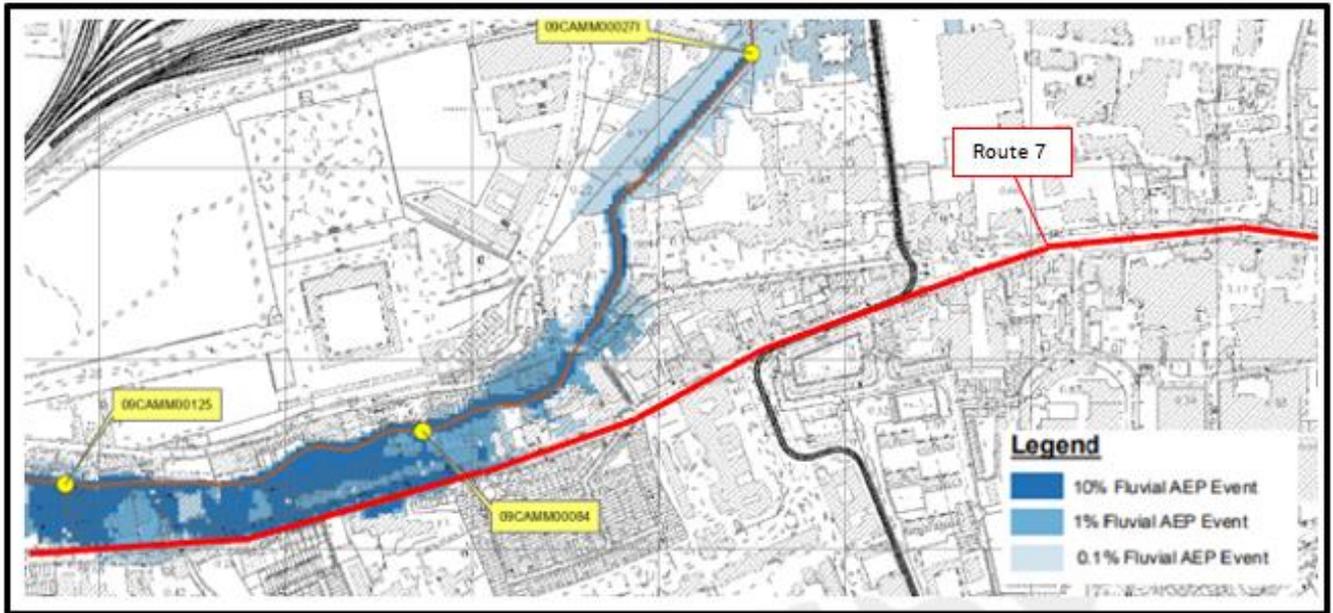


Figure 4.14 Extract of fluvial flood mapping from CFRAM study at Old Kilmainham Road, Ch B06+750 – Ch B07+250

4.4.2 Coastal Flood Extents

The Eastern CFRAM Study Flood Extent and Depth Maps for coastal flood risk are available online (www.floodinfo.ie). No risk of coastal flood risk was identified along this route, refer to Figure 4.15.

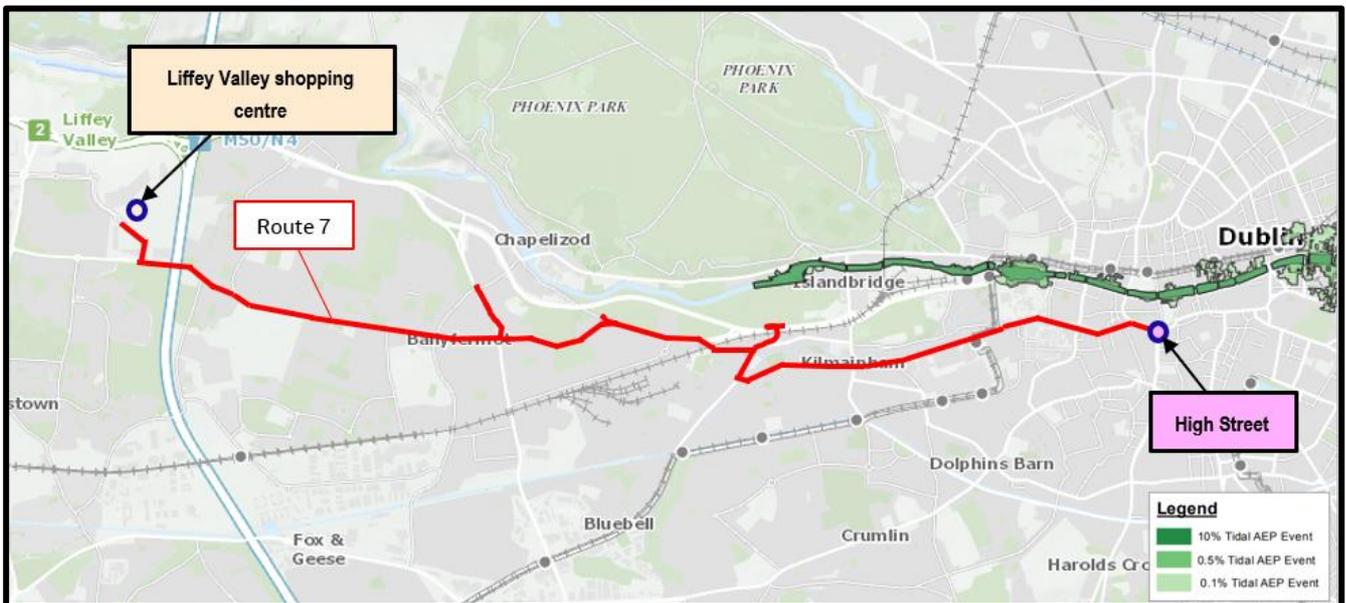


Figure 4.15 Extract of coastal flood mapping from Eastern CFRAM study

4.5 Rainfall Flood Extents

Pluvial flooding occurs during periods of heavy rainfall, when the rainfall rate is greater than the infiltration capacity. It is usually associated with high intensity rainfall events (typically > 30mm/h) resulting in overland flow and ponding in depressions in the topography. In urban situations underground sewerage/drainage systems and surface watercourses may be completely overwhelmed.

Pluvial flood extents are available for areas of Dublin and provide an indication of the level of risk. Pluvial mapping extends from the City Centre as far as the Coldcut Road M50 overpass. The flood mapping considered flood risk in the 10%, 1% and 0.5% AEP rainfall events. The rainfall extents along the Route No.7 Corridor were reviewed using the OPW flood info website (available at www.floodinfo.ie) and the 10% flood extents are illustrated in Figure 4.16 and Figure 4.17.

It should be noted that this mapping should be used to identify potential risk but is not appropriate for a site-specific flood risk assessment. It is reasonable to assume that the remainder of the Route No.7 corridor (between the Coldcut Road M50 overpass and Liffey Valley) is exposed to a similar level of flood risk.

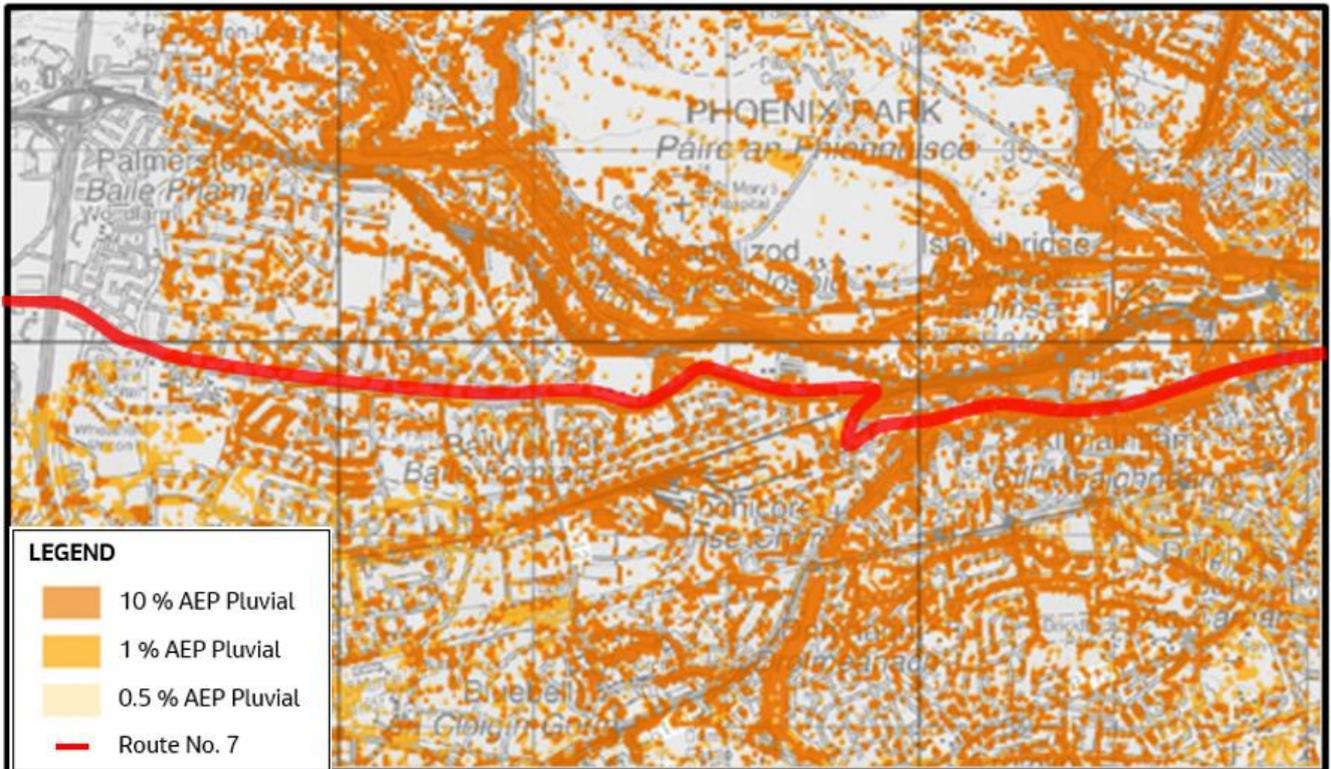


Figure 4.16 Extract of pluvial flood mapping on the Route No.7 bus corridor Liffey Valley to Kilmainham



Figure 4.17 Extract of pluvial flood mapping on the Route No.7 bus corridor Kilmainham to City Centre

4.6 Irish Coastal Protection Strategy Study (ICPSS)

The Irish Coastal Protection Strategy Study (ICPSS) produced for the OPW in 2013 provides an overview of coastal flood hazard and risk in Ireland. Flood maps were produced for the 0.5% and 0.1% AEP flood events. A volume of maps is also available which represent a projected future scenario for the year 2100 and include allowances for projected future changes in climate. Specifically, these represent the Mid-Range Future Scenario and allow for 500mm rise in Mean Sea Level.

Flood mapping for the 0.5% and 0.1% AEP present day flood extent is illustrated in Figure 4.18. This also shows no coastal flood risk along the Liffey Valley route.

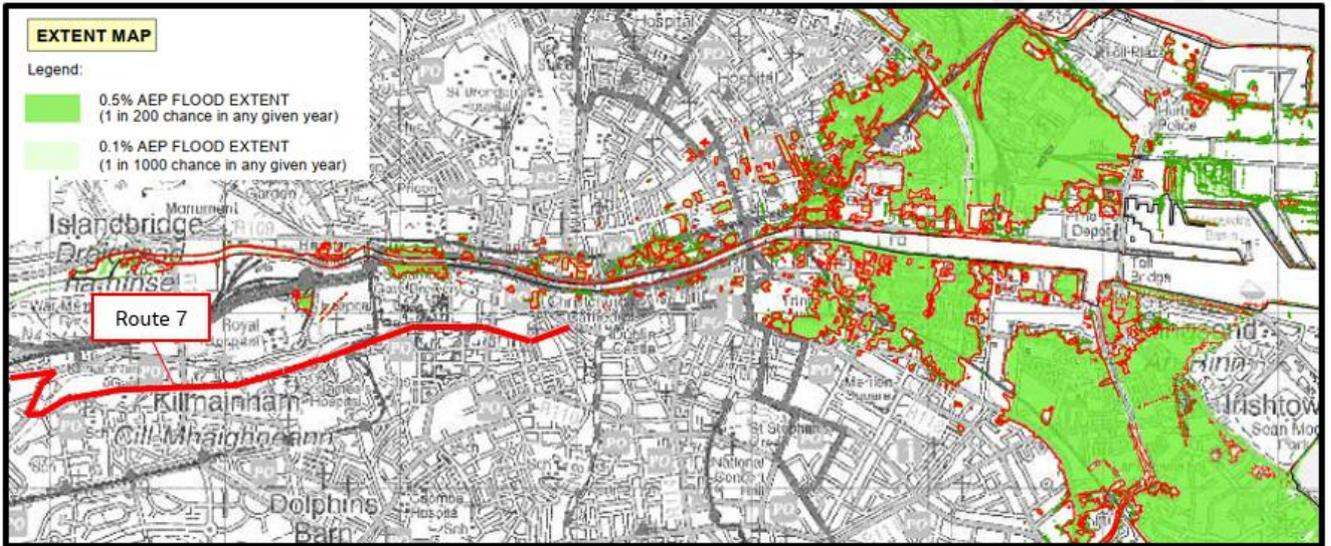


Figure 4.18 ICPSS coastal mapping. Liffey Valley to City Centre

4.7 Strategic Flood Risk Assessments (SFRA)

4.7.1 Dublin City Development Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Dublin Town Development Plan 2016-2022. This document states that part of the proposed works along Emmet Road and Old Kilmainham Road are located within Flood Zones A and B, refer to **Figure 4.19**.

A moderate risk of pluvial risk has been reported along much of the Proposed Scheme. This is not unexpected as much of the existing surface water drainage network was designed to provide a low standard of protection (typically 20% AEP or less). Areas of significant and extreme risk of pluvial flooding have been identified along Sarsfield Road, Emmet Road and Old Kilmainham Road parts of Proposed Scheme, refer to **Figure 4.20**.

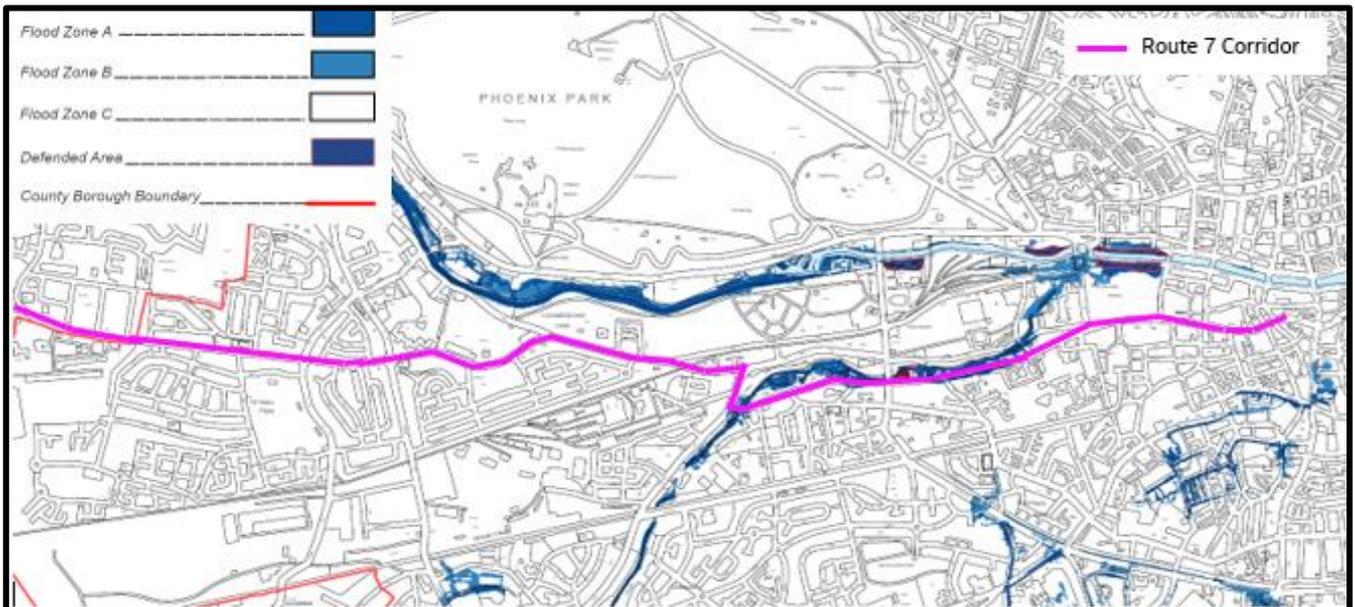


Figure 4.19 Dublin City Council Composite Flood Map.

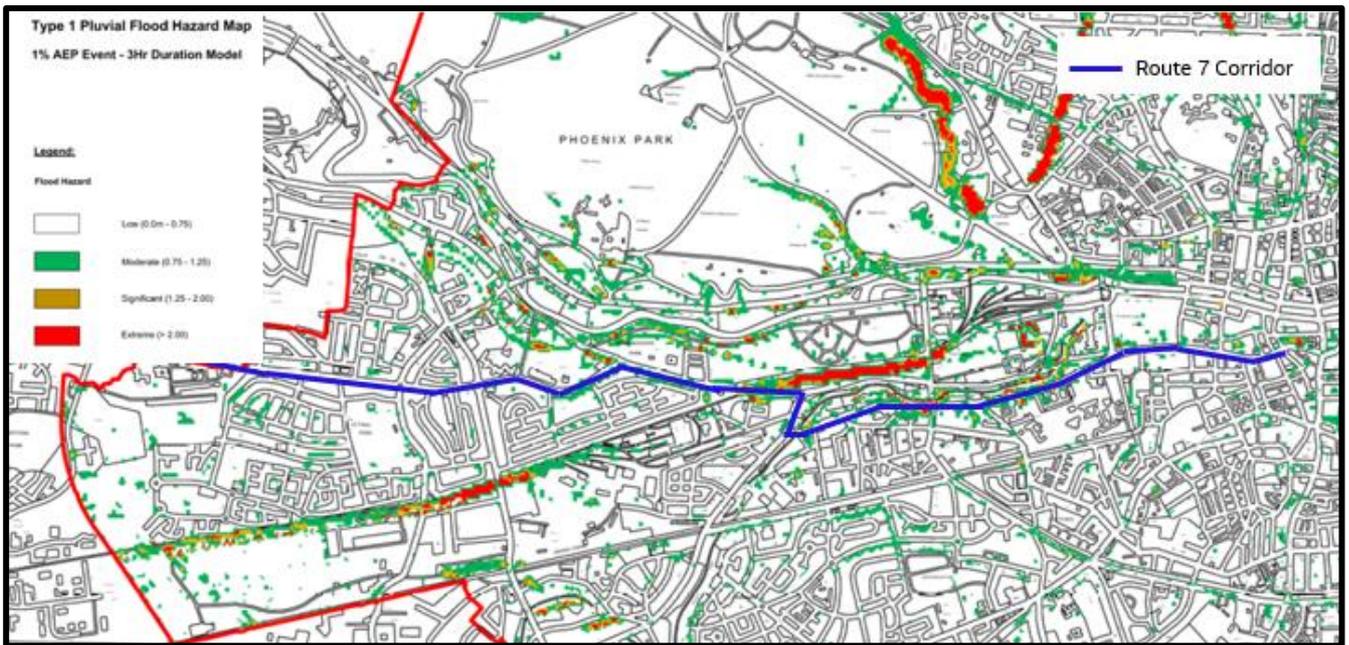


Figure 4.20 Dublin City Council Pluvial Flood Hazard Map.

4.7.2 South Dublin County Council Plan

A Strategic Flood Risk Assessment and Management Plan was prepared as part of the Dublin County Council Development Plan 2016-2022. This document states that the proposed works along Coldcut Road is located within Flood Zone C, refer to Figure 4.21.

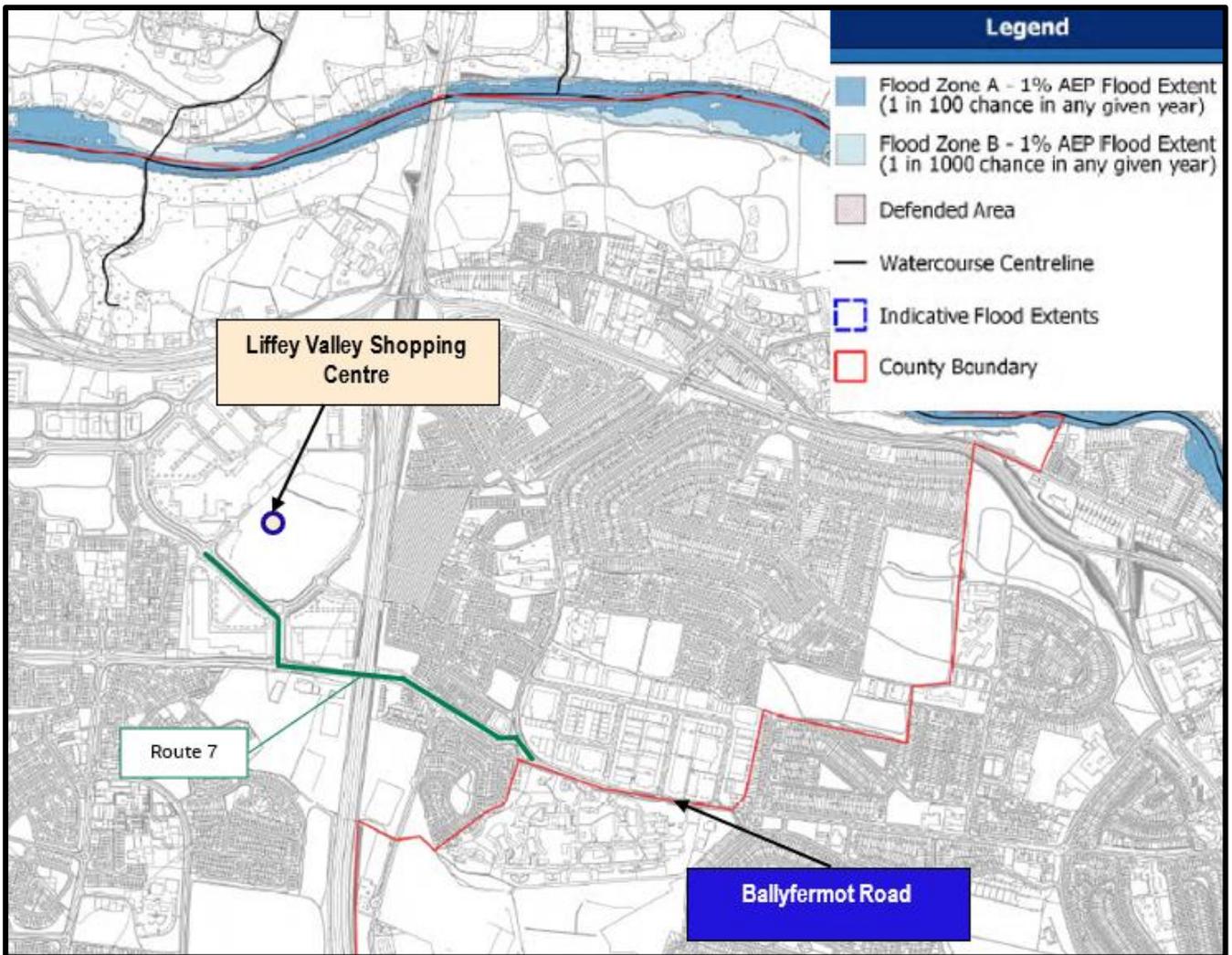


Figure 4.21 South Dublin County Council Composite Flood Map.

The proposed route is within the 0.1% and 1% AEP pluvial flood extents along Fonthill Road, refer to Figure 4.22

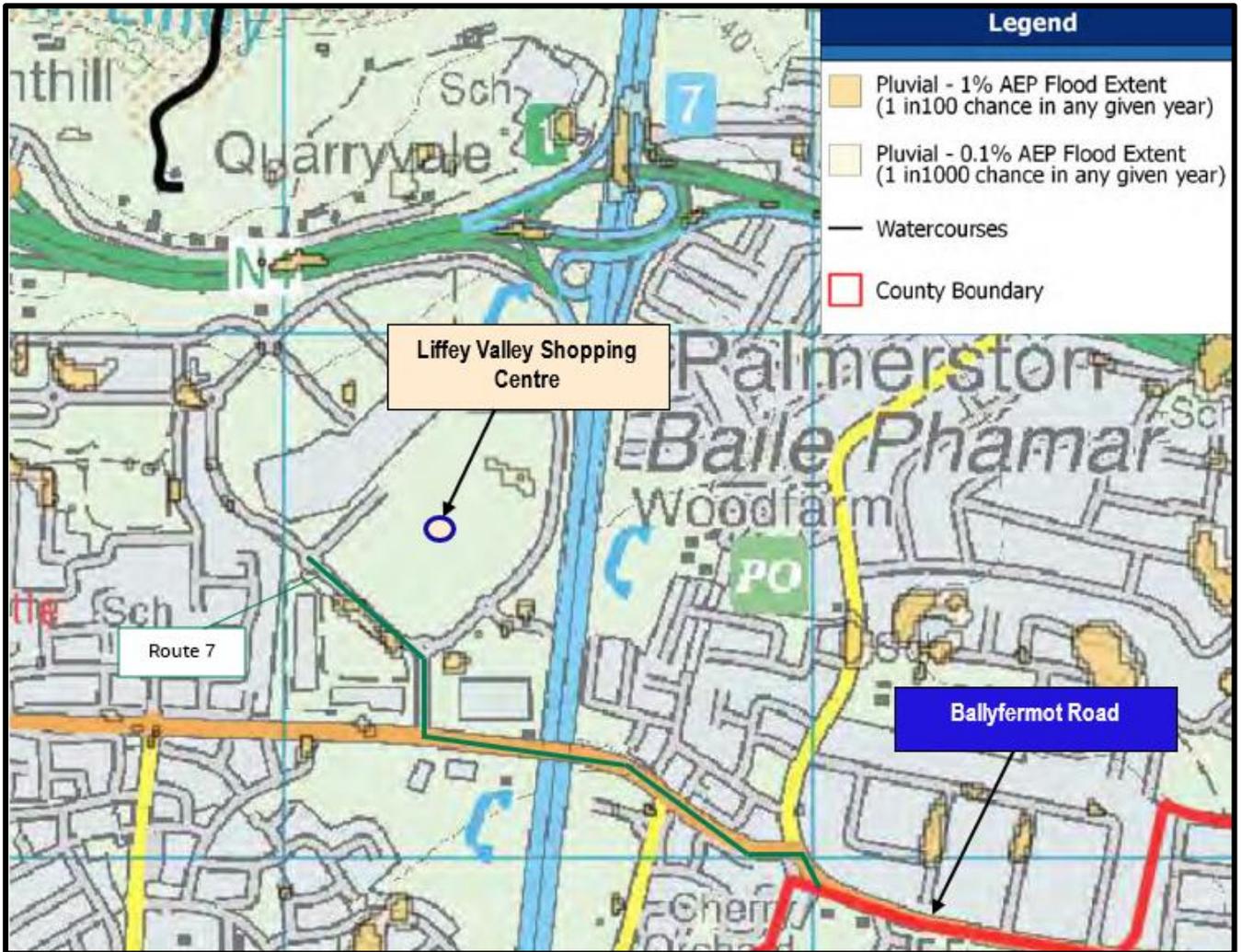


Figure 4.22 South Dublin County Council PFRA indicative pluvial flood zone mapping

5. Stage 2 Initial Flood Risk Assessment

This section assesses the risk of flooding to the proposed development site once the works are complete from a range of different sources, which is then used to develop a broader understanding of the risk characteristics to the proposed development.

5.1 Potential Sources of Flooding

Further to the Stage 1 assessment, there is no identified risk of coastal, estuarine or groundwater flooding to the Proposed Scheme. The remaining potential sources of flooding are listed below:

- **Fluvial** – Three locations across the scheme are at risk from fluvial flooding:
 - Emmet Road, bridge crossing over River Carmac (Ch B05+600 – B05+800). Risk of fluvial flooding in the 10%, 1% and 0.1% AEP floods.
 - Emmet Road (Ch B06+350 – B06+450). Risk of fluvial flooding in the 0.1% AEP floods.
 - Old Kilmainham Road (Ch B07+150 – Ch B07+500). Risk of fluvial flooding in the 10%, 1% and 0.1% AEP floods.
- **Pluvial** – The OPW flood info website showed risk of pluvial flooding along much of the route in the 10% AEP flood.
- **Artificial Drainage Systems** – much of the route is served by an existing drainage system which has limited capacity. There is a risk of flooding from this drainage network, as identified above, during heavy rainfall. It should be noted that any increases in the impermeable surfaces associated with the works shall be accounted for in new Sustainable Drainage (SuDS) infrastructure such as an attenuation system ensuring no change in existing runoff rates so the proposed development will not compromise the existing site drainage systems.

5.2 Initial Fluvial Flood Risk Assessment

Three fluvial flood risk areas have been identified for the Proposed Scheme namely:

- Emmet Road, Ch B05+600 – B05+800;
- Emmet Road, Ch B06+350 – B06+450; and
- Old Kilmainham Road, Ch B06+750 – B07+250.

All are associated with the Camac River. Further details including the level of flood risk are provided in the paragraphs below.

5.2.1 Emmet Road, Ch B05+600 – B05+800.

The Stage 1 assessment indicated that Emmet Road Ch B05+600 – B05+800 is at risk of fluvial flooding. The Eastern CFRAM study modelled the Camac River at its crossing with the Proposed Scheme at Emmet Road. The predicted flood extent is shown in Figure 5.1.

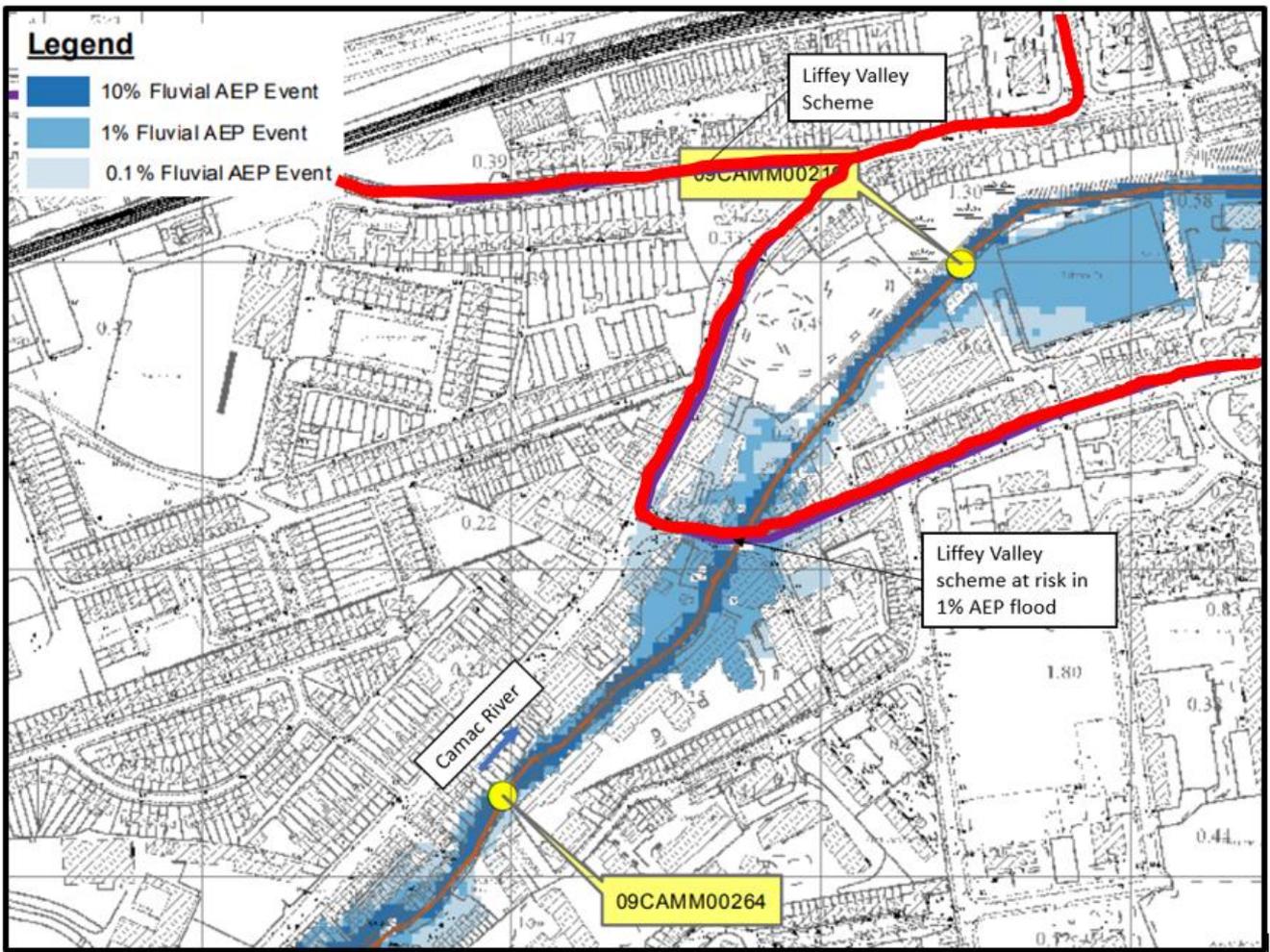


Figure 5.1 Eastern CFRAM study, Emmet Road Ch B05+600 – B05+800

The predicted flood levels have been obtained from the OPW CFRAM Study (See Appendix B) for the 10%, 1% and 0.1% AEP flood event and has been compared against the finished ground level for the Proposed Scheme; refer to Table 5.1. It should be noted that the finished ground level is unchanged from the existing ground level within Ch B05+600 – B05+800.

Table 5.1 Design Camac River Fluvial Flood Levels for route No.7 (Emmet Road Ch B05+600 – B05+800)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	19.0	19.32	+0.32
1% (1 in 100)	19.88		-0.56
0.1% (1 in 1000)	20.81		-1.49

* Values obtained from node 09CAMM00264

The nearest model node (09CAMM00264) is upstream of the crossing meaning the reported water levels are likely to overestimate potential flood depths on Emmet Road.

As shown, Proposed Scheme is not at risk of flooding in the 10% flood. Flooding is predicted to a depth of approximately 0.56m in the 1% AEP flood and 1.5m in the 0.1% AEP flood. As noted, due to the upstream location of the nearest model node, this is likely to be an overestimate of the potential level of flood risk.

The proposed scheme does not require modification of the existing bridge crossing of the Camac River and the existing road levels will also be maintained. There will therefore be no impact on the existing risk or extent of flooding in this location from the Camac River as a consequence of the Proposed Scheme.

Ch B05+600 – B05+800 Fluvial Flood Risk Assessment Summary:

- Between Ch B05+600 – B05+800, the Proposed Scheme is located in Flood Zone A;
- There is no change in flood risk to or arising from the Proposed Scheme from the Camac River as existing ground levels are unchanged and no modifications are undertaken to the existing bridge structure over the River;
- A Stage 3 FRA is not required as no works are proposed that will affect the hydraulic capacity of the existing bridge crossing of the Camac River;
- No change in ground levels are proposed meaning there will also be no change in the extent of fluvial flooding.

5.2.2 Emmet Road, Ch B06+350 – B06+450.

The Stage 1 assessment indicated that Emmet Road Ch B06+350 – B06+450 is at risk of fluvial flooding. The Eastern CFRAM study modelled the Camac River where it flows parallel to the Proposed Scheme at Emmet Road (Ch B06+350 – B06+450). The predicted flood extent is shown in Figure 5.2.

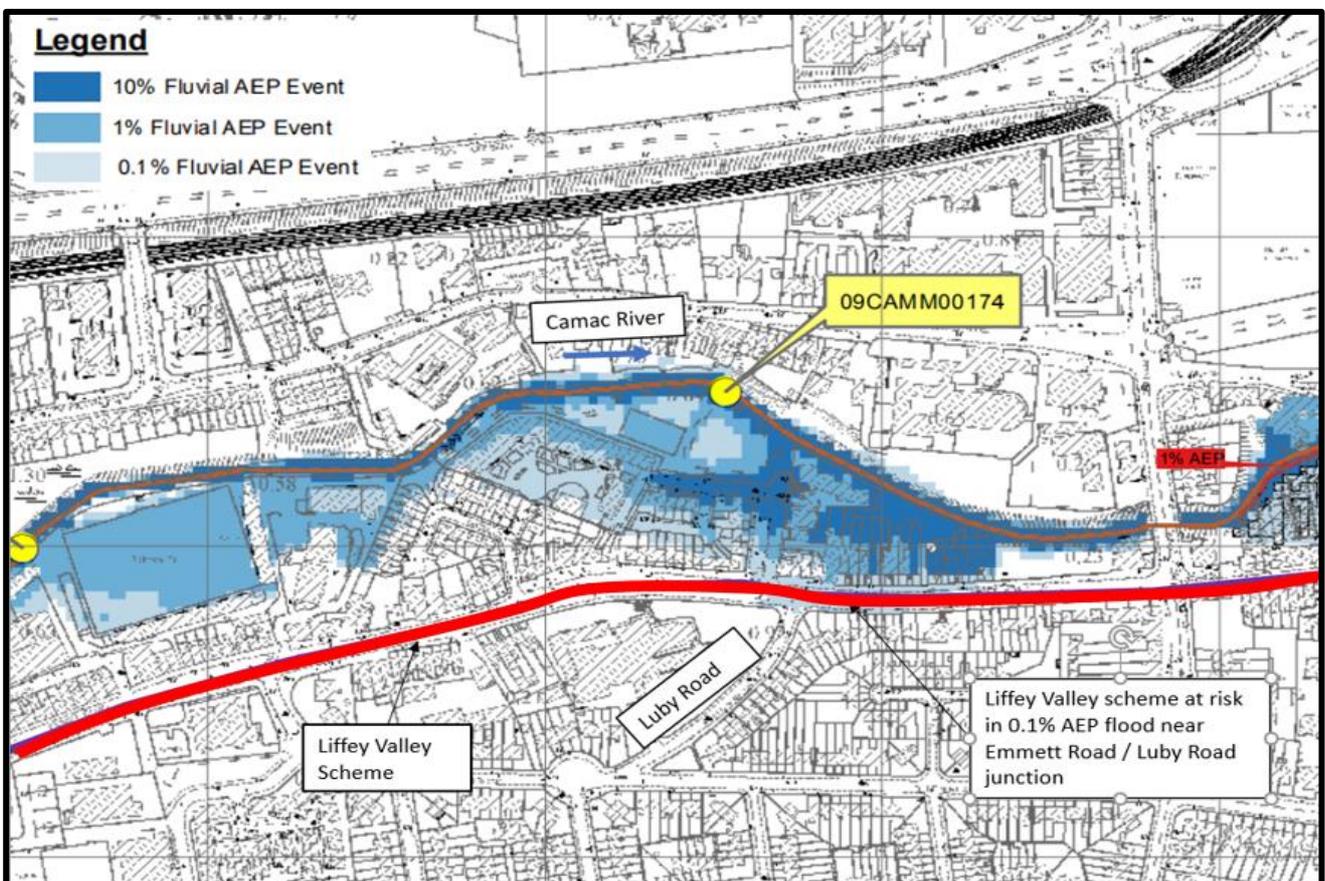


Figure 5.2 Eastern CFRAM study, Emmet Road Ch B06+350 – B06+450

The predicted flood levels have been obtained from the OPW CFRAM Study (See Appendix B) for the 10%, 1% and 0.1% AEP flood event and has been compared against the minimum ground level for the development; refer to Table 5.2. It should be noted that the finished ground level is unchanged from the existing ground level within reach Ch B06+350 – B06+450.

Table 5.2 Design Camac River Fluvial Flood Levels for route No.7 (Emmet Road Ch B06+350 – B06+450)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	11.76	12.91	+1.15
1% (1 in 100)	12.46		+0.46
0.1% (1 in 1000)	13.57		-0.66

* Values obtained from node 09CAMM00174

As shown, Proposed Scheme is not at risk of flooding in the 10% or 1% AEP floods. Flooding is predicted to a depth of approximately 0.66m in the 0.1% AEP flood. Due to the distance of the model node from the Proposed Scheme route, it is possible this overestimates the level of risk as hydraulic losses would be expected as flows pass across the floodplain.

The proposed scheme does not result in any change to existing ground levels within this reach. There will therefore be no impact on the existing risk or extent of flooding in this location from the Camac river as a consequence of the Proposed Scheme.

Ch B06+350 – B06+450 Fluvial Flood Risk Assessment Summary:

- Between Ch B06+350 – B06+450, the Proposed Scheme is located in Flood Zone B;
- There is no change in flood risk to or arising from the Proposed Scheme from the Camac river as existing ground levels are unchanged;
- A Stage 3 FRA is not required as no works are proposed that will affect the hydraulic capacity of the river or predicted extent of flooding.

5.2.3 Old Kilmainham Road, Ch B06+750 – B07+250.

The Stage 1 assessment indicated that Old Kilmainham road, Ch B06+750 – B07+250 is at risk of fluvial flooding. The Eastern CFRAM study modelled the Camac River where it flows parallel to the Proposed Scheme at Old Kilmainham Road (Ch B06+750 – B07+250). The predicted flood extent is shown in Figure 5.3.

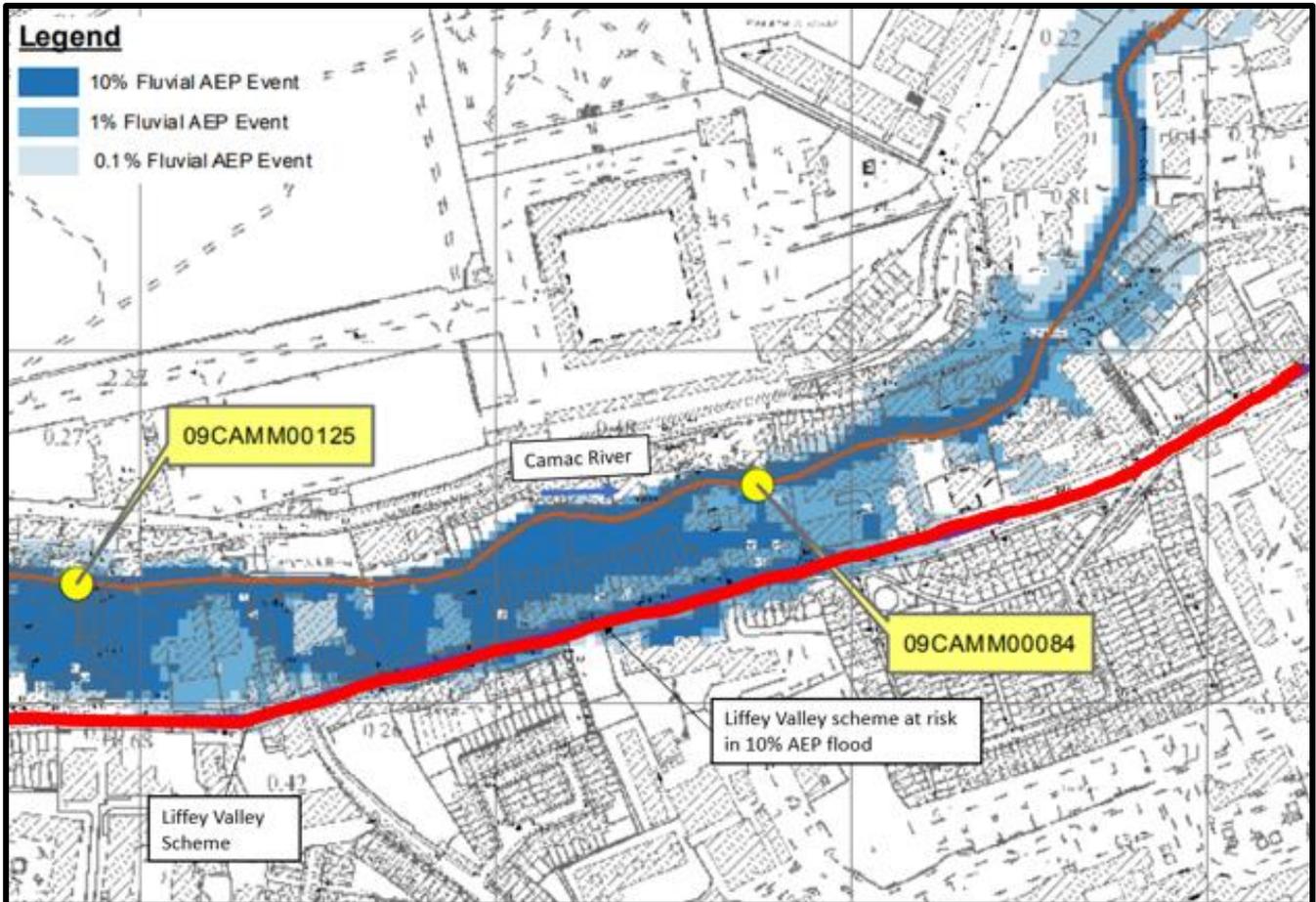


Figure 5.3 Eastern CFRAM study, Old Kilmainham Road, Ch B06+750 – B07+250

The predicted flood levels have been obtained from the OPW CFRAM Study (See Appendix B) for the 10%, 1% and 0.1% AEP flood event and has been compared against the minimum ground level for the Proposed Scheme; refer to Table 5.3. It should be noted that the finished ground level is unchanged from the existing ground level within reach Ch B06+750 – B07+250.

Table 5.3 Design Camac River Fluvial Flood Levels for route No.7 (Old Kilmainham Road, Ch B06+750 – B07+250)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	6.88	7.35	+0.47
1% (1 in 100)	7.68		-0.33
0.1% (1 in 1000)	8.49		-1.14

* Values obtained from node 09CAMM00084

Water levels at node 09CAMM00084 have been considered for the assessment. They were selected in preference to the levels for node 09CAMM000125 due to the presence of two bridge crossings immediately downstream of this node which raise upstream water levels meaning they will not be representative of the level of flood risk within reach Ch B06+750 – B07+250. This is because flooding of reach Ch B06+750 – B07+250 of the Proposed Scheme

occurs from flows overtopping the Camac River downstream of these two bridge crossings. The levels for node 09CAMM000125 were therefore considered to substantially overestimate the risk of flooding with the levels from node 09CAMM00084 providing a more appropriate assessment of flood risk.

As shown, Proposed Scheme is at risk of flooding in the 10%, 1% and 0.1% AEP floods. Flooding is predicted to a depth of approximately 0.33 m in the 1% AEP flood and 1.14 in the 0.1% AEP flood.

The proposed scheme does not result in any change to existing ground levels within this reach. There will therefore be no impact on the existing risk or extent of flooding in this location from the Camac River as a consequence of the Proposed Scheme.

Ch B06+750 – B07+250 Fluvial Flood Risk Assessment Summary:

- Between Ch B06+750 – B07+250, the Proposed Scheme is located in Flood Zone A;
- There is no change in flood risk to or arising from the Proposed Scheme from the Camac river as existing ground levels are unchanged;
- A Stage 3 FRA is not required as no works are proposed that will affect the hydraulic capacity of the river or predicted extent of flooding.

5.2.4 Fluvial Flood Risk Summary

The following three reaches of the Proposed Scheme are at risk from fluvial flooding from the Camac River:

- Emmet Road, Ch B05+600 – B05+800;
- Emmet Road, Ch B06+350 – B06+450; and
- Old Kilmainham Road, Ch B06+750 – B07+250.

Emmet Road (Ch B05+600 – B05+800) and Old Kilmainham Road (Ch B06+750 – B07+250) are located within the Flood Zone A whereas Emmet Road (Ch B06+350 – B06+450) is located in Flood Zone B.

Within all three reaches, the Proposed Scheme comprises local works to re-orientate the existing highway. No changes are to be made to the level of the highway or modifications undertaken to any of the existing bridge/culvert crossings. There will therefore be no change in the risk of flooding at these locations following completion of the Proposed Scheme.

Raising the level of the highway within these reaches to reduce the risk of flooding is not practicable due to its impact on neighbouring properties and associated junctions. There is no change in use proposed as part of the Proposed Scheme therefore this existing level of flood risk is considered to be acceptable. Alternative routes are also available to users across the wider city transport network in the event of flooding. A wider flood relief scheme along the Camac River would be required to reduce the level of flood risk to the Proposed Scheme. Such a scheme is outside of the remit of the Proposed Scheme.

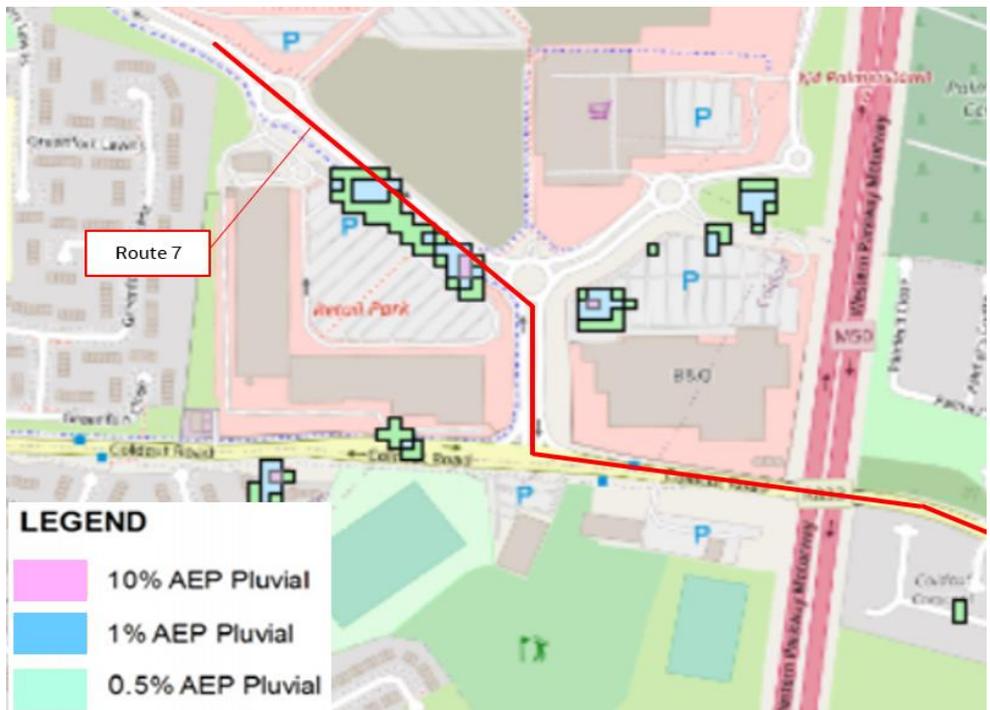
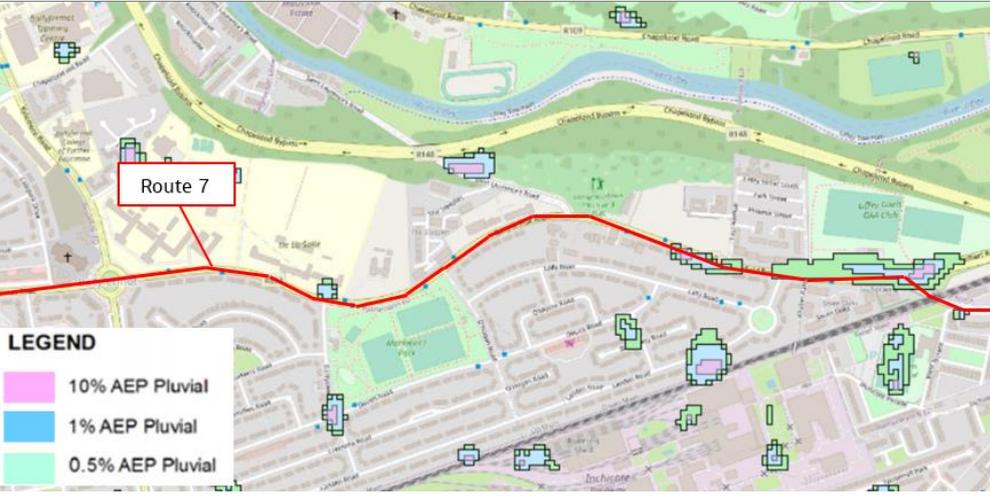
5.3 Initial Pluvial Flood Risk Assessment

Pluvial flooding occurs during periods of heavy rainfall, when the rainfall rate is greater than the infiltration capacity. It is usually associated with high intensity rainfall events (typically > 30mm/h) resulting in overland flow and ponding in depressions in the topography. In urban situations underground sewerage/drainage systems and surface watercourses may be overwhelmed.

Heavy rainfall is known to cause frequent ponding on the existing highway network. Typically, these flood events are short duration but could temporarily render parts of the bus corridor inaccessible to users (particularly cyclists).

Table 5.4 shows sections of the Route No.7 Corridor on Fonthill Road and Sarsfield Road which are at risk of flooding during a 0.5% AEP storm.

Table 5.4 Pluvial Flood Risk Areas

Location	Comments
	Fonthill Road
	Sarsfield Road

To reduce the risk of pluvial flooding would require extensive replacement and upgrade of the existing drainage networks along the full Proposed Scheme. This is beyond the scope of the project.

In line with the Dublin City Development Plan SFRA drainage from any new impermeable surfaces that are created by the scheme will be attenuated using Sustainable Drainage Systems (SuDS), as identified in The SuDS manual CIRIA 753. These measures will ensure no net increase in run off from the Proposed Scheme or additional flows being discharged to the existing drainage networks.

The existing risk of pluvial flooding to the Proposed Scheme is therefore unchanged. There is no change of use proposed as part of the Proposed Scheme therefore this level of risk is considered to be acceptable.

5.4 Artificial Drainage Systems

Flooding occurs from artificial drainage systems during periods of heavy rainfall, when the local drainage system reaches capacity and surcharges from manholes and/or gullies.

The wider route is currently served by an existing drainage system. Topographical survey results suggest that there are several locations where there are depressions that will naturally accumulate surface water along route No.7. The potential risk of flooding from Artificial Drainage Systems is as stated in section 5.1. As noted, in line with the Dublin City Development Plan SFRA drainage from any new impermeable surfaces that are created by the scheme will be attenuated using Sustainable Drainage Systems (SuDS), as identified in The SuDS manual CIRIA 753. These measures will ensure no net increase in run off from the Proposed Scheme or additional flows being discharged to the existing drainage networks.

5.5 Groundwater Flooding

Groundwater flooding can occur when groundwater rises up from the underlying water table or the water table rises above the surrounding ground level. This is usually associated with periods of prolonged rainfall or very high tides. There are no historic records of groundwater flooding along the Proposed Scheme. It can therefore be concluded that the risk of flooding to the site from groundwater is low.

5.6 Flood Risk due to Climate Change

Future climate change is predicted to give rise to an increased risk of flooding through rising sea levels and an increase in river flows and the frequency and intensity of extreme rainfall. The OPW has identified two potential scenarios for the impacts of climate change that are known as the Mid-Range Future Scenario (MRFS) and High-End Future Scenario (HEFS). Table 5.5 summarises the predicted impacts of both scenarios on predicted sea levels, river flows and rainfall depths over the next 100-years.

Table 5.5 Climate Change Forecast

Parameter	Mid-range Future Scenario (MRFS)	High-End Future Scenario (HRFS)
Mean Sea Level Rise	+500mm	+1000mm
River Flows	+20%	+30%
Extreme Rainfall Depths	+20%	+30%

The Mid-Range Future Scenario (MRFS) scenario is intended to represent the 'likely' future scenario based on a range of forecasts. The High-End Future Scenario (HEFS) represents a more extreme forecast that is at the upper end of accepted projections.

For the purposes of this flood risk assessment, the potential impact of climate change on flood risk to the proposed development has been made relative to the MRFS scenario as suggested in the recent document Ref PL 2/2014 issued by the Department of Housing, Local Government and Heritage.

Table 5.6 summarises the potential flood risk impacts with climate change on the proposed development.

Table 5.6 Climate Change Impact

Source of Flooding	Likely Impacts of Climate Change	Discussion
Coastal	No change	There is no existing risk of coastal flooding to the Proposed Scheme route. The ICPSS (Section 4.6) shows future climate change will not result in potential flooding of the route from coastal sources.
Fluvial	Increase	Refer to Table 5.7, Table 5.8 and Table 5.9 and associated text.
Estuarine	No change	There is no risk of coastal flooding to the Proposed Scheme. As a consequence, there is also no risk of estuarine flooding.
Pluvial	No change (Proposed systems) Increase (Existing systems)	<p>Future climate change will result in increased rainfall depths over the proposed development. The impacts are as follows:</p> <ul style="list-style-type: none"> For existing drainage systems there will be an increase in the risk of flooding as no works can be practically undertaken to increase their capacity. For new drainage systems constructed as part of the development, this will not result in an increase in the risk of pluvial flooding. This is because these systems will be designed to allow for the effects of future climate change.
Artificial Drainage Systems	No change (Proposed systems) Increase (Existing systems)	Any new impermeable surfaces associated with the works shall be catered for in additional stormwater infrastructure ensuring any additional runoff will not compromise the capacity or performance of the existing drainage systems. All additional stormwater drainage required will be designed to cater for the effects of future climate change.
Groundwater	No Impact	The scheme is not at risk from groundwater flooding. Future climate change will not affect this conclusion.

Future climate change has the potential to increase the risk of fluvial flooding to the proposed route. Table 5.7, Table 5.8 and Table 5.9 compare the maximum forecast increase in fluvial flood levels with the effects of climate change against the proposed route ground levels.

Table 5.7 Design Camac River Fluvial Flood Levels for route No.7 (Emmet Road Ch B05+600 – B05+800)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	19.30	19.32	+0.02
1% (1 in 100)	20.13		-0.81
0.1% (1 in 1000)	21.25		-1.93

Table 5.8 Design Camac River Fluvial Flood Levels for route No.7 (Emmet Road Ch B06+350 – B06+450)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	12.00	12.91	+0.91
1% (1 in 100)	12.76		+0.15
0.1% (1 in 1000)	14.09		-1.18

Table 5.9 Design Camac River Fluvial Flood Levels for route No.7 (Old Kilmainham Road, Ch B06+750 – B07+250)

AEP Event	Flood Level (mAOD)	Minimum Ground Levels (mAOD)	Difference / Freeboard Allowance (m)
10% (1 in 10)	7.15	7.35	+0.20
1% (1 in 100)	7.90		-0.55
0.1% (1 in 1000)	8.87		-1.52

As shown, Ch B05+600 – B05+800 and Ch B06+750 – B07+250 will be at risk from flooding in the 1% and 0.1% AEP floods. The reach Ch B06+350 – B06+450 will be at risk of flooding in the 0.1% AEP flood only. When subject to flooding, the potential depths at all locations would be prohibitive to vehicle and pedestrian traffic.

As noted, raising the level of the highway within these reaches to reduce the risk of flooding is not practicable due to its impact on neighbouring properties and associated junctions. There is no change in use proposed as part of the Proposed Scheme therefore this level of flood risk is considered to be acceptable. Alternative routes are also available to users across the wider city transport network in the event of flooding. A wider flood relief scheme along the Camac River would be required to reduce the level of flood risk to the Proposed Scheme due to climate change. Such a scheme is outside of the remit of the Proposed Scheme.

5.7 Summary of Flood Risk

The flood risk to the proposed development is summarised in Table 5.10 below.

Table 5.10 Summary of Flood Risk to Proposed Development

Flood Risk	Summary of Impact	Notes
Coastal	Low	The risk of coastal flooding is low
Fluvial	High	<p>The following reaches of the Proposed Scheme are at risk from fluvial flooding from the Camac river:</p> <ul style="list-style-type: none"> ▪ Emmet Road Ch B05+600 – B05+800 ▪ Emmet Road Ch B06+350 – B06+450 ▪ Old Kilmainham Road, Ch B06+750 – B07+250 <p>No change in ground level is proposed as part of the scheme and there will be no change to the risk of flooding. As noted, the proposed works comprise extension to an existing highway; maintaining the existing level of flood risk is considered to be acceptable as there is no planned change in use. Alternative routes are also available to users across the wider city transport network in the event of flooding.</p>
Estuarine	Low	The risk of estuarine flooding is low.
Pluvial	Low	<p>Fonthill Road and Sarsfield Avenue are at risk of flooding for 0.5% AEP storm events. Widescale improvement to the existing drainage network to alleviate this risk is considered to be beyond the scope of the Proposed Scheme.</p> <p>All new drainage infrastructure will be designed in line with the BusConnects Drainage Strategy that includes recommendations from the Great Dublin Strategic Drainage Study and CIRIA 753.</p>
Artificial Drainage Systems	Low	All new drainage infrastructure will be designed in line with the BusConnects Drainage Strategy that includes recommendations from the Greater Dublin Strategy Drainage Study and Ciria 753 SuDS Manual.
Groundwater	Low	The risk of groundwater flooding is low

6. Stage 2: Potential Flood Risk Impacts from Development

Section 5 considered the flood risk to the proposed development. This section will consider the potential change in flood risk to the surrounding areas from the works for each source.

6.1 Impacts on Coastal Flooding

The Proposed Scheme is not at risk from coastal flooding. The proposed scheme therefore has no impact on coastal flood risk.

6.2 Impacts on Fluvial Flooding

The Proposed Scheme is at risk from fluvial flooding from the Camac River. The proposed development could result in an increase in the risk of fluvial flooding from the Camac River if it were to:

- Reduce the conveyance of the existing watercourse and floodplain network;
- Reduce the volume of floodplain storage availability; and
- Increases site runoff rates and volume.

Section 5 showed that the Proposed Scheme will not require any modification to existing bridge crossings of the Camac River. The Proposed Scheme will also not result in any change in ground level within any existing flood risk areas. The current predicted extent, depth and onset of flooding from the Camac River will therefore not change as a result of the Proposed Scheme.

Mitigation measures to ensure no increase in site runoff and volume are described in Sections 6.4 and 6.5 below.

6.3 Impacts on Estuarine Flooding

The Proposed Scheme is not at risk from estuarine flooding. The proposed scheme therefore has not impact on coastal flood risk.

6.4 Impacts on Pluvial Flooding

In order to assess the increase in pluvial flood risk the following points need to be considered:

- Will the proposed development increase the rainfall runoff rate?
- Will the proposed development alter existing flow- or drainage paths?

As noted, the Proposed Scheme will result in an increase in the area of impermeable surfaces to accommodate improved bus, cycle and pedestrian access along the route. To ensure no associated increase in flood risk, the scheme developed an overarching Drainage Strategy¹ to ensure the implementation of sustainable Drainage Measures (SuDS). These measures which will be further developed through detailed design are in line with CIRIA SuDS manual C753 (2015), Greater Dublin Regional Code of Practice and associated GSDS Technical Documents. The proposed measures are designed to ensure no increase in existing runoff rates along the Proposed Scheme route as consequence of the works.

There will therefore be no change in the risk of pluvial flooding as a consequence of the Proposed Scheme. Further detail of the measures proposed are contained in Section 6.5.

¹ BusConnects Core bus Corridor Drainage Design Basis, Rev 5, February 2021

6.5 Impacts on Flooding from Artificial Drainage Systems

As noted, any increase in impermeable surface areas associated with the works is catered for in additional stormwater infrastructure ensuring any additional runoff will not compromise the existing system. Therefore, it can be concluded that the works will not give rise to any change in the risk of flooding arising from this source.

The increase in impermeable surface area has been offset by the use of SuDS to ensure no change on existing runoff rates that are discharged to any existing drainage system or outfall to a watercourse. The SuDS measures have been designed in CIRIA SuDS manual C753 (2015), Greater Dublin regional Code of Practice and associated GSDS Technical Documents.

The methodology to design the additional stormwater network and associated SuDS measures is set out in the projects overarching Drainage Strategy². For the Proposed Scheme, the route was split into catchments based upon gradient, topography and outfall location. The additional impermeable area within each catchment was then identified and new storm water infrastructure provided. Prior to discharge to the existing network or outfall to a watercourse, SuDS measures are applied to ensure no increase in existing runoff rates within or being discharged to the existing drainage network.

SuDS measures were selected following a hierarchy which favoured source type solutions close to the new impermeable areas e.g. tree pits as opposed to tanks and other regional type solutions at the downstream end of the network. A conceptual model of this approach is presented in Table 6.1.

Table 6.1 The SuDS Management Train. Source: reproduced by Jacobs from CIRIA SuDS Manual 2015

<u>Scale</u>		<u>SuDS Management Train</u>
	<u>Source</u>	Rainwater Harvesting – capture and reuse within the local environment
		Pervious Surfacing Systems – structural surfaces that allow water to penetrate into the ground reducing discharge to a drainage system e.g. pervious pavement, tree pits
	<u>Site</u>	Infiltration Systems – structures which encourage infiltration into the ground e.g. Bioretention Basins
		Conveyance Systems – components that convey and control the discharge of flows to downstream storage components e.g. Swales
<u>Regional</u>	Storage Systems – components that control the flows before discharge e.g. attenuation ponds, tanks, oversized pipes or basins	

It should be noted that the selection of a SuDS measure was conditioned by local factors as, in some instances, private land ownership prevented the use of source or site solutions, with the only available option to oversize new pipes beneath the road surface to attenuate any additional flow. In all instances however, SuDS measures are implemented to ensure no increase in the net rate of runoff from any new impermeable areas.

The proposed drainage design for the Proposed Scheme is presented in the drainage drawings, showing new impermeable areas and their associated SuDS measures. All measures and their associated drainage networks have been designed using WINDES MicroDrainage Models and are sized to contain the 100-year storm with a 20% allowance for future climate change. A summary of these measures is also listed below.

² BusConnects Core bus Corridor Drainage Design Basis, Rev 5, February 2021

- **Section 1: Liffey Valley Shopping Centre to Coldcut Road Junction**

- Two 5 m wide swales along the eastern side of Fonthill Road (Ch A0+000 – A0+150). The storage volume provided equals 244 m³. There is an oil separator at the outlet and the permissible outflow is 2l/s.
- Two 2.4 m wide swales along the northern side of Fonthill Road (Ch A0+200 – A0+450). The storage volume provided equals 39.2 m³.
- Attenuation (swales) along the southern side of Fonthill Road (Ch A0+200 – A0+450). The storage volume provided equals 172.0 m³.
- Attenuation pond to the west of Fonthill Road roundabout (Ch A0+450). This pond provides 125 m³ storage volume. There is an oil separator at the outlet and the permissible outflow is 2l/s.

- **Section 2: Coldcut Road to Kylemore Road Junction**

- Oversized pipe along the northern side of Coldcut Road to provide attenuation storage of 30 m³ (Ch B0+000 – B0+150).
- Attenuation pond north to Coldcut Road (bottom of Palmer's Lawn (Ch B0+350). The pond area is 144m². There is an oil separator at the outlet and the permissible outflow is 2l/s.
- Two proposed filter drains along either side of Coldcut Road (Ch B0+300 – B0+500). The attenuation storage provided would be 62 m³ and the permissible outflow is 2l/s.
- Underground attenuation storage of 42 m³ under Coldcut Road (Ch B0+650). There is an oil separator at the outlet and the permissible outflow is 2l/s.
- Attenuation pond to the west of Kennelsfort Road Upper and north to Coldcut Road (Ch B0+750). This pond provides 45 m³ storage volume. The permissible outflow is 2l/s.
- Two proposed filter drains along either side of Coldcut Road (Ch B0+520 – B0+800).
- A filter drain along Kennelsfort Road Upper and Ballyfermot Road (Ch B0+750 – B0+850).
- Two proposed filter drains along either side of Ballyfermot Road (Ch B0+520 – B0+800).
- Two proposed filter drains along either side of Ballyfermot Road (Ch B0+850 – B1+400).
- Attenuation storage on the grassed area in Cherry Orchard Hospital (Ch B1+300). The area is 250m². There is an oil separator at the outlet and the permissible outflow is 2l/s.
- Attenuation volume along the northern side of Ballyfermot Road (four tree pits and a 2.4 m swale) to provide attenuation storage of 2 m³ (Ch B1+850 – B1+950). The permissible outflow is 2l/s.
- A filter drain along Ballyfermot Road (Ch B1+200 – B2+350). The attenuation storage provided would be 3 m³ and the permissible outflow is 2l/s.

- **Section 3: Kylemore Road to Inchicore Road Junction**

- A filter drain along the northern side of Ballyfermot Road (Ch B2+900 – B3+125). The attenuation storage provided would be 360 m³ and the permissible outflow is 2l/s.
- Attenuation storage on the grassed area in De La Salle National School (Ch B3+175). The area is 250m². There is an oil separator at the outlet and the permissible outflow is 2l/s.
- A filter drain along the northern side of Ballyfermot Road (Ch B3+200 – B3+550). The attenuation storage provided would be 36 m³. There is an oil separator at the outlet and the permissible outflow is 2l/s.
- Attenuation pond on the grassed area east of the crossroads between St.Laurence's Road and Sarsfield Road (Ch B3+850). This pond provides 129 m³ storage volume. There is an oil separator at the outlet and the permissible outflow is 2l/s.

- Attenuation (a 2.4 m wide swale) along the northern side of Sarsfield Road (Ch A3+975 – A4+160). The storage volume provided equals 35.0 m³.
 - A proposed storm water pipe (Ch A3+350 – A4+710) which will attenuate runoff created by the additional impermeable areas from the works to the existing storm water network.
- **Section 4: Inchicore Road Junction to South Circular Road Junction**
 - A filter drain along the northern side of Emmet Road (Ch B6+460 – B6+520). The attenuation storage provided would be 7 m³.

6.6 Impacts on Groundwater Flooding

The proposed works do not involve any new works below existing ground levels that would cause an increase in the risk of groundwater flooding.

6.7 Summary of Potential Flood Risk Impacts from Development

The flood risk impacts from the proposed development are summarised in Table 6.2

Table 6.2 Summary of potential flood risk impacts on surrounding areas as a result of the development

Flood Risk	Potential Scheme Impact	Discussion & Mitigation (where Required)	Residual Scheme Impact (with mitigation)
Coastal	No Impact	No impact as the proposed development is not at risk of coastal flooding.	No impact
Fluvial	No Impact	No impact on channel or floodplain storage and conveyance from the works.	No impact
Estuarine	No impact	No change in ground levels or new structures are proposed that will impact on the current flood extent	No impact
Pluvial	Increase	As noted, the upgrade works has the potential to increase the rate of runoff from the creation of additional impermeable surfaces. The proposed scheme will however include full mitigation in the form of Sustainable Drainage Systems to ensure no change to the existing runoff rates.	No impact
Artificial Drainage Systems	No impact	Any additional drainage will include SuDS measures to maintain existing site runoff rates meaning no change in flood risk.	No impact
Groundwater	No impact	Below-ground elements of the works are localised and will not impact ground water movements.	No impact

7. Flood Risk Management and Evaluation

7.1 The Sequential Approach to Development Planning

The FRA indicates that part of the Proposed Scheme will be located in Flood Zones A and B. 'The Planning System and Flood Risk Management: Guidelines for Planning Authorities and Technical Appendices, 2009' classifies the proposed development as 'highly vulnerable' with respect to flooding.

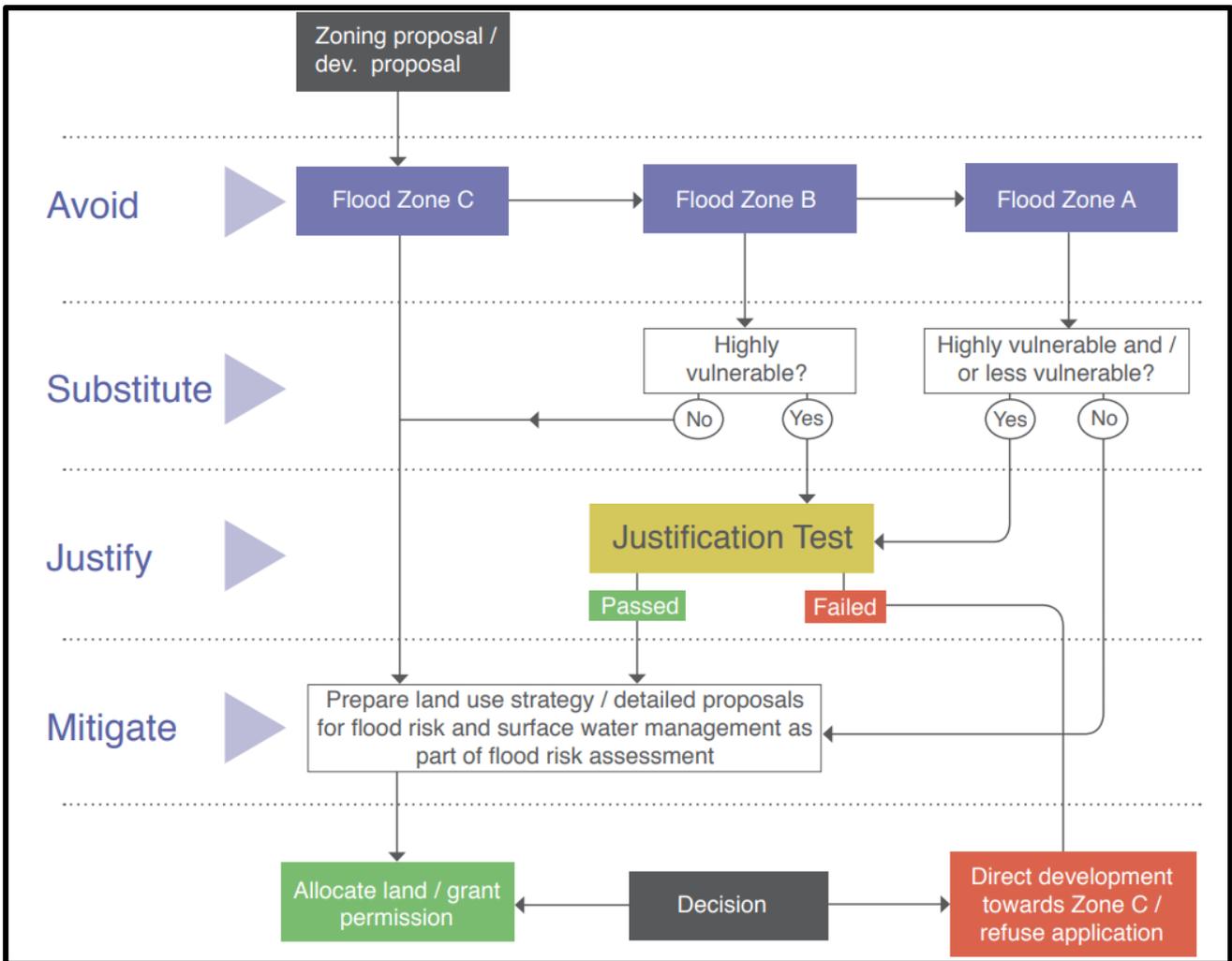
Application of the sequential approach within the FRM Guidelines would be to steer the Proposed Scheme away from flood zones A and B. This is not practicable however, as the works comprise modification and extension to an existing highway. Raising the level of the highway to reduce the risk of flooding is also not practicable as this would have a significant detrimental impact on adjacent properties.

Document reference PL 2/2014 issued by the Department of Housing, Local Government and Heritage (9th March 2021), sought to provide clarification on the use of Flood Mapping in planning applications and application of flood zones within older developed areas of towns and cities. Document PL 2/2014 noted that where developments concern the extension to existing assets, the sequential approach cannot always be used to locate them in lower areas of flood risk. The Justification Test will therefore not apply however, a commensurate assessment of the risk of flooding from the development is required to ensure no adverse impacts.

Given the scale and strategic importance of the Proposed Scheme to transport provision in Dublin and classification as a 'highly vulnerable' development in accordance with the FRM, whilst not strictly required based on PL 2/2014, an assessment of the proposed scheme in the spirit of a justification test was undertaken to demonstrate that the development was compatible with the existing level of flood risk.

7.2 Justification of the Proposed works

Parts of the Proposed Scheme are located in Flood Zones A and B. An assessment of the proposed scheme in the spirit of a justification test was undertaken to demonstrate that the development was compatible with the existing level of flood risk.



7.2.1 Justification Test

'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (2009), 5.15, Box 5.1 (reproduced below) as amended by PL 2/2014 sets out the criteria for the Justification Test. An assessment of the proposed development against these criteria is presented in Table 7.1.

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 proposal 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.

Refer to section 5.28 in relation to minor and infill developments.

Table 7.1 Assessment against Justification Test Criteria

Criteria to be satisfied	Justification	Criteria Met
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.	Proposed Scheme comprises re-orientation and extension to an existing highway. The lands are zoned accordingly for this purpose.	Yes
The development will not increase flood risk elsewhere, and, if practicable, will reduce overall flood risk.	As shown in Section 5, the works will not increase the flood risk from any source.	Yes
The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably practicable.	<p>The works comprise modifications to an existing highway and, as noted, it is not practicable to reduce the level of flood risk to the Proposed Scheme.</p> <p>The wider objective of the Proposed Scheme is to promote more sustainable forms of transport and reduce the number of cars. In this regard, the Proposed Scheme can be regarded as meeting these criteria as it will reduce the number of vehicles potentially exposed to flooding.</p> <p>SuDS measures implemented as part of the scheme will also improve the quality of runoff, delivering a net benefit to the environment.</p>	Yes
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.	As stated in Section 5, the development will incorporate SuDS to ensure there is no increase runoff rates as a consequence of the works. Therefore, there will be no increase in flood risk from an increase in the area of impermeable surfaces as part of the works.	Yes
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 proposed development meets the objectives set out in the Dublin City Development Plan 2016-2022 as it forms a key part of achieving the required rate of sustainable urban growth by promoting active travel and public transport.	Yes

Whilst a Justification Test is not considered to be necessary for the Proposed Scheme. The proposed development is still considered to meet the criteria of the Justification Test set out in Box 5.1 in the 'Planning System and Flood Risk Management – Guidelines for Planning Authorities (Nov 09)'.

8. Conclusions and Recommendations

8.1 Conclusions

The following sources of flood risk occur along the Proposed Scheme:

- A risk of pluvial flooding due to the limited capacity of the existing highway drainage network; and
- A risk of fluvial flooding from the Camac River.

Pluvial Flooding

There is a high risk of pluvial flooding along the entire Proposed Scheme. This is a function of the capacity of the existing surface water network, which is typically designed to contain a 20% AEP storm. It is beyond the scope of the Proposed Scheme to increase the capacity of the existing surface water network.

The Proposed Scheme will result in the creation of additional impermeable surfaces for local sections of road widening. SuDS measures have been implemented to ensure that there is no change in existing runoff rates as a consequence of the scheme. This will ensure no increase in the risk of pluvial flooding.

Fluvial Flooding

Part of the Proposed Scheme is at risk from fluvial flooding from Camac River.

The Proposed Scheme will not affect the hydraulic capacity of the Camac River or any structures which cross it. No works are proposed to modify any existing bridges that would reduce their hydraulic capacity. The existing level of the road will also be maintained. The Proposed Scheme will therefore not result in any change to the existing risk of fluvial flooding.

As noted, the proposed works typically comprise local widening of the existing highway. It is not possible to raise the level of the highway to reduce the existing level of flood risk. It is also beyond the scope of the Proposed Scheme to implement a wider flood relief scheme for the Camac River to reduce the risk of fluvial flooding from the watercourses.

Climate Change

Climate change will result in an increased risk of flooding to the Proposed Scheme due to:

- Increased river flows; and
- Increased rainfall depths and intensity.

Increased rainfall depths and intensities will increase the risk of pluvial flooding from the existing surface water drainage network. New drainage measures which installed as part of the scheme, including any SuDS, are designed to allow for future climate change.

There will be an increased risk of fluvial flooding to the Proposed Scheme as a consequence of climate change. As noted, it is not possible to reduce the current risk of fluvial flooding to the Proposed Scheme as the existing road levels need to be maintained. The Proposed Scheme will not exacerbate the impacts of climate change on the risk of fluvial flooding.

The impact of climate change on coastal flooding is not applicable to the Proposed Scheme as the current and future risk is so low.

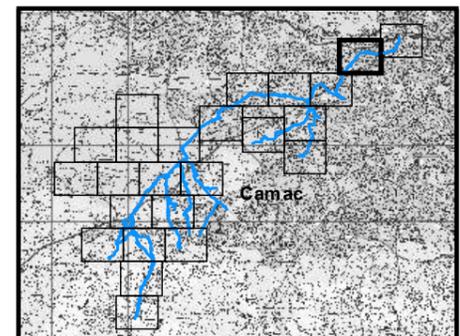
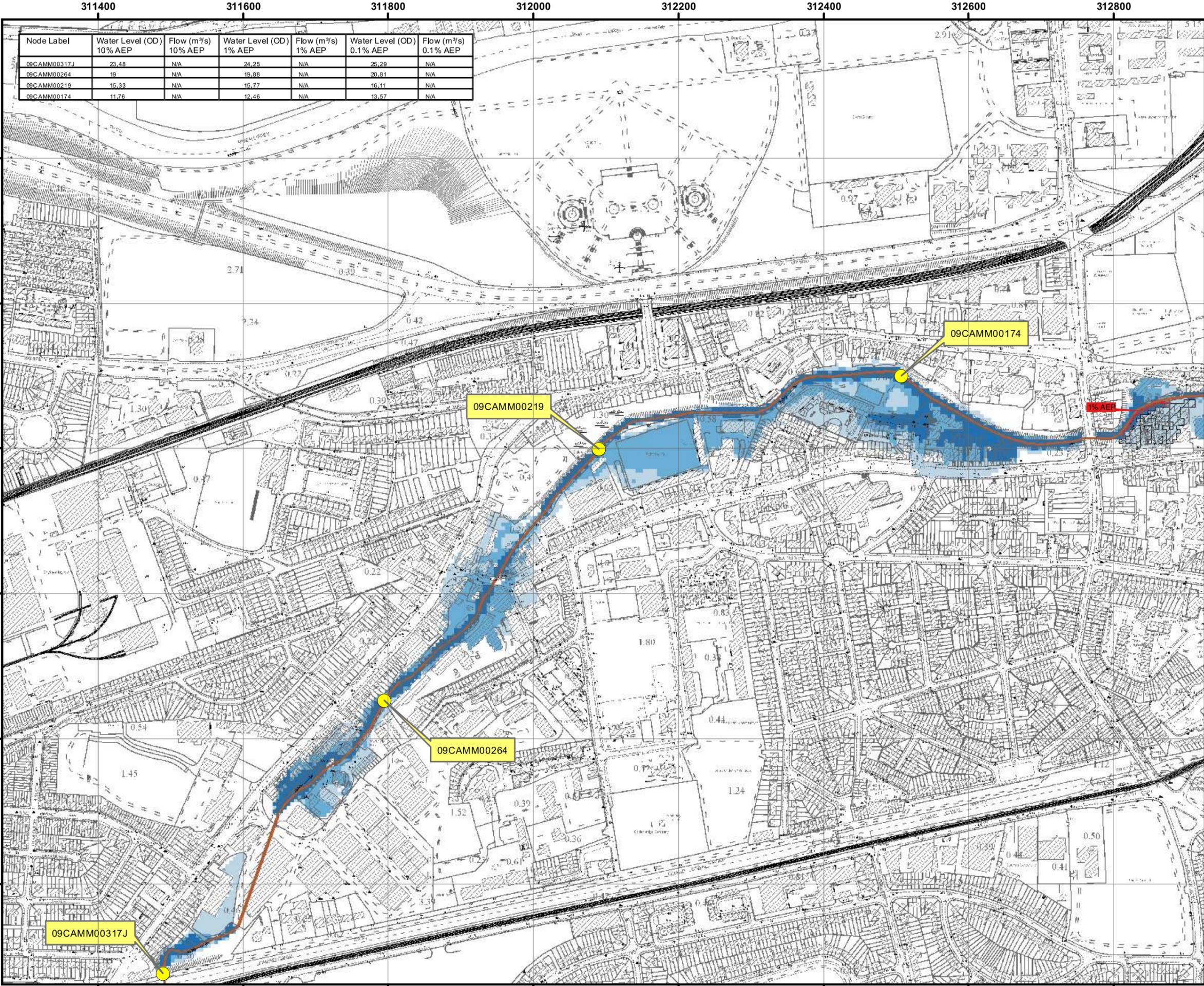
A Stage 3 Detailed Risk Assessment is not considered necessary as there will be no change in existing flood risk patterns or processes as consequence of the Proposed Scheme.

Appendix A. Information Sources Checklist

No.	Information Source	Status	Reference/Comments
1	OPW Preliminary Flood Risk Assessment indicative fluvial flood maps	X	Not available
2	National Coastal Protection Strategy Study flood and coastal erosion risk maps.	X	Not available
3	Predictive and historic flood maps, and Benefiting Lands Map	✓	Flooding History was provided by OPW floodinfo.ie
4	Predictive flood maps produced under the CFRAM studies	✓	CFRAM maps are available and have been used.
5	River Basin Management Plans and reports	✓	River Basin Management Plan for Ireland (2018-2021)
6	Indicative assessment of existing flood risk under Preliminary Flood Risk Assessment	X	
7	Previous Strategic Flood Risk Assessments	✓	Dublin City Development Plan 2016-2022 (Strategic Flood Risk Assessment)
8	Expert advice from OPW who may be able to provide reports containing the results of detailed modelling and flood-mapping studies including critical damage areas, and information on historic flood events and local studies etc.	X	
9	Topographical maps, in particular digital elevation models produced by aerial survey or ground survey techniques.	✓	Topographic Survey Data dated 17 February 2020 is available.
10	Information on flood defence condition and performance	N/A	
11	Alluvial deposit maps	N/A	
12	'Liable to Flood' markings on the old 6" Inch Map	X	

13	Local Libraries and newspaper reports	✓	Adequate information on Flooding History was provided by OPW floodmaps.ie
14	Interviews with local people, local history/natural history societies etc.	X	
15	Walkover survey to assess potential sources of flooding, likely routes for flood water and the site's key features, including flood defences, and their condition	X	

Appendix B. OPW CFRAM Mapping



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
 - Embankment
 - Wall
 - Defended Area
 - 1% AEP Standard of Protection of Flood Defence (Walls / Embankments)
 - 1% AEP Standard of Protection of Flood Defence (Walls / Embankments)
 - Node Point
 - Node ID Node Label

FINAL

REV: 01	NOTE: SOP label updated (Pg 21) Removal of Def. Area (Pg 21)	DATE: 13/11/2017
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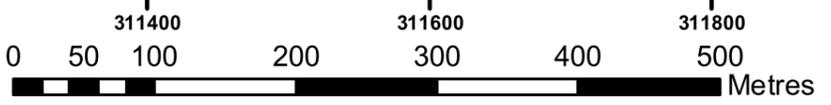


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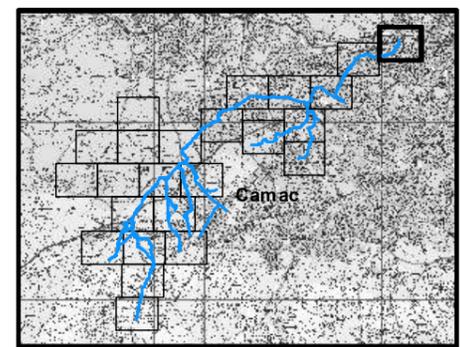
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Map: Camac Fluvial Flood Extents
Map Type: EXTENT
Source: FLUVIAL
Map Area: HPW
Scenario: CURRENT
Drawn By: C.McG. Date: 13 November 2017
Checked By: A.S. Date: 13 November 2017
Approved By: S.P. Date: 13 November 2017
Drawing No.: E09CAM_EXFCD_F1_23
Map Series: Page 23 of 24
Drawing Scale: 1:5,000 @A3



Node Label	Water Level (OD) 10% AEP	Flow (m ³ /s) 10% AEP	Water Level (OD) 1% AEP	Flow (m ³ /s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m ³ /s) 0.1% AEP
09Camm00084	6.88	N/A	7.68	N/A	8.49	N/A
09Camm000271	3.29	32.00	4.37	50.7	6.09	88.70
09Camm00125	9.61	N/A	10.18	N/A	10.93	N/A



IMPORTANT USER NOTE:
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- Legend**
- 10% Fluvial AEP Event
 - 1% Fluvial AEP Event
 - 0.1% Fluvial AEP Event
 - Modelled River Centreline
 - AFA Extents
 - Embankment
 - Wall
 - Defended Area
 - Standard of Protection of Flood Defence (Walls / Embankments)
 - 1% AEP
 - Node Point
 - Node ID Node Label

FINAL

REV: 01	NOTE: SOP label updated (Pg 21) Removal of Def. Area (Pg 21)	DATE: 13/11/2017
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Map:	
Camac Fluvial Flood Extents	
Map Type:	EXTENT
Source:	FLUVIAL
Map Area:	HPW
Scenario:	CURRENT
Drawn By:	C.McG. Date: 13 November 2017
Checked By:	A.S. Date: 13 November 2017
Approved By:	S.P. Date: 13 November 2017
Drawing No.:	E09CAM_EXFCD_F1_24
Map Series:	Page 24 of 24
Drawing Scale:	1:5,000 @A3

