Chapter 13
(Water) Appendices

Galway City Council

BusConnects Galway: Cross-City Link (University Road to Dublin Road)

Flood Risk Assessment

253352-00

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This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Executive Summary

Arup was commissioned by Galway City Council to prepare a site-specific Flood Risk Assessment (FRA) to support a planning application for the proposed Bus Connects Galway: Cross-City Link (University Road to Dublin Road) transport infrastructure development within Galway City Centre.

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).

Galway City has historically been prone to fluvial and/or tidal flooding with some significant events occurring in recent years. Parts of the site are at risk of flooding from the River Corrib and surrounding canals and waterways. 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 6.7km of road infrastructure, cycle lane and pedestrian walkway upgrades and therefore interfaces with many 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 upgraded surface water drainage system, additional green area, SUDs features such as tree pits, bioretention areas and catchpits, oversized pipes, and an attenuation tank 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 Galway City 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 Introduction

1.1 Background

Arup was commissioned by Galway City Council (GCC) to prepare a site-specific Flood Risk Assessment (FRA) to support a planning application for the proposed Cross City Link.

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 then 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 Assessment completed for the Galway City Development Plan 2017 – 2023.

1.2 Proposed Scheme

Galway City Council proposes to develop the BusConnects Galway: Cross-City Link (R863 University Road to R338 Dublin Road) (herein referred to as 'the Proposed Scheme') as part of the Galway Transport Strategy.

The Proposed Scheme is a public transport priority corridor encompassing pedestrian crossings, upgraded footpaths, enhanced cycle facilities and additional bus priority measures, from University Road to Dublin Road. The Proposed Scheme is being progressed to enable more sustainable and effective movement in the transport networks in Galway City, and the wider region.

The Cross City Link route covers a total length of approximately 6.7km of road infrastructure, cycle lane and pedestrian walkway upgrades from University Road to Dublin Road. The route is shown in Figure 1.

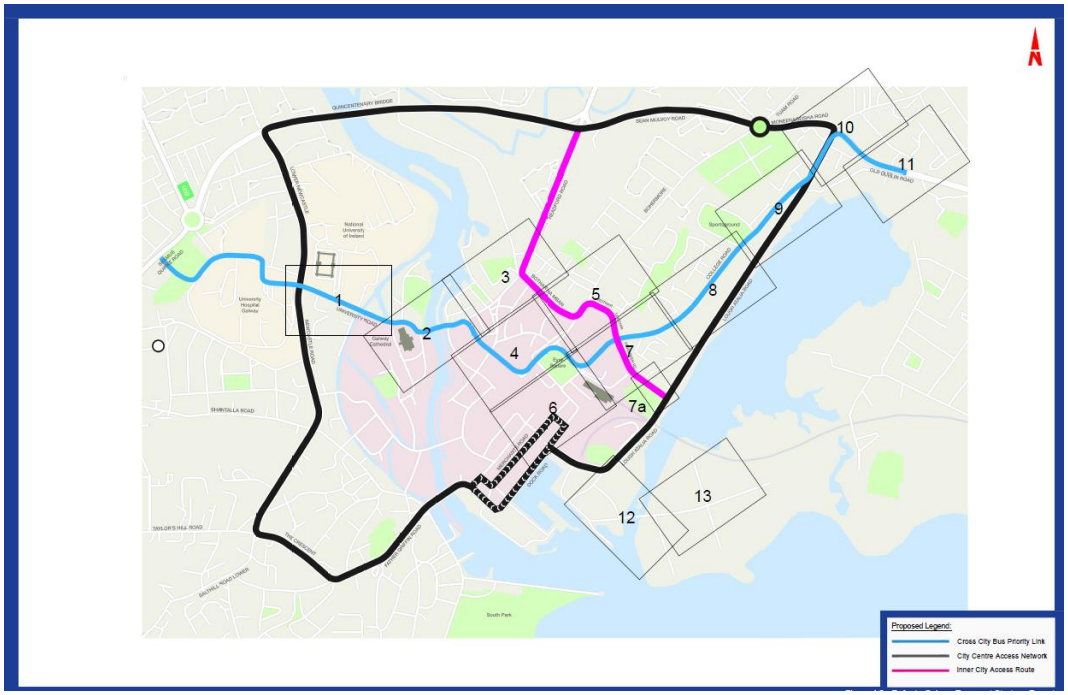

Figure 1: Cross-City Link (blue) of the Proposed Scheme layout

The Proposed Scheme commences at the junction of the University Road and Newcastle Road and moves eastwards along University Road and across the Salmon Weir Bridge. It continues to St Vincent's Avenue, St Francis Street, Eglinton Street and into Eyre Square, routing along the northern and eastern sides of Eyre Square, on to Forster Street and through College Road. The Scheme continues to Dublin Road and terminates approximately 370m east of the junction at Moneenageisha.

Primary access to the Proposed Scheme will be from Lower Newcastle and the N6 from the University Roadside and via the Dublin Road and Well Park Road for the Moneenageisha junction. Emergency access/egress for all emergency services will be provided from all access routes.

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

1.3 Site Location

The Proposed Scheme is located within the Galway city centre, extending on the west from the University Road and R864 junction at the University Hospital Galway, travelling along University Road to the Galway Cathedral and city centre and extending east to College Road along Lough Atalia. Approximate points of eastern and western bounds are Irish Transverse Mercator (ITM) reference E: 530541, N: 725639 and E: 529071, N: 725716, respectively. The location of the Proposed Scheme including Site Compounds is shown in Figure 2.

Figure 2: Site location (© Open Street Map (and) contributors)

The site route crosses, from west to east, the Eglington Canal, Gaol River, Distillery River, the River Corrib, and Friars River. Additionally, sections of the site terminate on waterfronts at the Commercial Docks and Lough Atalia. The development is located along the major road infrastructure from University Road to Dublin Road. The proposed main Site Compounds are situated south of the site at Galway Harbour.

The River Corrib flows in a southerly direction through the development site.

The site slopes from north to south, falling from its highest point of +19.07mOD at Prospect Hill to the lowest points of +3.61mOD at Dock Road and +3.80mOD on Lough Atalia Road.

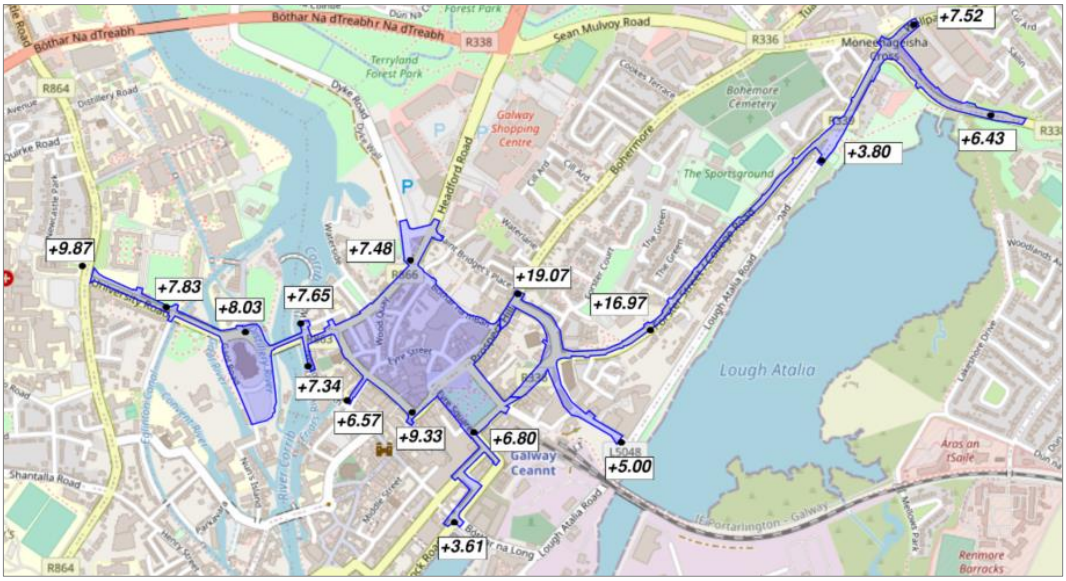

Figure 3: Site topographic levels (Information: APEX Surveys, 28th April 2017, Background: © Open Street Map (and) contributors)

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.

1.5 Summary of Data Sources

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

- Galway City Development Plan 2017 – 2023 including its Strategic Flood Risk Assessment,
- Western CFRAM Hydrology and Hydraulics Reports and predictive flood mapping (https://www.floodinfo.ie/publications/),
- Western CFRAM Catchment Flood Risk Management Plan (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,
- Proposed scheme planning application drawings.

2 Stage 1 – Flood Risk Identification

2.1 Historic Flooding Maps

The OSI Historic 6" map marks out flooding vulnerability along College Road and Dublin Road with incidents noted to occur at spring tide. Directly south of the Moneenageisha Road junction historic floods are outlined. This indicates a historic tendency for flooding at this low point of the road.

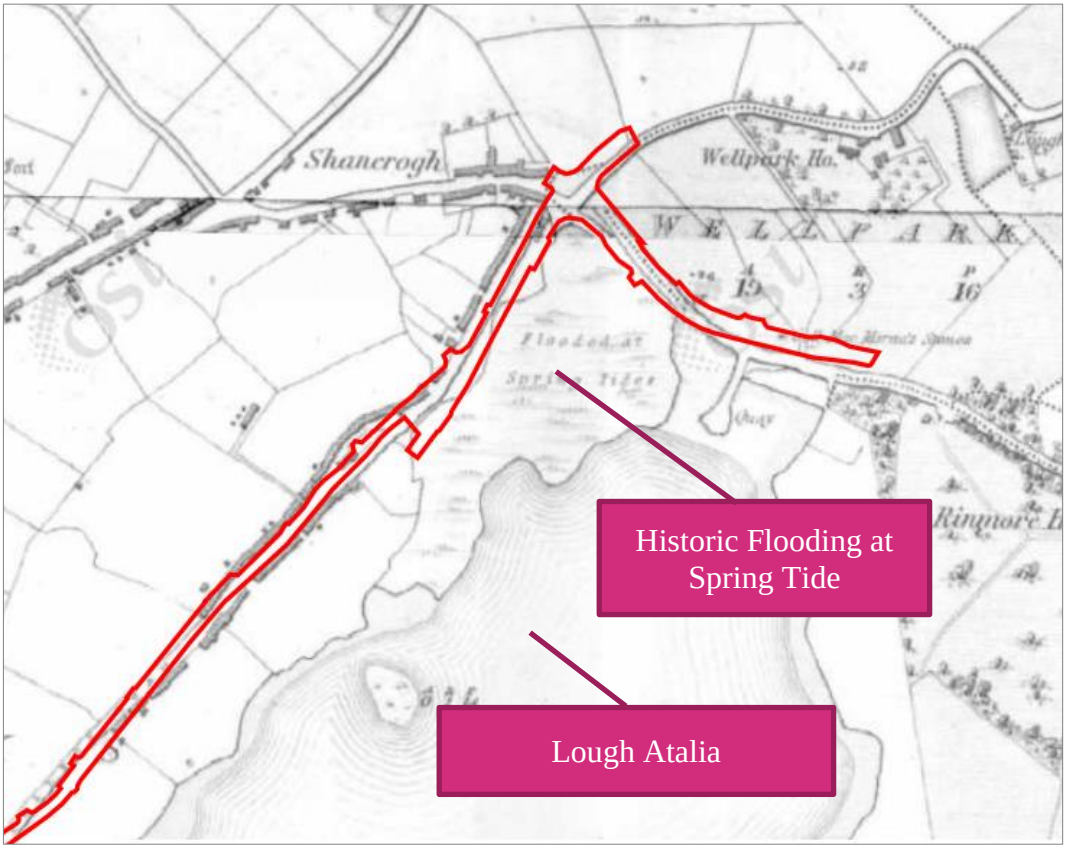

Figure 4: OSI Historic 6'' Mapping from Beehive

2.2 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 Western Catchment Flood Risk Assessment Management Study (Western CFRAMS). 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.

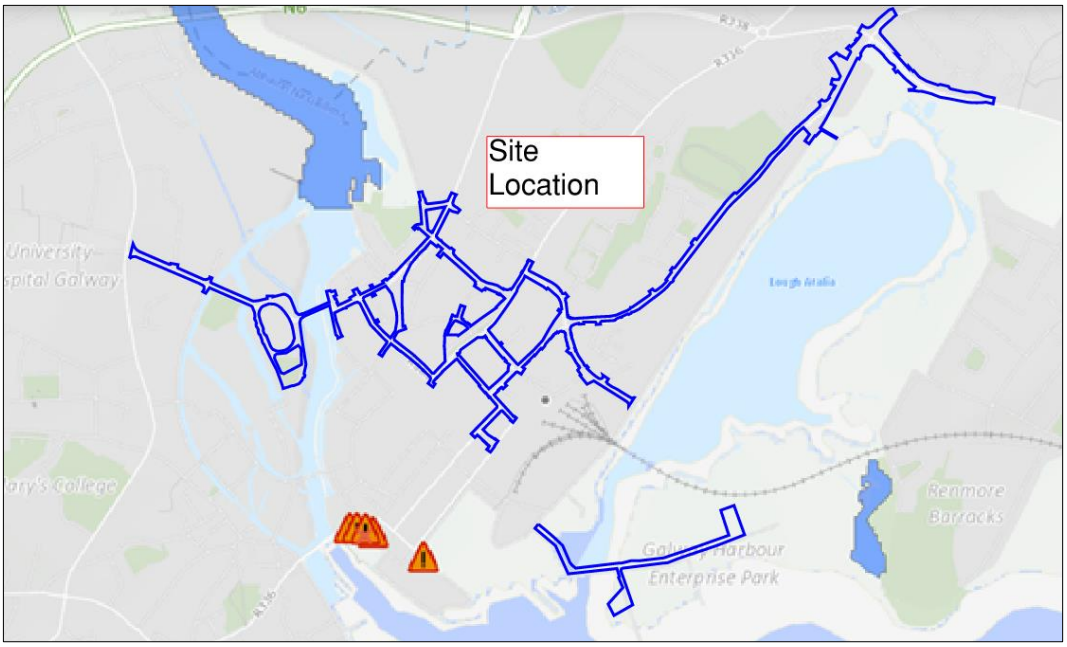

Figure 5: Past Flood Events - Extract from the National Flood Hazard Mapping Website

Galway City 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 near the subject site are listed in Table 1. However, none of the above recorded flood events have occurred within the boundary of the Proposed Scheme site.

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

Date of flood event	Location	Flooding mechanism
17 – 20 January 1995	Docks, Flood Street & Quay Street	Pluvial / Tidal
28 January 2013	Galway City	Pluvial
18 December 2013	Salthill & Galway	Tidal
3 January 2014	Salthill & Galway	Tidal
1 February 2014	Salthill & Galway	Tidal

2.3 Fluvial Flood Risk Map

The Western CFRAM was completed in recent years and provided predicted fluvial and tidal flood maps in Galway City for a range of return periods.

An extract from the Western CFRAMS fluvial flood extent map is presented in Figure 6. The predicted extents for the 1 in 10-, 100- and 1000-year fluvial flood events are shown.

The flood map indicates that the southern portion of Gaol Road south of the Galway Cathedral lies within the 1 in 1000-year fluvial flood extent (Flood Zone B), with the rest of the site is located outside of the 1 in 1000-year fluvial flood extent.

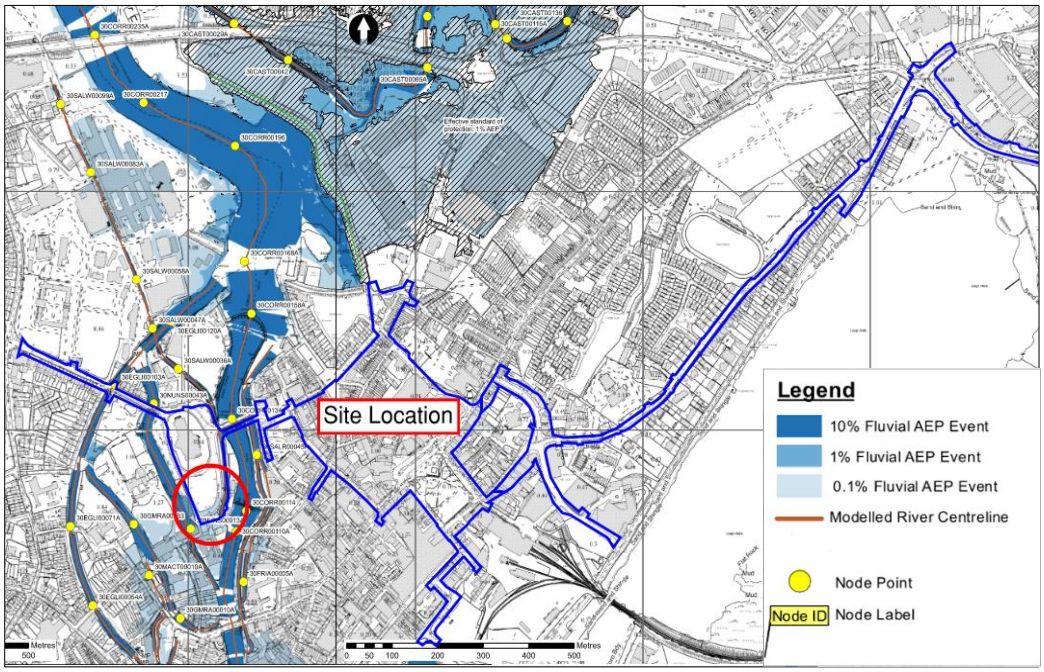

Figure 6: Flood Extents - Extract from Western CFRAMS fluvial flood extent map, current scenario

2.4 Tidal Flood Risk Map

An extract from the Western CFRAMS tidal flood extent map is displayed in Figure 7. 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 Western CFRAM Coastal study.

The flood map indicates that most of the site is in areas outside the 1 in 1000-year tidal flood extent, categorised as Flood Zone C. However, three sections of the work within the Lough Atalia/College Road region (no. 1 in figure 7) were categorised as Flood Zone B and an additional area along Dock Road was categorised as Flood Zone A (no.2 in Figure 7) and small encroachment at Dyke Road.

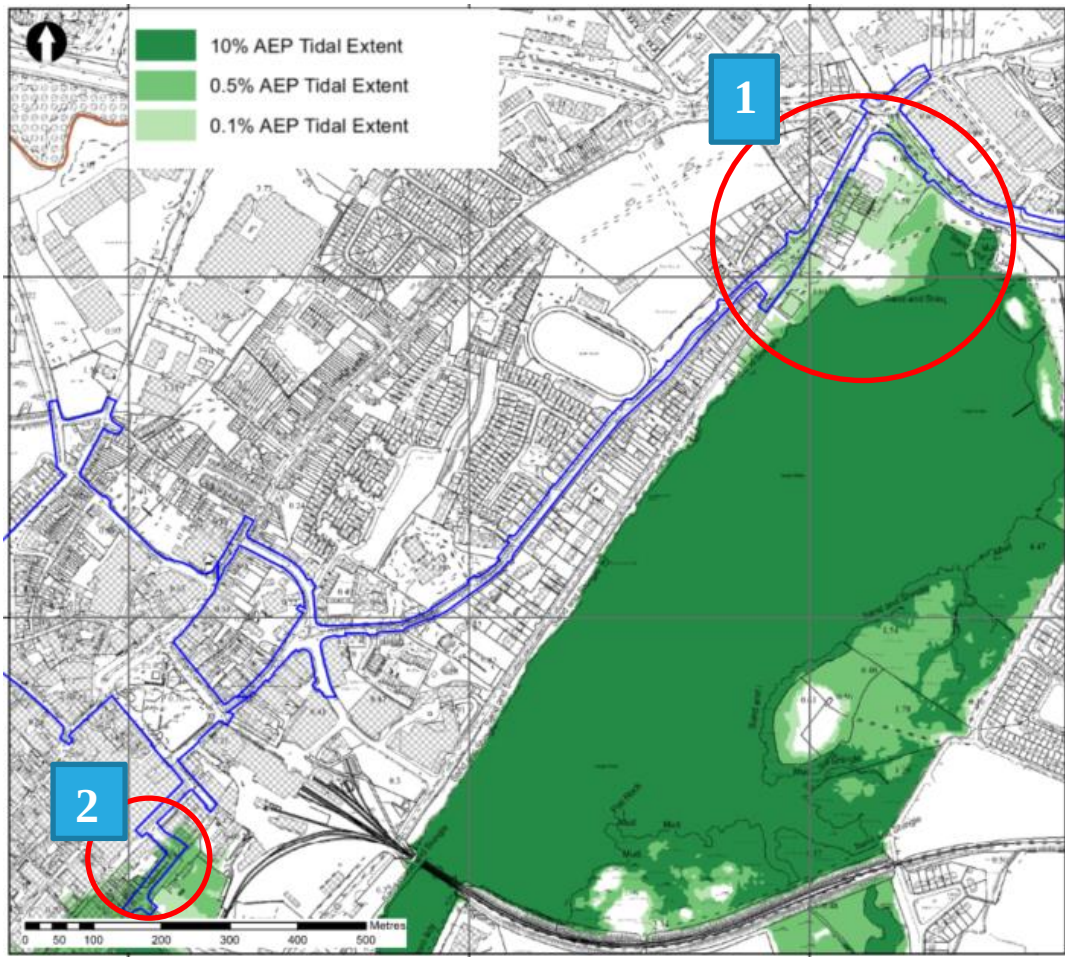

Figure 7: Extract from the Western CFRAM tidal flood extent map

2.5 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 PFRA mapping undertaken by the OPW was reviewed. An extract of the OPW PFRA map is presented in Figure 8.

The PFRA map indicates that the site and many of the roads in the vicinity of the site are not within areas at high risk of pluvial flooding (orange). Therefore, the risk of pluvial flooding at the site is considered low.

It should be noted that the PFRA maps are only indicative. Pluvial flooding to the site may still exist and hence should be mitigated with appropriate landscaping and adequately designed drainage system where required if the development proposal goes ahead as planned.

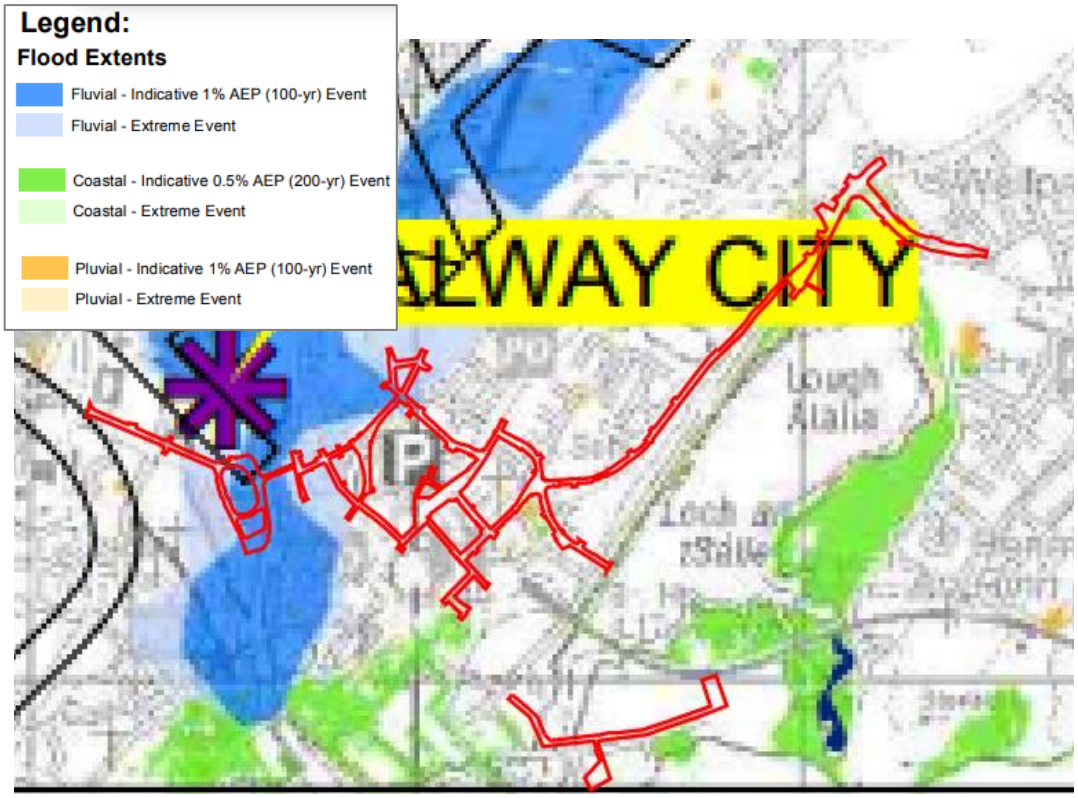

Figure 8: Extract from OPW PFRA pluvial flood map (www.myplan.ie)

2.6 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 9. It should be noted that the groundwater flooding data maps are only indicative. These maps are developed to indicate areas of high groundwater likelihood given the karst limestone rock formation found in this western area of the country.

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

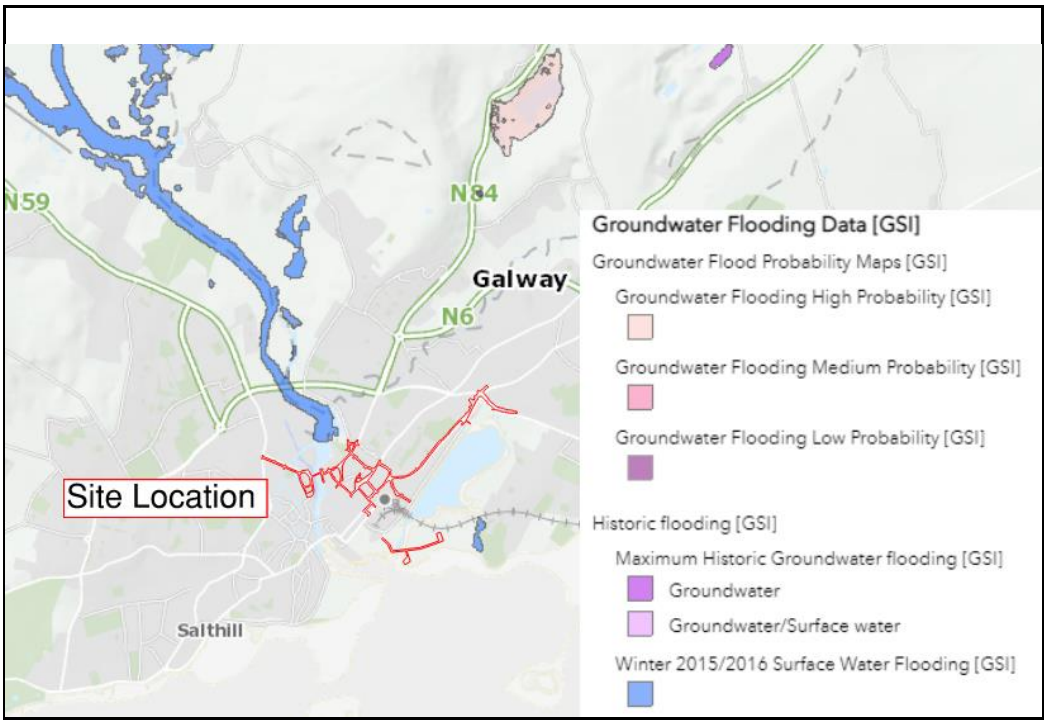

Figure 9: Extract from GSI Groundwater Flood Map (floodinfo.ie)

Figure 10 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 Lough Atalia and a small area of extreme vulnerability in the southern section of Nuns Island at Gaol Road. This suggests that groundwater levels at the site may be relatively shallow. Additionally, it is known that highly permeable rock is present in these locations.

Therefore, it is likely that the vulnerability rating is indicative of a relatively shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways. Coupled with a permeable rock, this represents a moderate risk of groundwater flooding which is limited to the construction stage.

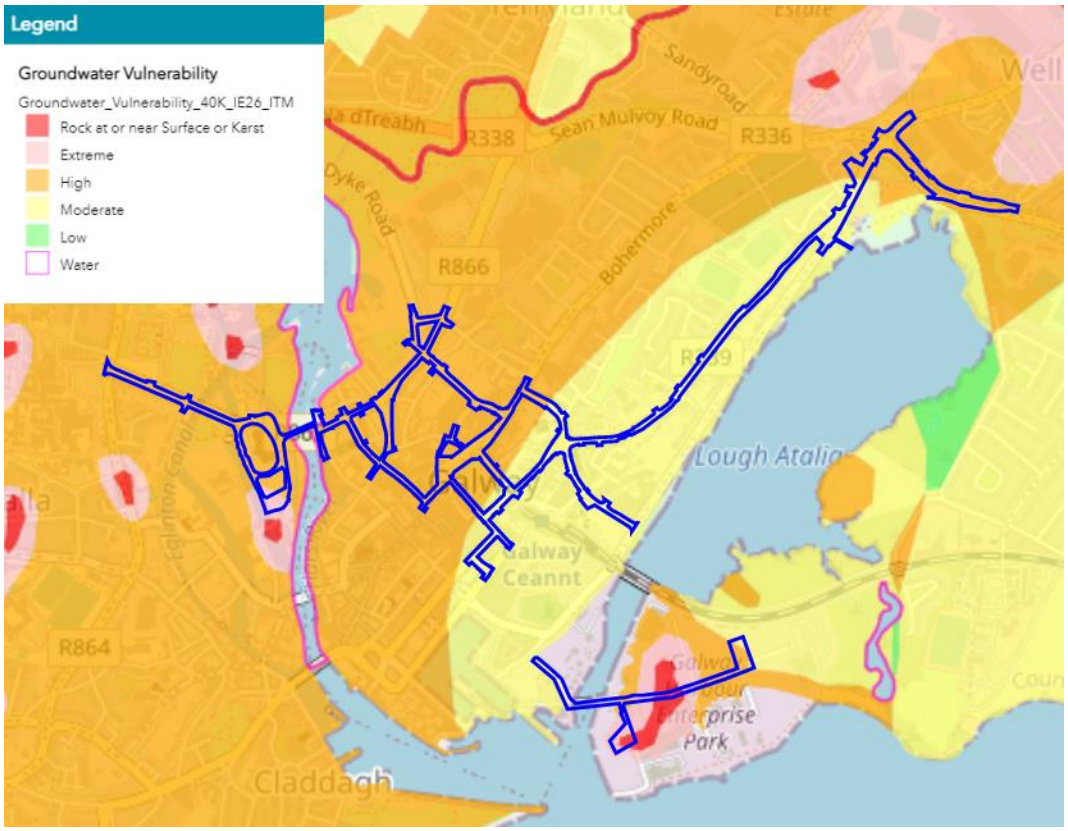

Figure 10: Extract from GSI spatial resources Groundwater Vulnerability Mapping

2.7 Mechanical/Operational Failure

There are several bridges and locks on River Corrib and other waterways which may fail or block due to mechanical error, deterioration, and operational problems. Of these, the Salmon Weir Barrage and the lock at Eglington Canal constitute a significant source of flooding to the Study Area. The OPW regulate the flow of the River Corrib and level of Lough Corrib via the Salmon Weir Barrage. The Barrage is open almost always open during winter and as required depending on existing and forecasted rainfall. The flow in Eglington Canal is controlled by lock gates which may cause flooding if the lock gate fails for any reason. The canal is known to have burst its banks in the past under extreme tide and/or storm surge. The Eastern CFRAM maps also showed that the canal the Nuns Island area for the 0.1% AEP event.

2.8 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:

- Parts of the site at Gaol Road have a moderate risk of fluvial flooding from Gaol River. The remainder of the site have a low probability of fluvial flooding.

- Part of the site at Dock Road have a high probability of tidal flooding. Areas around Lough Atalia have a moderate risk of tidal flooding. Most of the Proposed Scheme site has a low probability of flooding.
- The site is partially located within Flood Zones A and B.
- The risk of pluvial flooding to the site is considered low with the site identified as being outside the pluvial flood extents in the draft OPW PFRA mapping. 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.
- The Salmon Weir and the Eglington Canal lock have been identified as the main sources of flooding due to mechanical or operational failure.

2.9 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, tidal and groundwater sources. Therefore, the flood risk assessment is progressed to Stage 2: Initial Flood Risk Assessment.

3 Stage 2 – Initial Flood Risk Assessment

3.1 General

For Stage 2: Initial Flood Risk Assessment, the Proposed Scheme is divided into 21no. 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.

3.2 University Road

Along University Road (from the junction with Newcastle Road to the Salmon Weir Bridge), the proposed Scheme Works will involve creating grassed area, provision of an entry treatment at the National University of Ireland, Galway (NUIG), provision of two raised tables along the route at Canal Road Upper and Fisheries Field, and the provision of two new signalised pedestrian crossings.

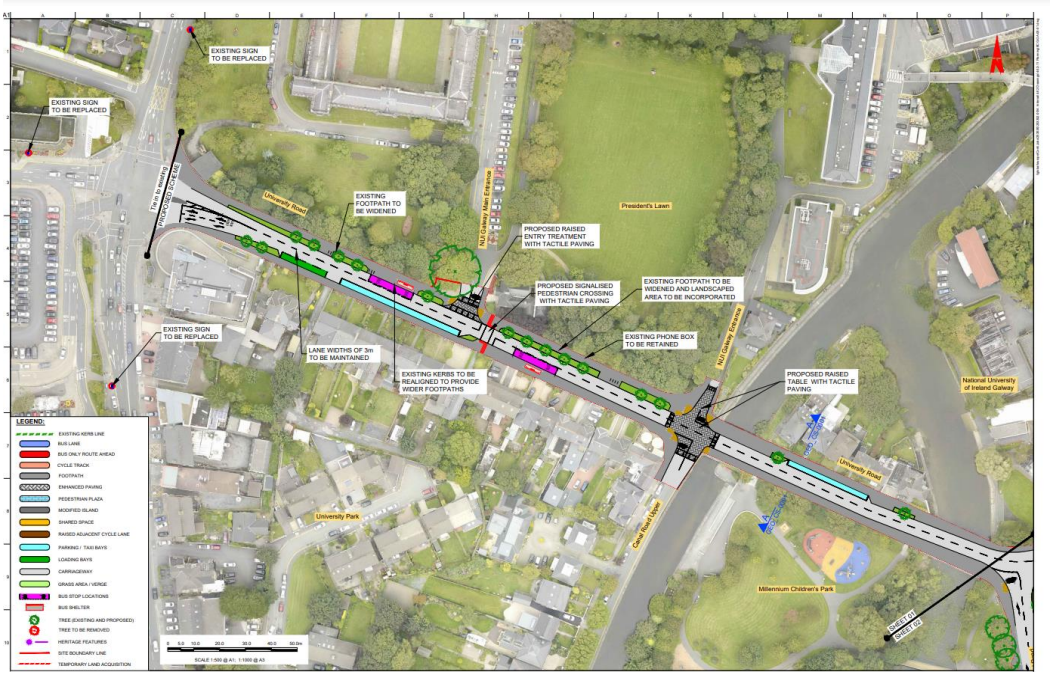

Figure 11: University Road Section of Works

Fluvial Flooding

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

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 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways. Management of the groundwater may be required during construction.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.3 Gaol Road and Galway Cathedral

To the west of Galway Cathedral, on Gaol Road the Works involve creating grassed area at the junction with University Road and to the south on Gaol Road the works involve re-development of the car and coach parking area to the south of Galway Cathedral. To the east of Galway Cathedral, the works involve the closure of the existing carriageway to vehicles and creation of a paved pedestrianised plaza area.

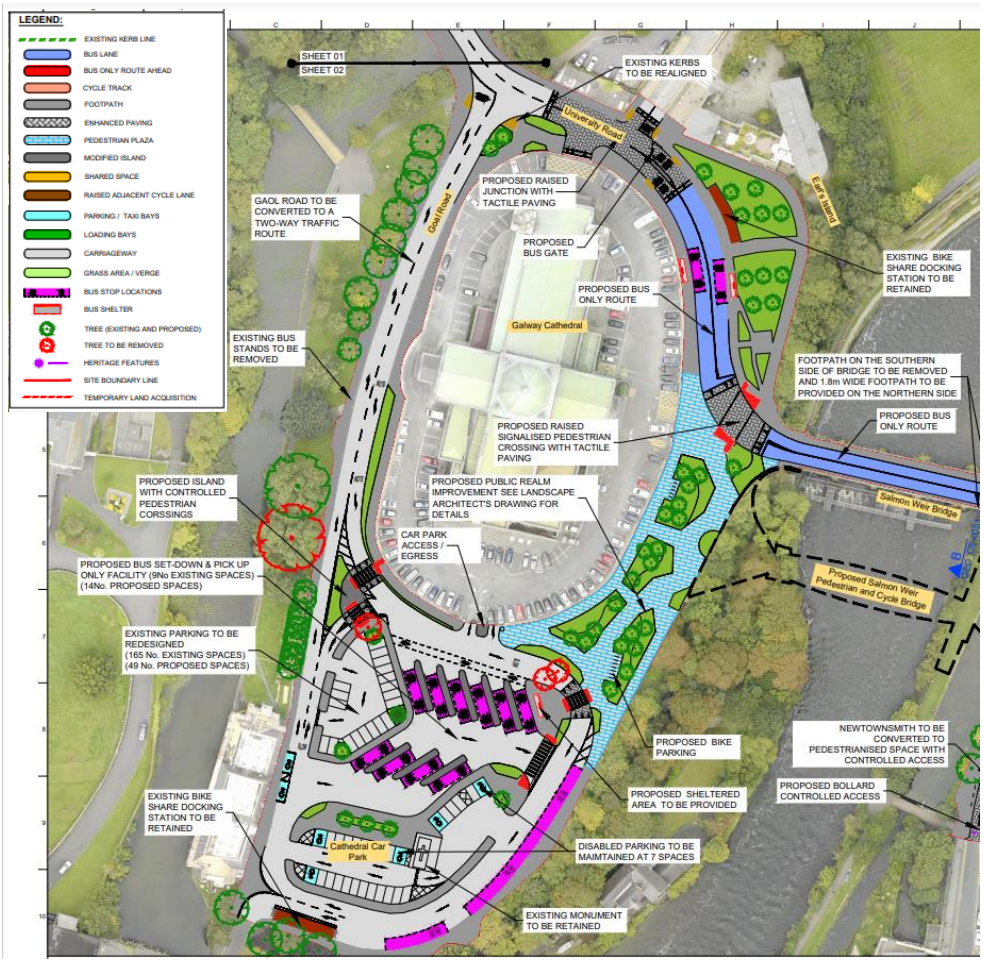

Figure 12: Gaol Road and Galway Cathedral Section of Works

Fluvial Flooding

The area of development is within the 0.1% AEP extent and is therefore classified as Flood Zone B. Figure 13 includes the modelled 10%, 1% and 0.1% AEP return period water levels for the displayed nodes. The node closest to Gaol Road along Gaol River is 30NUNS00013A. The 1 in 100-year fluvial water level at the node is 6.38mOD and the 1 in 1000-year fluvial water level is 6.86m OD.

The node closest to the site on the River Corrib is 30CORR00110A. The 1% AEP fluvial water level at the node is 4.1mOD and the 0.1% AEP fluvial flood levels is 5.42m OD.

At the location at risk of flooding, Gaol Road lies at 6.51m OD. The flood risk to the road is from overtopping of the Gaol River during the 0.1% AEP fluvial flood event.

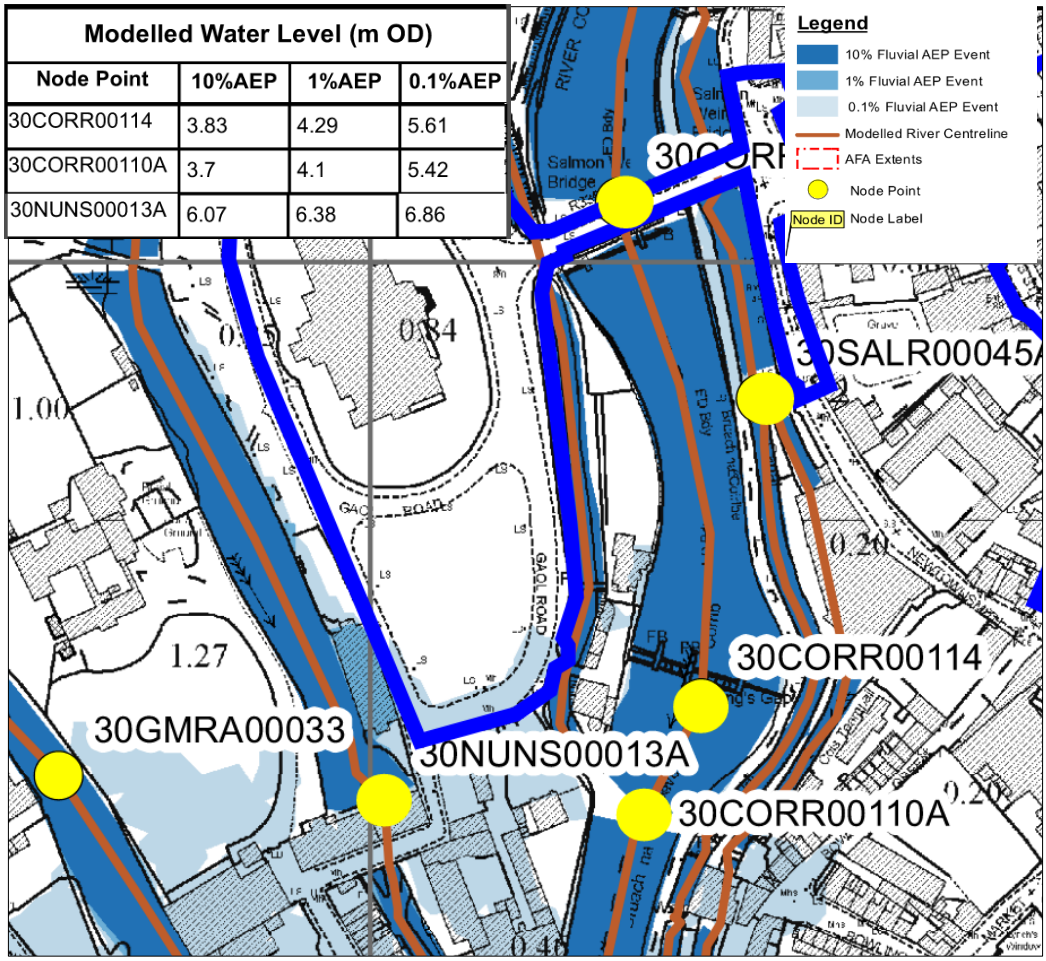

Figure 13:Gaol Road and Galway Cathedral Fluvial Flooding

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.4 Salmon Weir Bridge

There are some kerb realignment works proposed on the existing Salmon Weir Bridge. To improve the safety of the pedestrian environment, the existing kerb lines will be reconstructed to provide a single 1.8m wide footpath along the northern side, in place of the two existing footpaths which are approximately 1.1m to 1.2m wide.

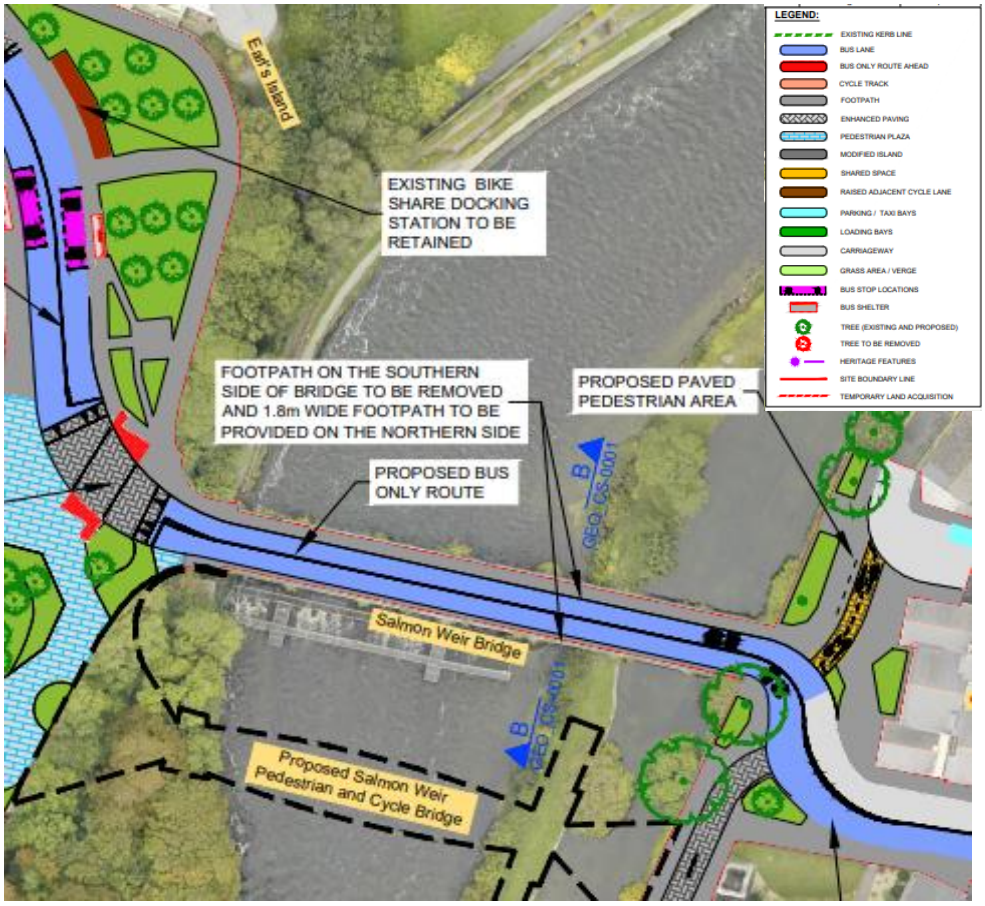

Figure 14: Salmon Weir Bridge Section of Works

Fluvial Flooding

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

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

As this section of the Proposed Scheme is a bridge, it is not affected by groundwater and therefore is not at risk.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.5 Newtownsmith/Waterside

The works at this location will involve the permanent closure of Waterside (west of the Court House) as it approaches St. Vincent's Avenue from the north (with the resultant space used to create a public space), and the narrowing of Newtownsmith as it approaches St. Vincent's Avenue from the south (reduced to a single northbound traffic lane, with resultant wider footpaths).

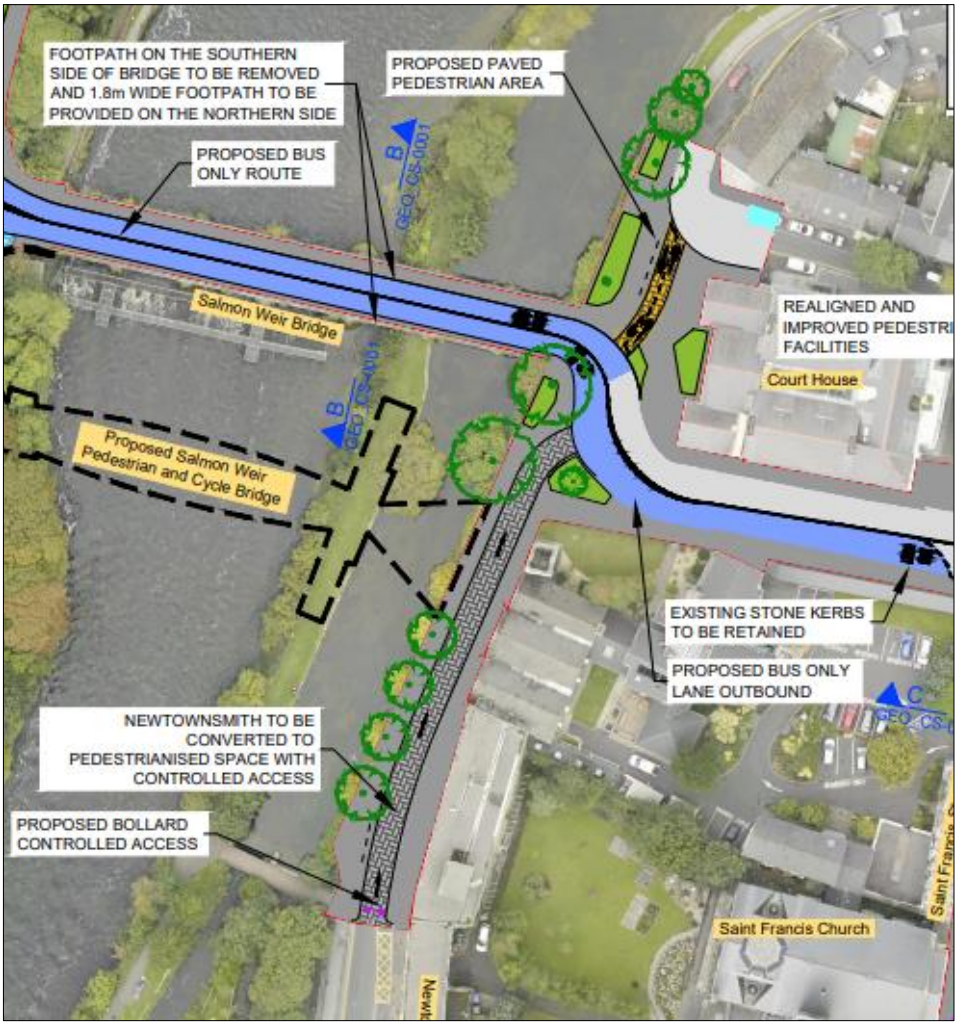

Figure 15: Newtownsmith Section of Works

Fluvial Flooding

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

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.6 St. Vincent's Avenue/Walsh's Terrace

Localised works along St. Vincent's Avenue and Walsh's Terrace (between the Salmon Weir Bridge and Dyke Road) involve the redesign of the junction at Woodquay which is to be tightened up and replaced with a single, in-only southbound road from St. Vincent's Avenue. A new entry treatment is to be provided at the junctions of Corrib Terrace and Riverside on St. Vincent's Avenue to improve pedestrian safety while retaining access. Landscaping interventions are proposed at this location on St. Vincent's Avenue to improve pedestrian connectivity between Wood Quay and the park area to the north.

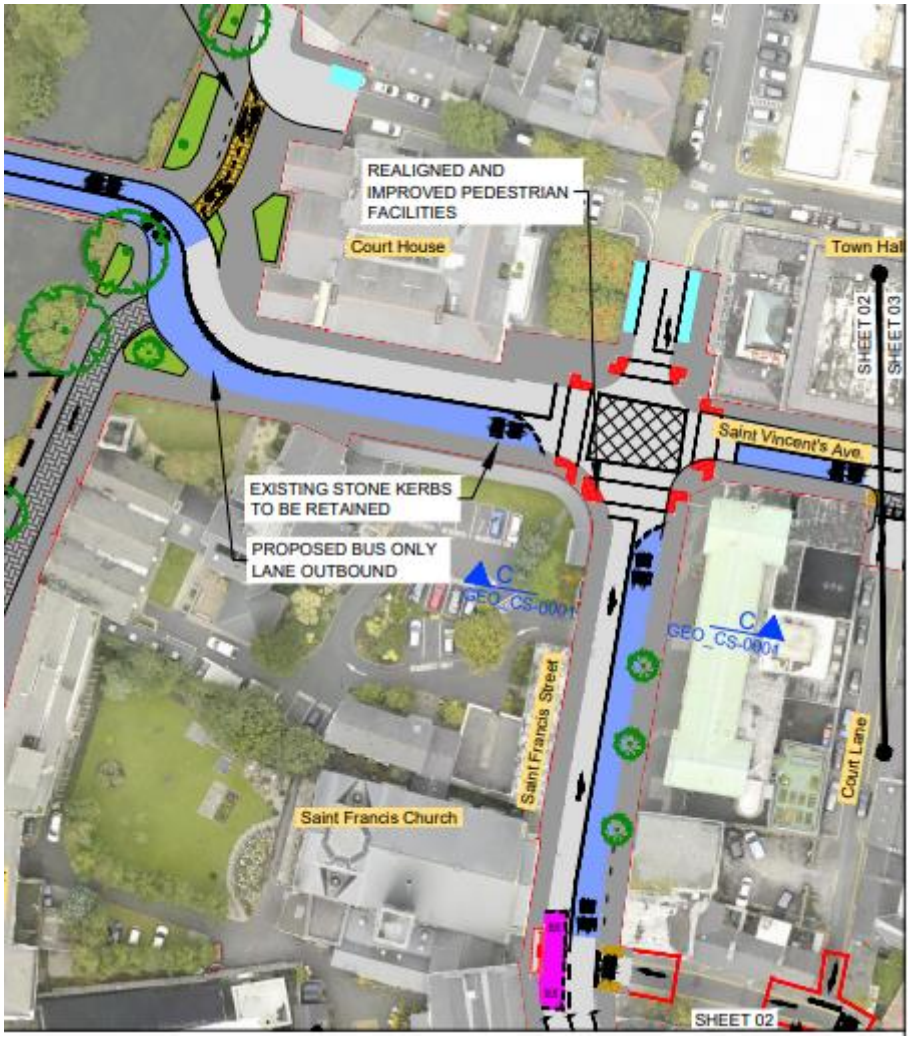

Figure 16: St. Vincent's Avenue/Walsh's Terrace Section of Works

Fluvial Flooding

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

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.7 Woodquay/Daly's Place/Mary Street

The works within Woodquay involve the removal of a substantial portion of the carriageway space and conversion of same to a pedestrian public space through creation of grassed area, the rationalisation of the junctions with St. Vincent's Avenue to the north into a single junction only, and the provision of a southbound traffic lane linking Woodquay to Daly's Place/Eyre Street. Entry treatments are also proposed at the junction with St. Brendan's Avenue and the junction with St. Anthony's Place.

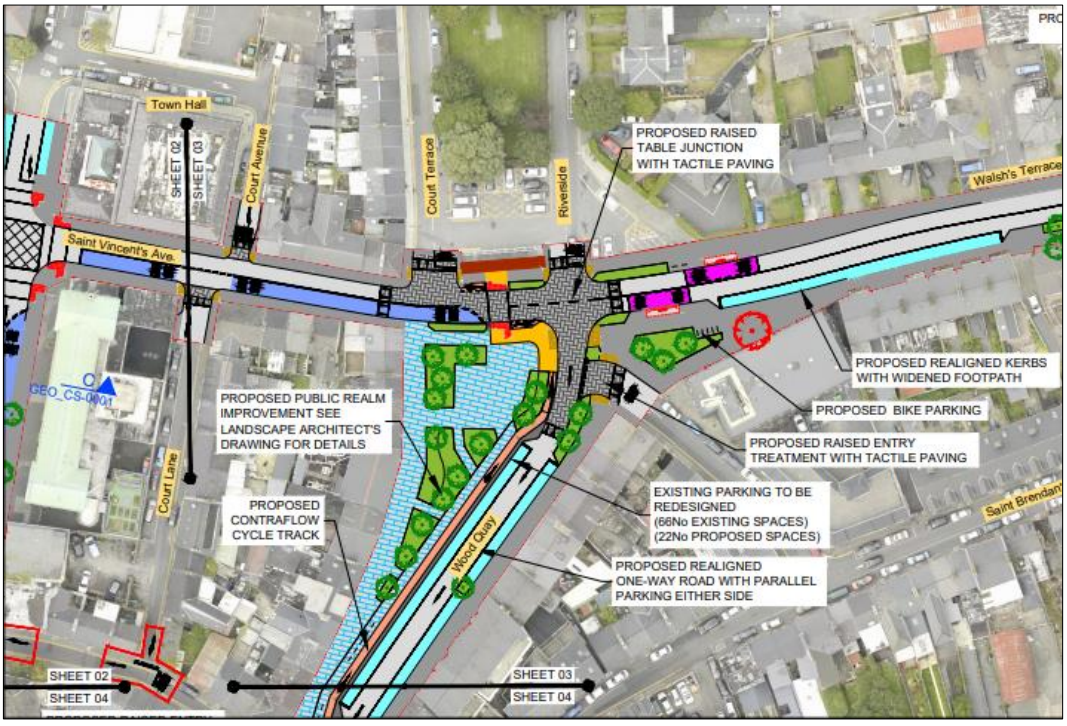

Figure 17: Woodquay/Daly's Place/Mary Street Section of Works

Fluvial Flooding

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

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.8 Dyke Road/Headford Road

Works on Dyke Road and the Headford Road include footpath widening and the signalisation of the junction of Dyke Road (heading north) and Dyke Road (heading east) and the signalisation of the junction of Dyke Road/Headford Road/St. Bridget's Place junction.

A short section of Dyke Road is also to have the carriageway widened, approaching the signalised junction of Dyke Road northbound/Dyke Road eastbound. Junctions to be signalised will have pedestrian crossings incorporated.

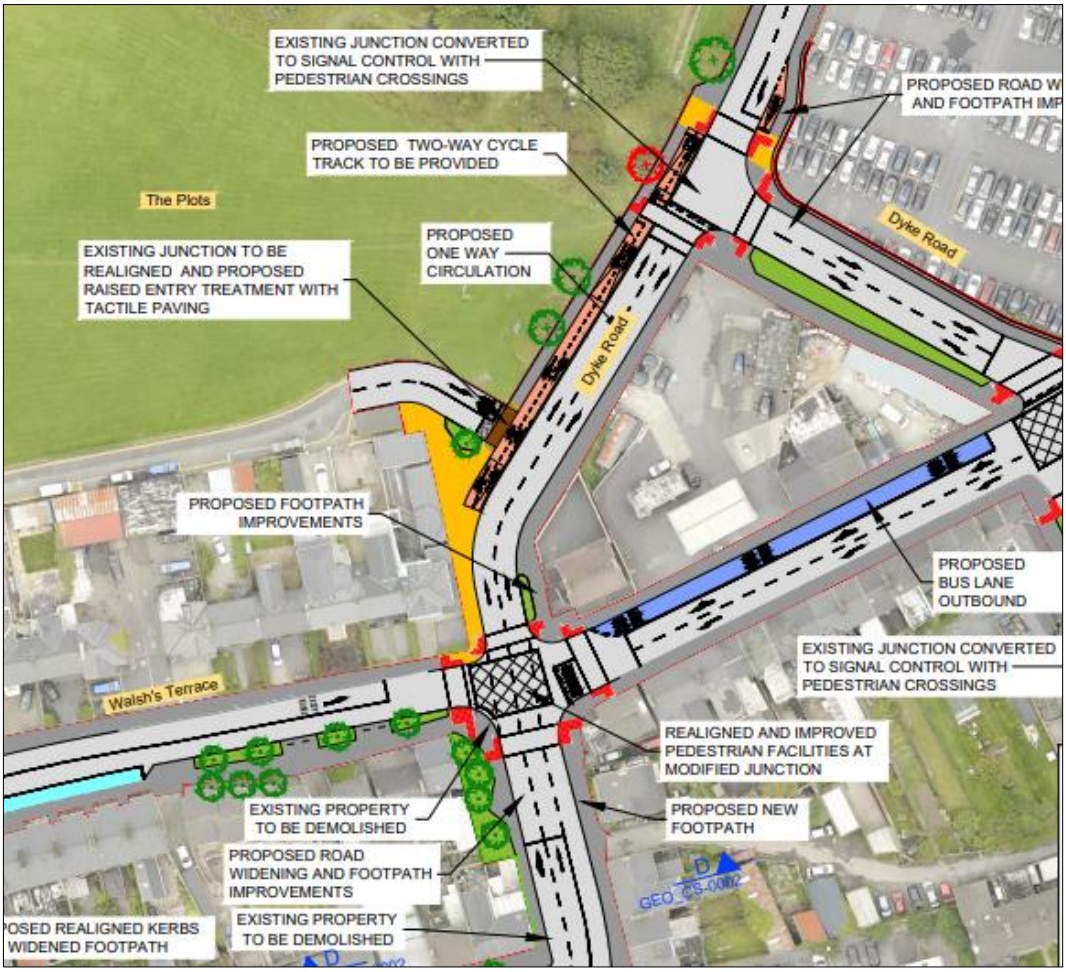

Figure 18: Dyke Road/Headford Road Section of Works

Fluvial Flooding

The area of development is outside the 1% AEP but not from the 0.1%AEP and is therefore classified as Flood Zone B. However, this is because of the protection provided by the Dyke Road embankment (see Figure 19 – note that the cross hatch represents a defended area). It is noted that this embankment provides a flood defence of up to the 1% AEP (with no allowance for freeboard) and hence may overtop under the 0.1% AEP event. The Western CFRAM Preliminary Options Report (JBA, 2016) documented that this embankment was damaged and repaired in 2007. The condition of the embankment is described as “fair” and there is a possibility that a breach may occur in the future and hence this FRA assumes that this defence will be maintained on ongoing basis to sustain the existing level of protection.

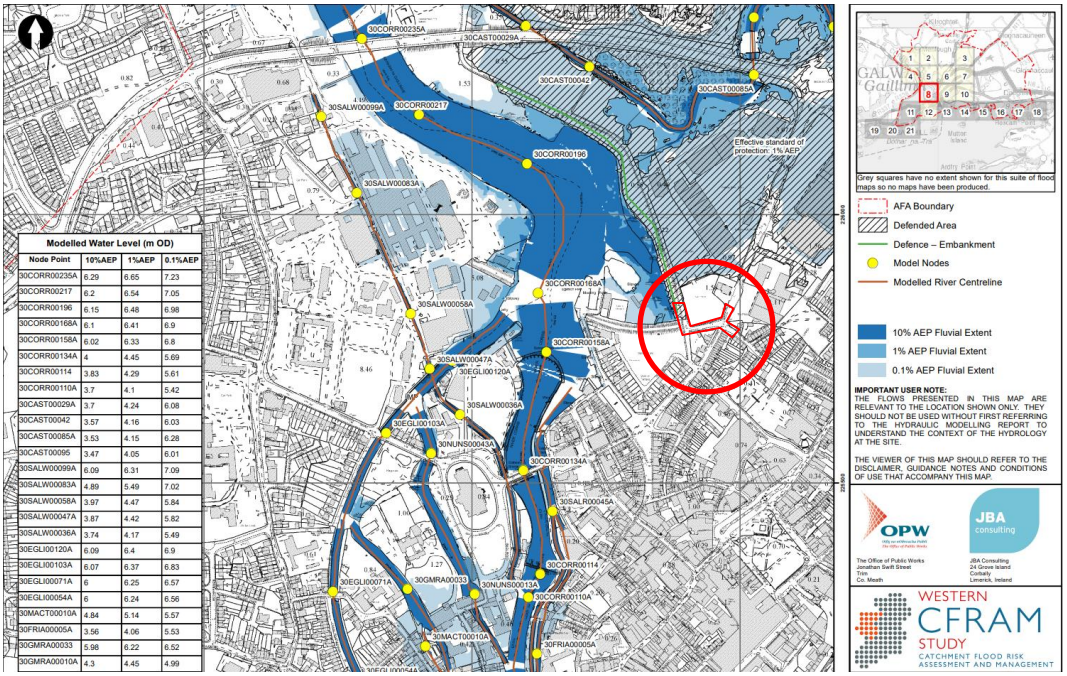

Figure 19 Dyke Road Flood Defence

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.9 St. Francis Street/Eglinton Street/Williamsgate Street

The works on St. Francis Street/Eglinton Street will involve provision of a new signalised crossing on St. Francis Street and the signalisation of the junction with Mary Street/Daly's Place.

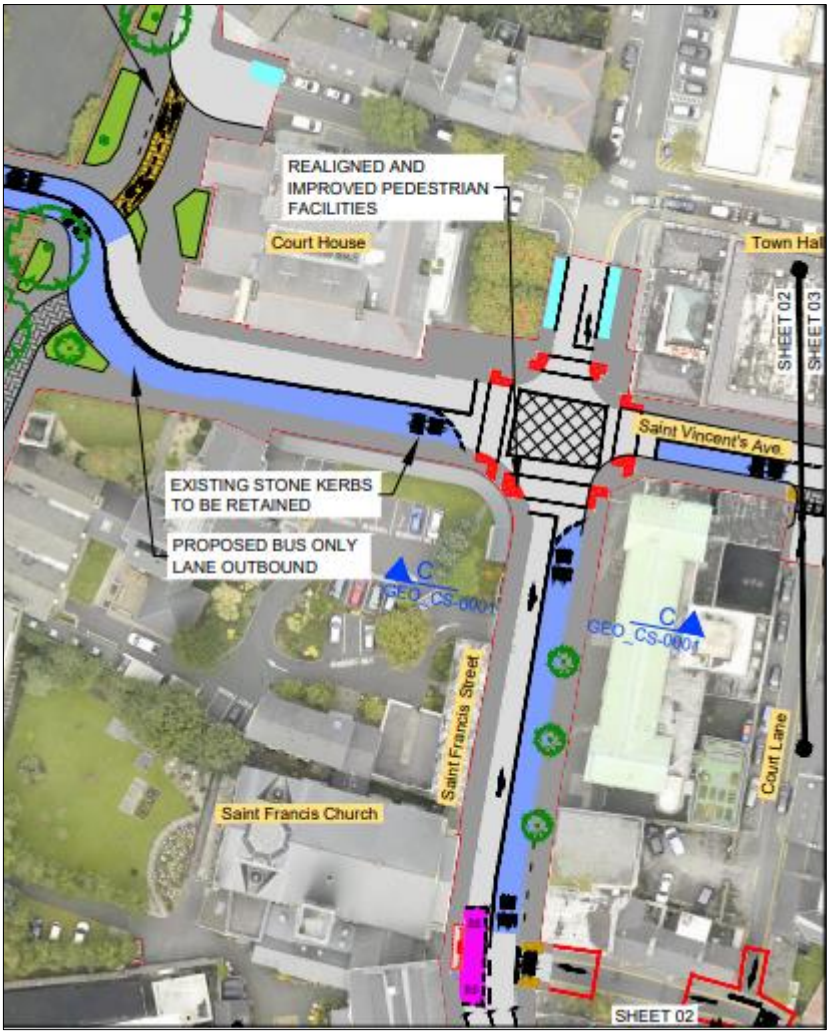

Figure 20: St. Francis Street/Eglinton Street/Williamsgate Street Section of Works

Fluvial Flooding

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

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.10 Bóthar na mBan/St. Brendan's Avenue

At Bóthar na mBan/St. Brendan's Avenue the proposed works include realigned and improved pedestrian facilities at modified Bóthar na mBan/St. Brendan's Avenue junction and entry treatments to St. Brendan's Avenue west of Bóthar na mBan and to the overflow car park for County Hall.

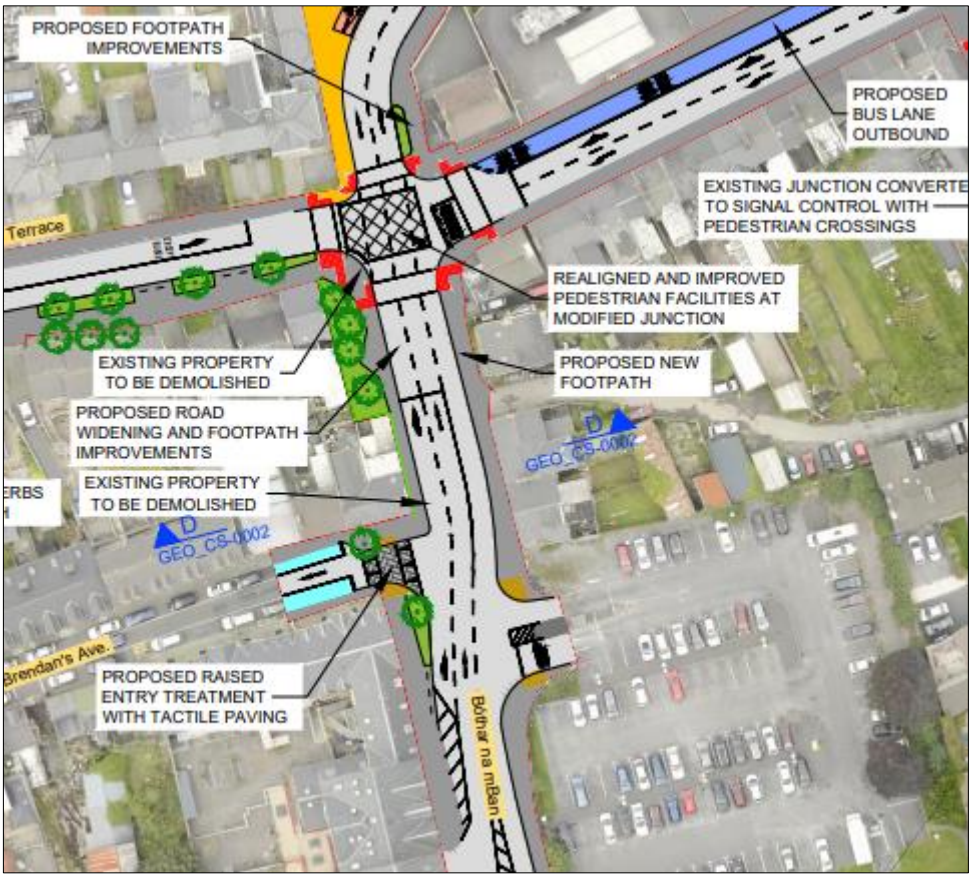

Figure 21: Bóthar na mBan/St. Brendan's Avenue Section of Works

Fluvial Flooding

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

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.11 Prospect Hill

The works on Prospect Hill will comprise of the signalisation of the junction with Bohermore/Bóthar Uí hEithir and the realignment of the junction with Bóthar na mBan (to re-designate Prospect Hill to the south-west as the minor arm of a T-junction with a proposed entry treatment).

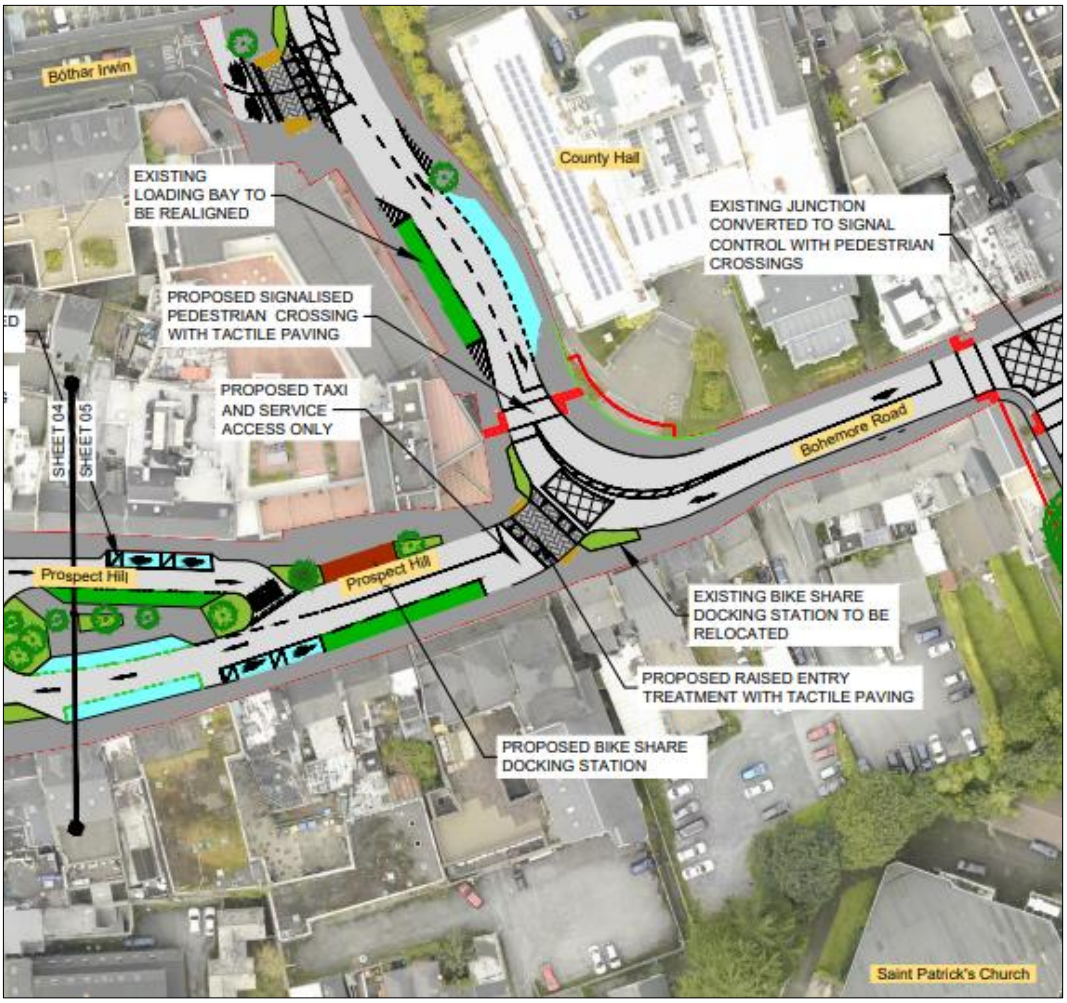

Figure 22: Prospect Hill

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.12 Eyre Square North/Eyre Square East/Eyre Square South

The works on Eyre Square North involve the removal of the carriageway space running parallel to Eyre Square North (to the north of the Liam Mellows Statue) and conversion of this area to a pedestrianised public space.

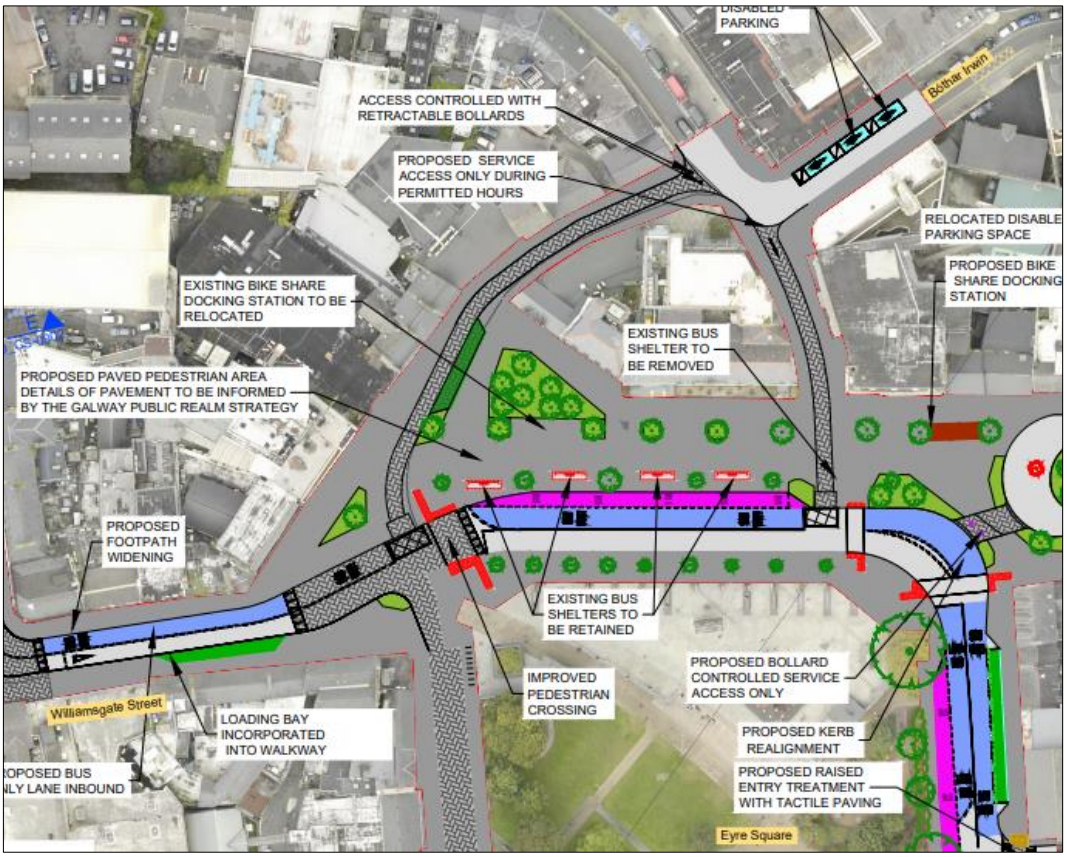

Figure 23 : Eyre Square North/Eyre Square East/Eyre Square South

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 has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.13 Victoria Place/Merchant's Road/Queen Street

Localised works on Victoria Place, Merchant's Road and Queen Street primarily involve footpath widening, provision of new raised uncontrolled pedestrian crossings and two new signalised pedestrian crossings on Forthill Road. An entry treatment is proposed at the junction of Forthill Road and Queen Street, and a new footpath is proposed on the south-eastern side of Dock Road, between Queen Street and Bóthar na Long.

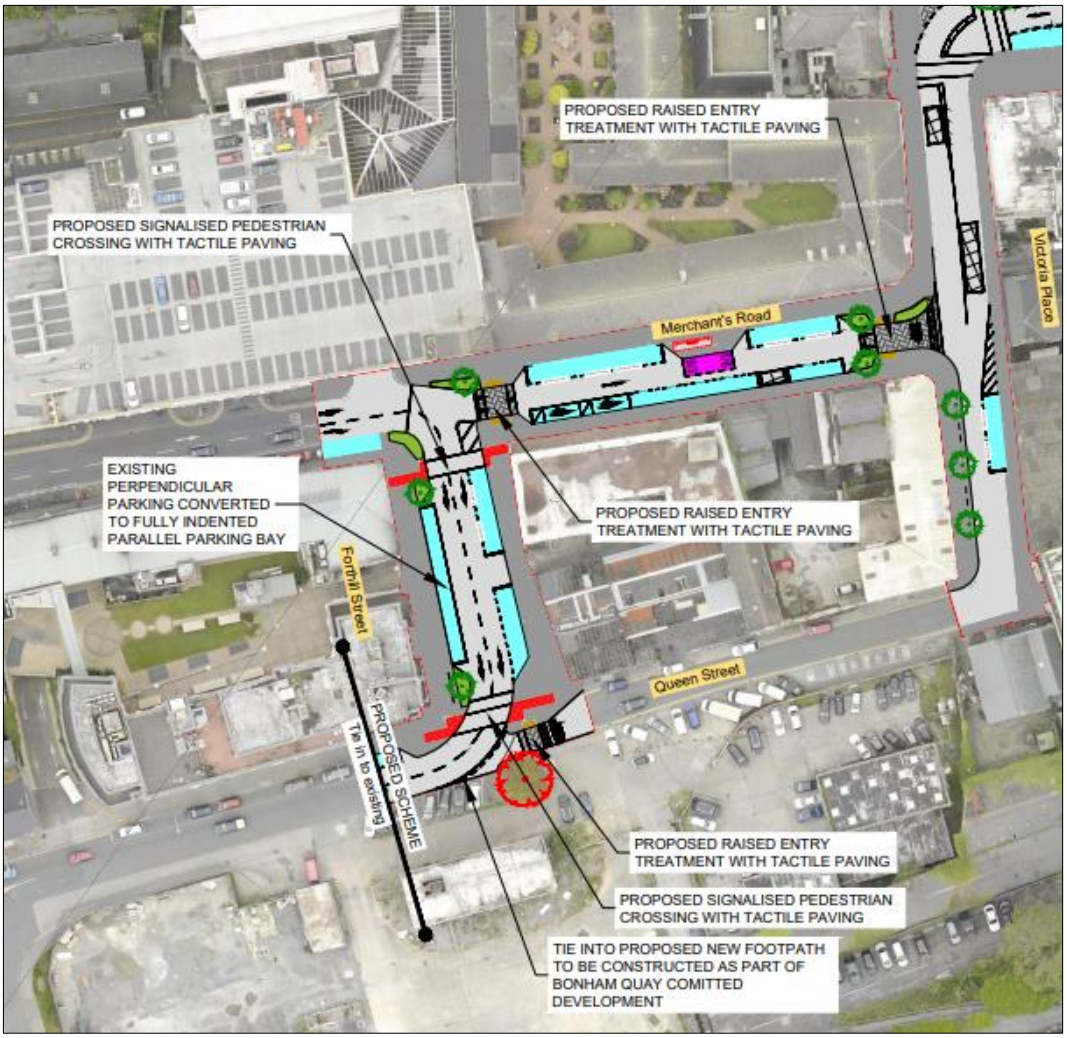

Figure 24:Victoria Place/Merchant's Road/Queen Street

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 predominantly within the 0.5% AEP extent and is therefore classified as Flood Zone A (Figure 25).

Ground levels in this area are noted to be between 3.4 and 3.7m OD. Flood depths during tidal flooding events can be approximated to be between 0.25m and 1.0m for the 0.5% AEP flood event as shown in Figure 26.

Figure 25: Victoria Place/ Merchants Road/Queen Street Flood Zone Identification

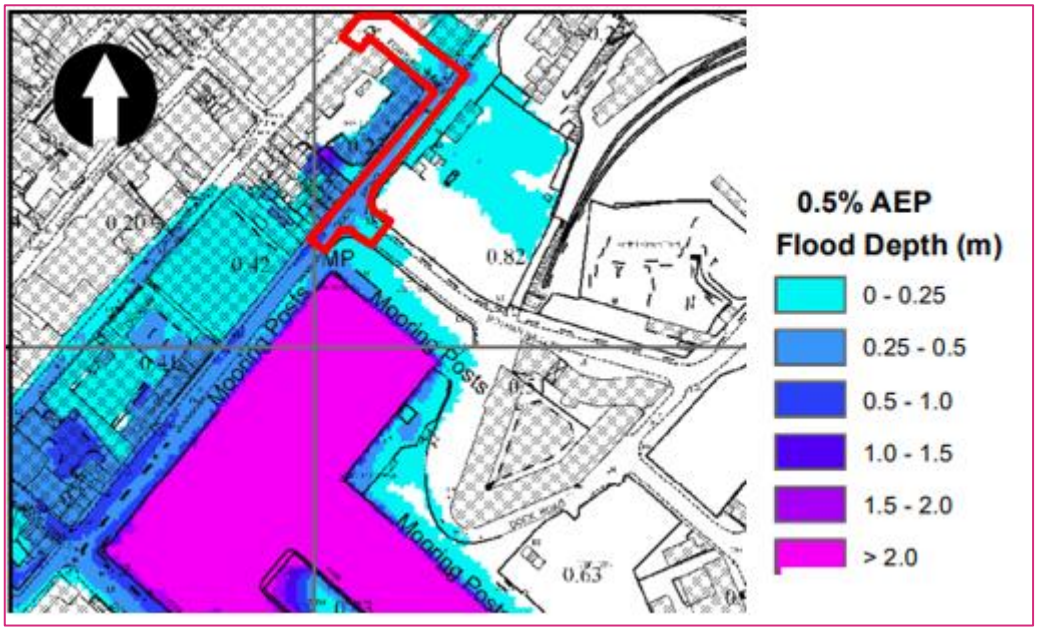

Figure 26 Victoria Place/Merchants Road/ Queen Street Tidal Flood Depth

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map as shown in Figure 9. The area is noted as moderate groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map. However, historic records show that pluvial floods occurred near the site along Dock and Flood Street.

3.14 Forster Street

The works on Forster Street are localised to the eastern end of the street, in the vicinity of the junction with Bóthar Uí hEithir/College Road/Fairgreen Road.

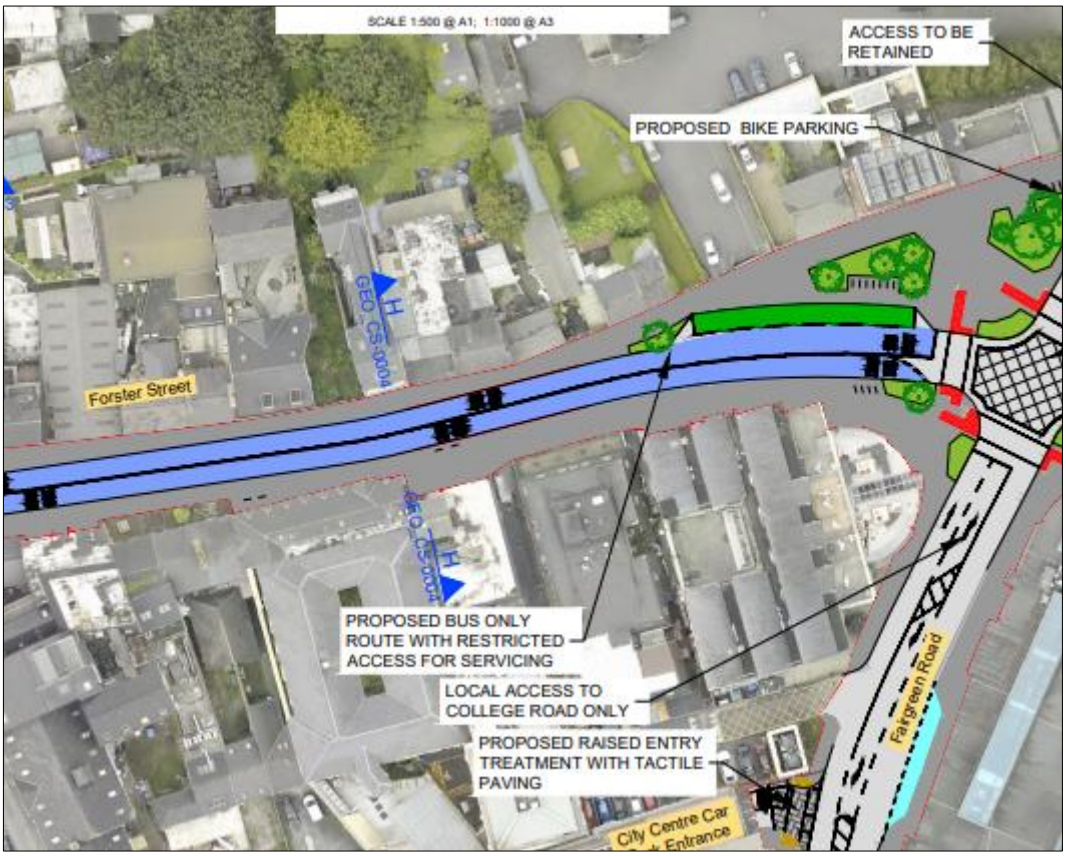

Figure 27:Forster Street Section of Works

Fluvial Flooding

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

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 has not been indicated in this area by the GSI Groundwater Flood Map as shown in Figure 9. The area is noted as moderate groundwater vulnerability as per Figure 10. However, it is likely that the vulnerability rating is indicative of a moderate water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.15 College Road/Forster Street/Fairgreen Road/Bóthar Uí hEithir Junction

The works at this junction will comprise of junction upgrade works to reduce the overall size and provide wider footpaths and shorter crossing distances. Therefore, the works will primarily comprise of footpath widening and the removal of islands within the main carriageway and the installation of replacement traffic signals.

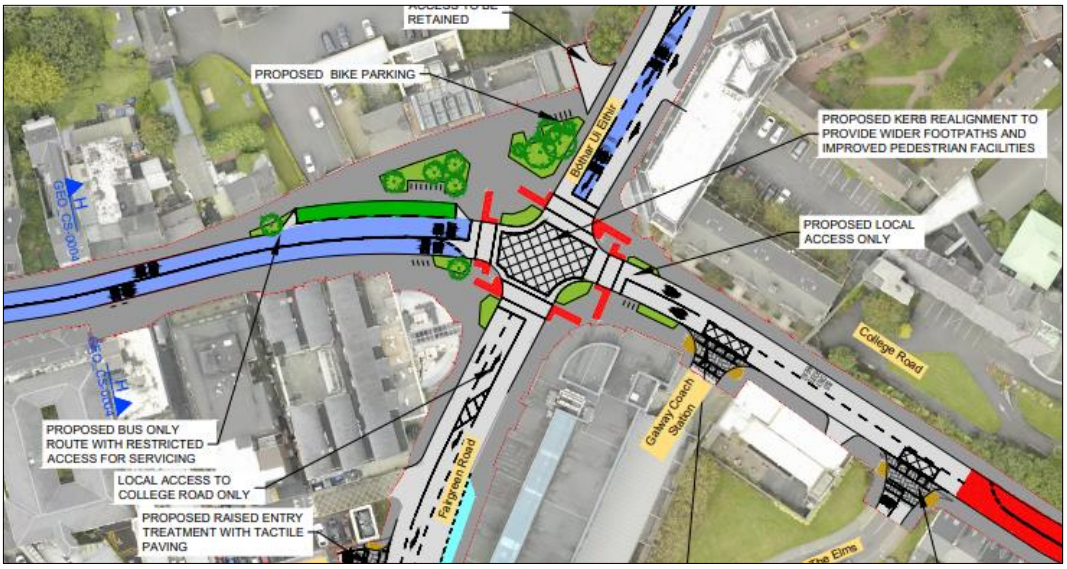

Figure 28: College Road/Forster Street/Fairgreen Road/Bóthar Uí hEithir Junction

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 0.1%, 0.5% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as moderate groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the sea and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.16 Bóthar Uí hEithir

Works on Bóthar Uí hEithir are localised in nature and will primarily comprise of localised footpath widening at the junction to the south (with Forster Street/College Road) and the junction to the north (with Prospect Hill/Bohermore).

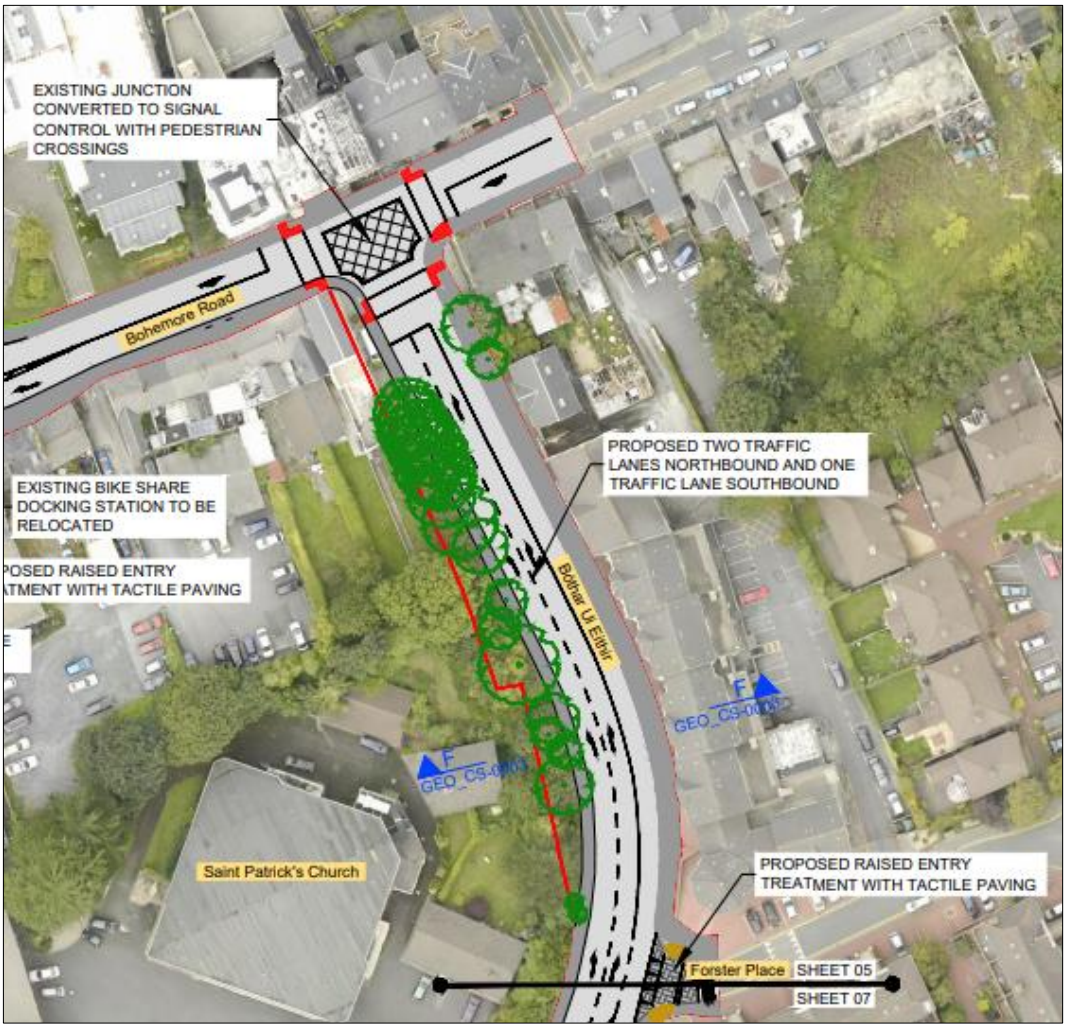

Figure 29: Bóthar Uí hEithir Section of Works

Fluvial Flooding

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

Tidal Flooding

The area of development is outside of the 0.1%, 0.5% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as moderate to high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a moderate water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.17 Fairgreen Road

The works at Fairgreen Road will primarily comprise of the upgrade at the signalised junction with College Road/Forster Street, the provision of new entry treatments and some localised footpath widening in the vicinity of the entrance to the Radisson Blu Hotel.

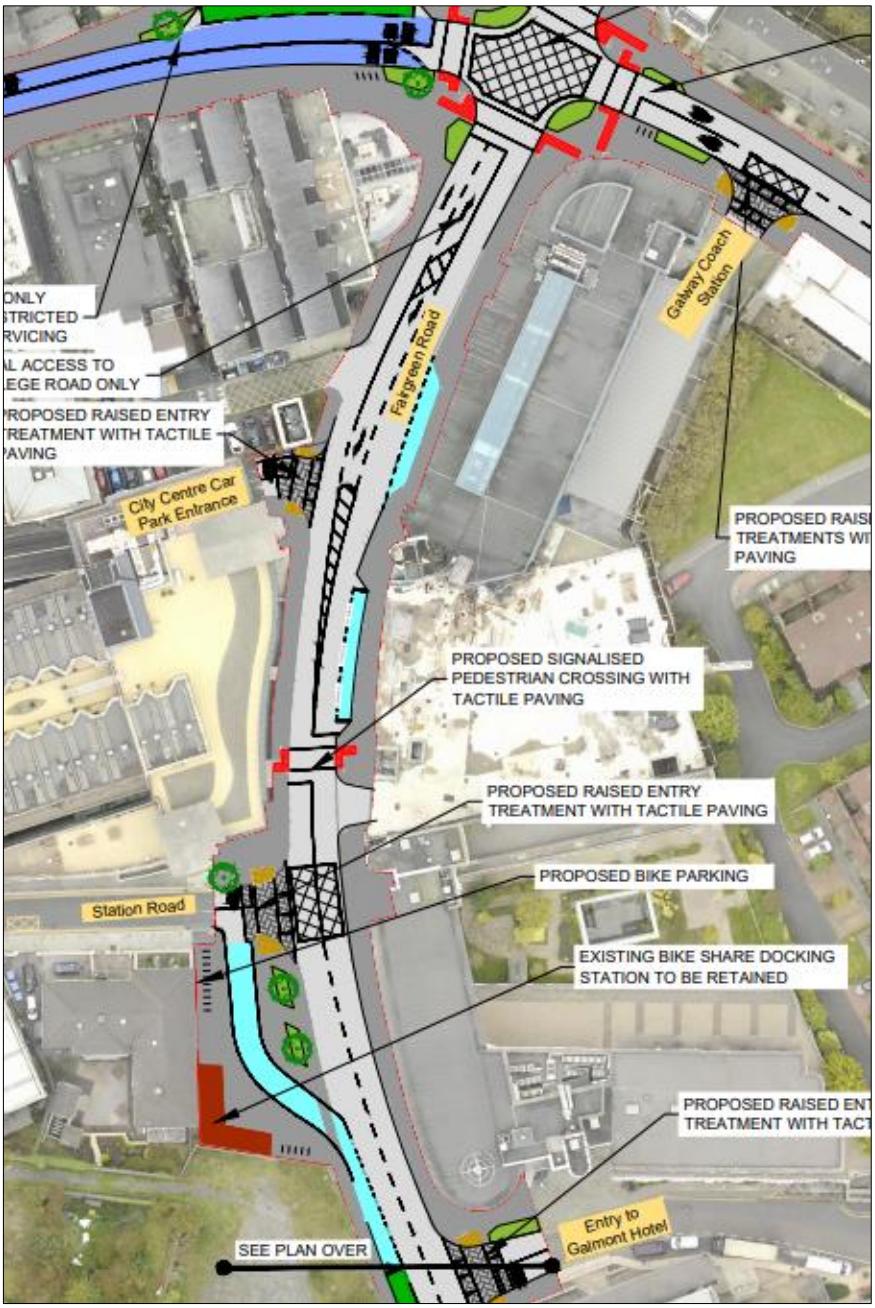

Figure 30: Fairgreen Road Section of Works

Fluvial Flooding

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

Tidal Flooding

The area of development is outside of the 0.1%, 0.5% and 10% AEP and is therefore classified as Flood Zone C.

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as moderate groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a moderate water table due to the site's proximity to the River Corrib and surrounding canals and waterways.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.18 College Road (to junction with Lough Atalia Road)

The works along College Road between the junction with Forster Street and the junction with Lough Atalia Road will primarily comprise of localised footpath widening works, the provision of entry treatments at several junctions, new priority pedestrian crossings and the installation of a bus gate on College Road, west of the entrance to Galway City Hall.

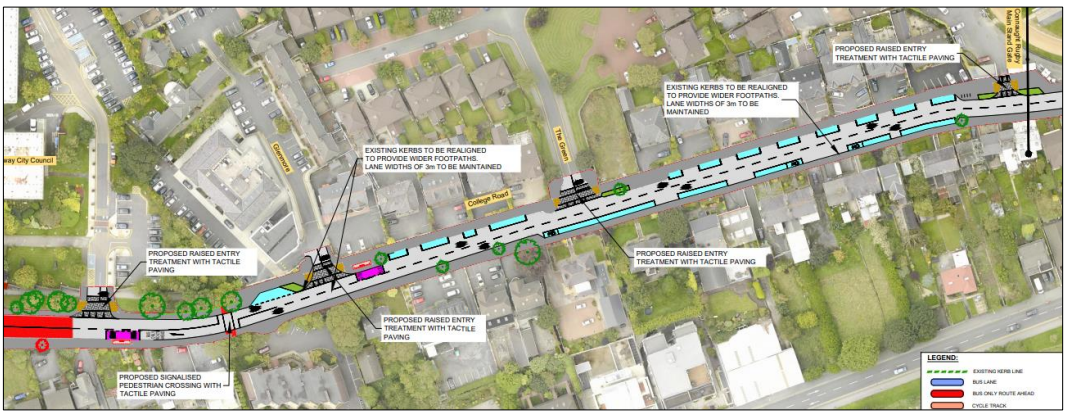

Figure 31: College Road (to junction with Lough Atalia Road) Section of Works

Fluvial Flooding

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

Tidal Flooding

Most of the area of development is outside of the 0.5% but a small portion of it is within the 0.1% AEP and is therefore classified as Flood Zone B.

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as moderate groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a moderate water table due to the site's proximity to the sea.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.19 College Road/Lough Atalia Road Junction

The development proposes to realign the junction of College Road and Lough Atalia Road, to a formal T-junction (with College Road forming the minor arm and Lough Atalia Road forming the major arm). This junction will be signalised, with pedestrian crossings provided on two of the three arms.

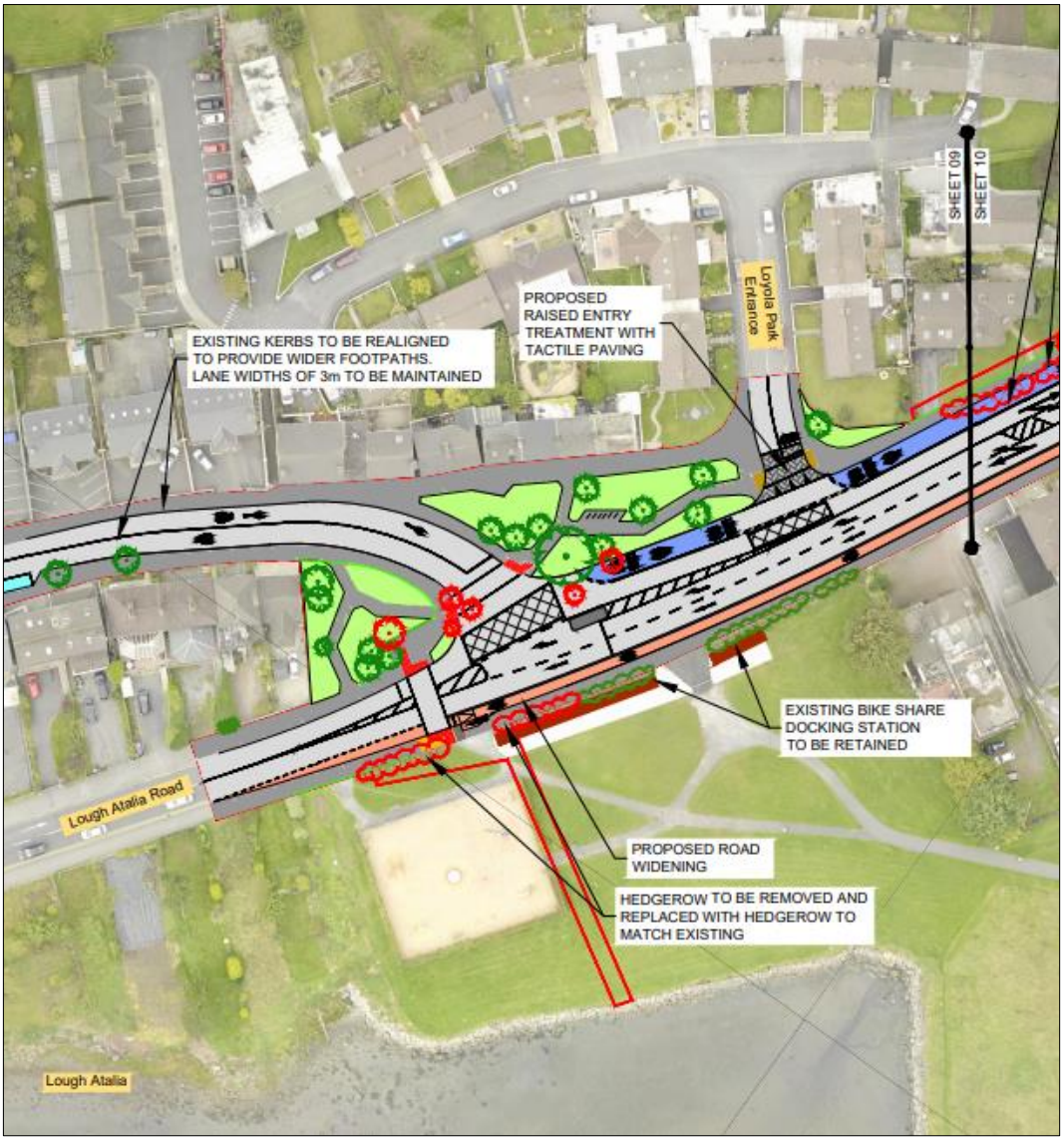

Figure 32: College Road/Lough Atalia Road Junction Section of Works

Fluvial Flooding

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

Tidal Flooding

The area of development is predominantly within the 0.1% AEP extent and is therefore classified as Flood Zone B.

Ground levels in this area are noted to be 3.80m OD at the lowest point. Nodal water depths during tidal flooding events have not been made available through the CFRAMs study but can be assumed to reach a maximum of 1m for the 0.1% AEP flood event as shown in Figure 33.

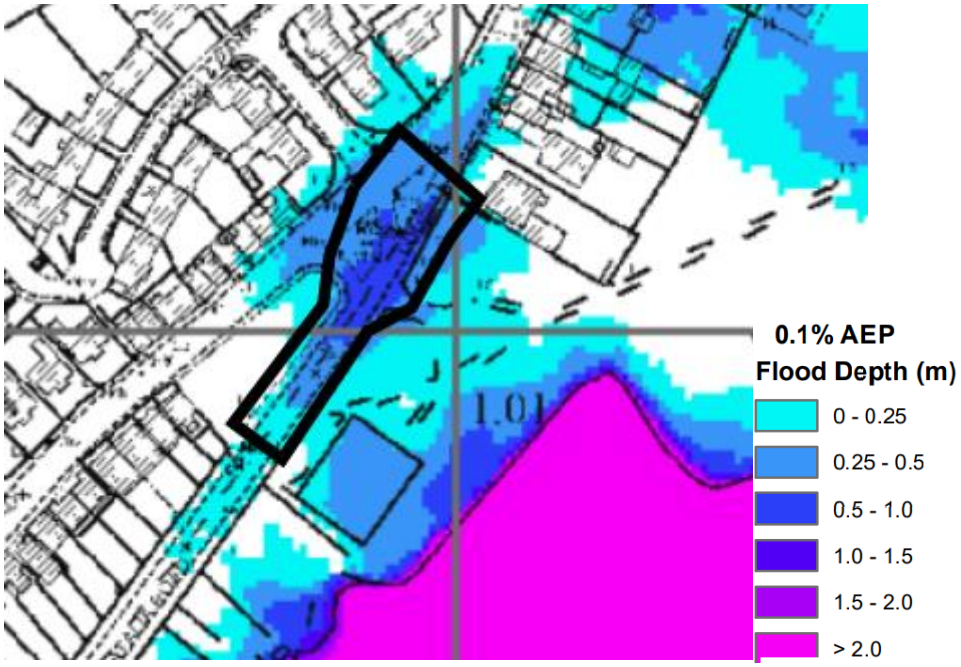

Figure 33: College Road/Lough Atalia Road Junction Tidal Flooding

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as moderate groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the sea.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.20 College Road/Lough Atalia Road to Moneenageisha Junction

The works proposed on College Road (between Lough Atalia Road and Moneenageisha) will comprise of significant carriageway widening on the north-western side of College Road to facilitate the construction of an additional outbound bus lane.

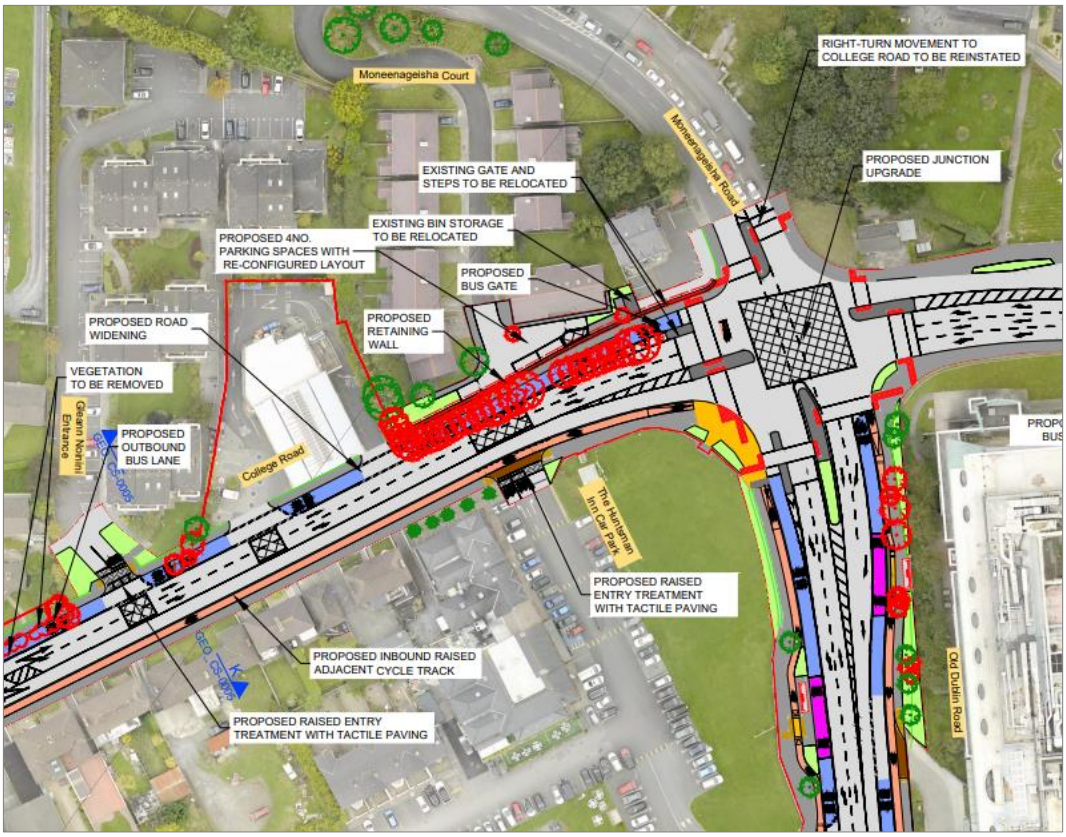

Figure 34: College Road/Lough Atalia Road to Moneenageisha Junction Section of Works

Fluvial Flooding

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

Tidal Flooding

The area of development is predominantly within the 1:1,000 year or 0.1% AEP extent and is therefore classified as Flood Zone B.

Ground levels in this area are noted to be 3.73m OD at the lowest point. Water levels during tidal flooding events have not been made available through this CFRAMs study but can be assumed to be greater than 3.73m OD for 0.1% AEP flood event. Flood extents are predicted to reach a depth of between 0-0.25m along a section of the road as per Figure 35.

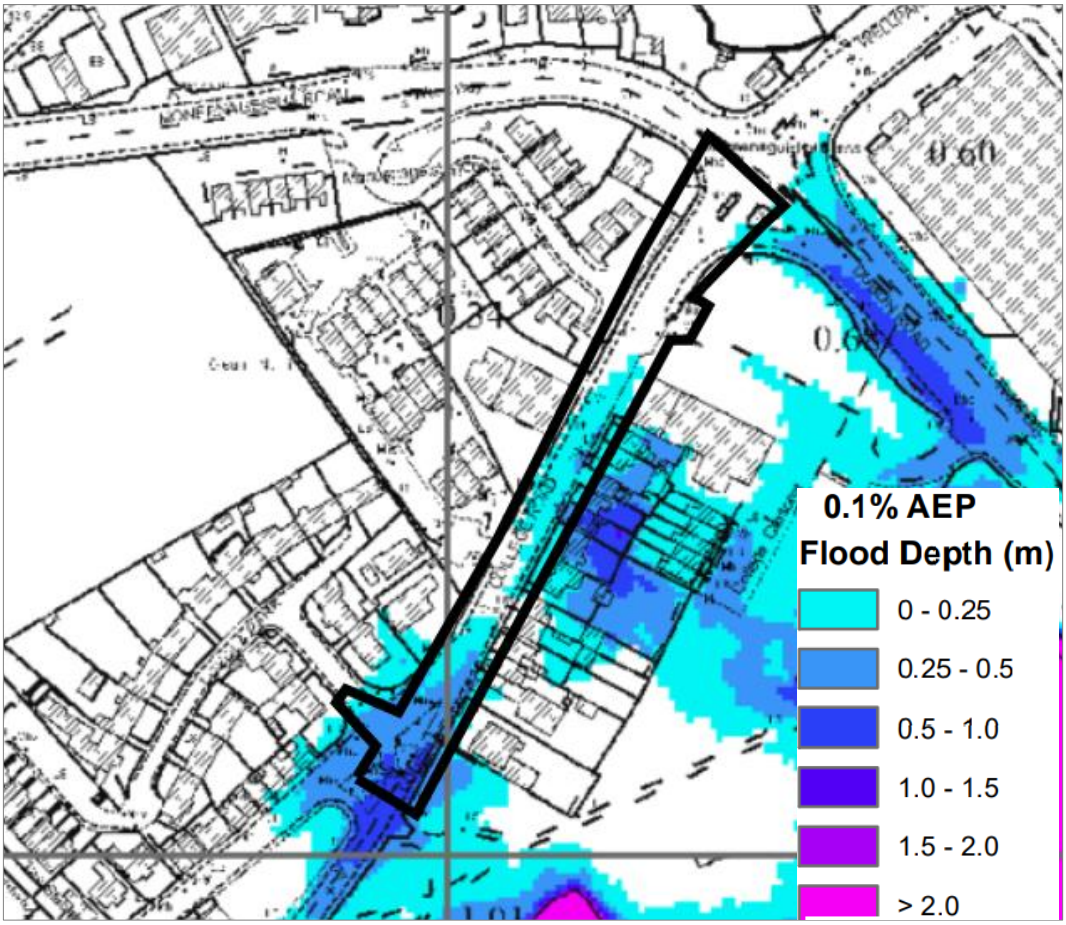

Figure 35: College Road/Lough Atalia Road to Moneenageisha Junction Tidal Flooding

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as moderate to high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the sea.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.21 Moneenageisha Junction

The works at the junction at Moneenageisha involve the upgrade of the junction to reduce the junction footprint by removal of the existing left-slip islands on the College Road and the Dublin Road arms, and the relocation of several splitter islands at the junction.

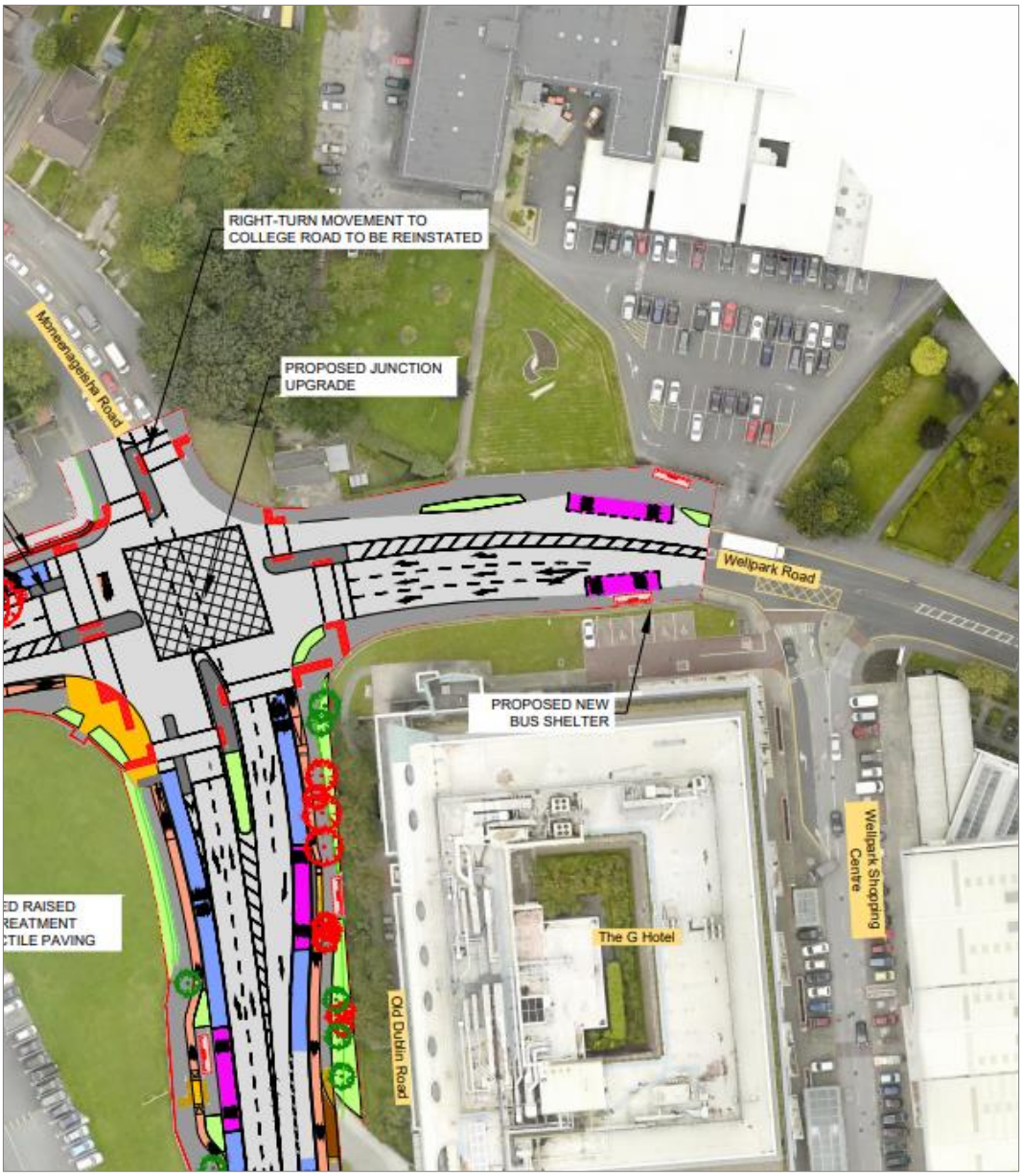

Figure 36: Moneenageisha Junction Section of Works

Fluvial Flooding

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

Tidal Flooding

The area of development is predominantly outside the flood extents with a small portion at the Dublin Road tie-in falling within the 1:1000 year or 0.1% AEP extent and is therefore classified as Flood Zone B.

Ground levels in this area are noted to be 3.9m OD at the lowest point.

Water levels during tidal flooding events have not been made available through this CFRAMs study but can be assumed to be greater than 3.9m OD for 0.1% AEP flood event. Flood extents are predicted to reach a depth of between 0-0.25m along the portion of road as per Figure 37.

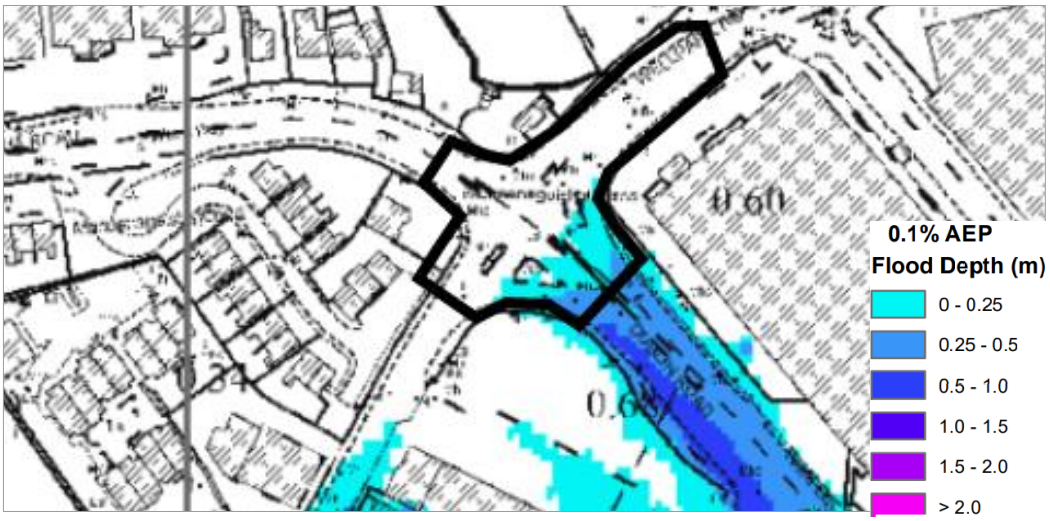

Figure 37 Moneenageisha Junction - Tidal Flooding

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the sea.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.22 R338 Dublin Road

The works on the R338 Dublin Road will comprise of the installation of inbound and outbound bus lanes, raised adjacent cycle lanes and footpaths on both sides of the road. This is to be achieved via a combination of carriageway widening, re-purposing of existing traffic lanes and setting back the existing footpath.

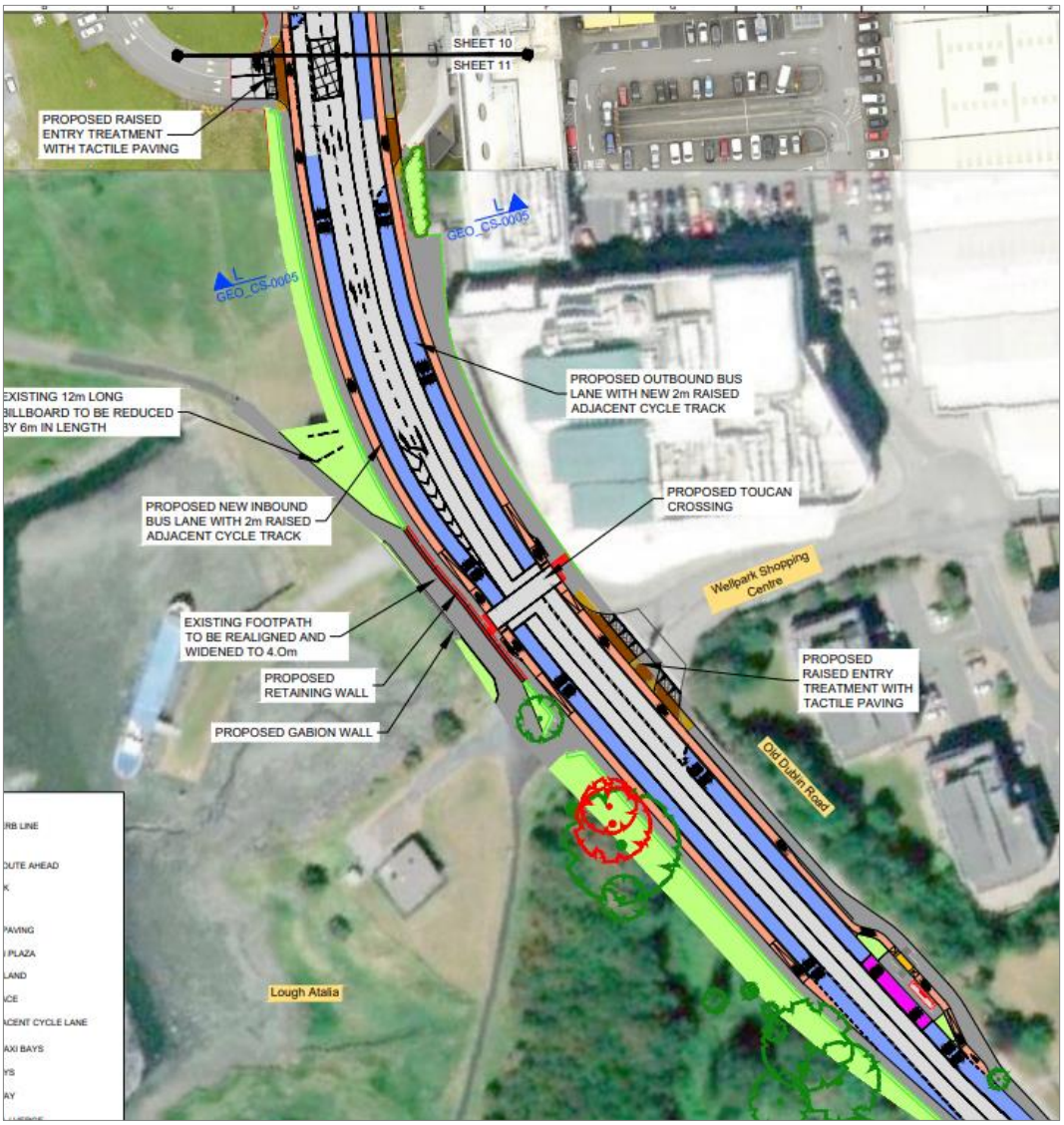

Figure 38:R338 Dublin Road Section of Works

Fluvial Flooding

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

Tidal Flooding

The area of development is predominantly outside the flood extents with a small portion at the Dublin Road tie-in falling within the 1:1000 year or 0.1% AEP extent and is therefore classified as Flood Zone B.

Ground levels in this area are noted to be 3.9m OD at the lowest point. Water levels during tidal flooding events have not been made available through this CFRAMs study but can be assumed as greater than 3.9m OD for 1% AEP flood event. Flood extents are predicted to reach a depth of between 0-1 m along the portion of road as per.

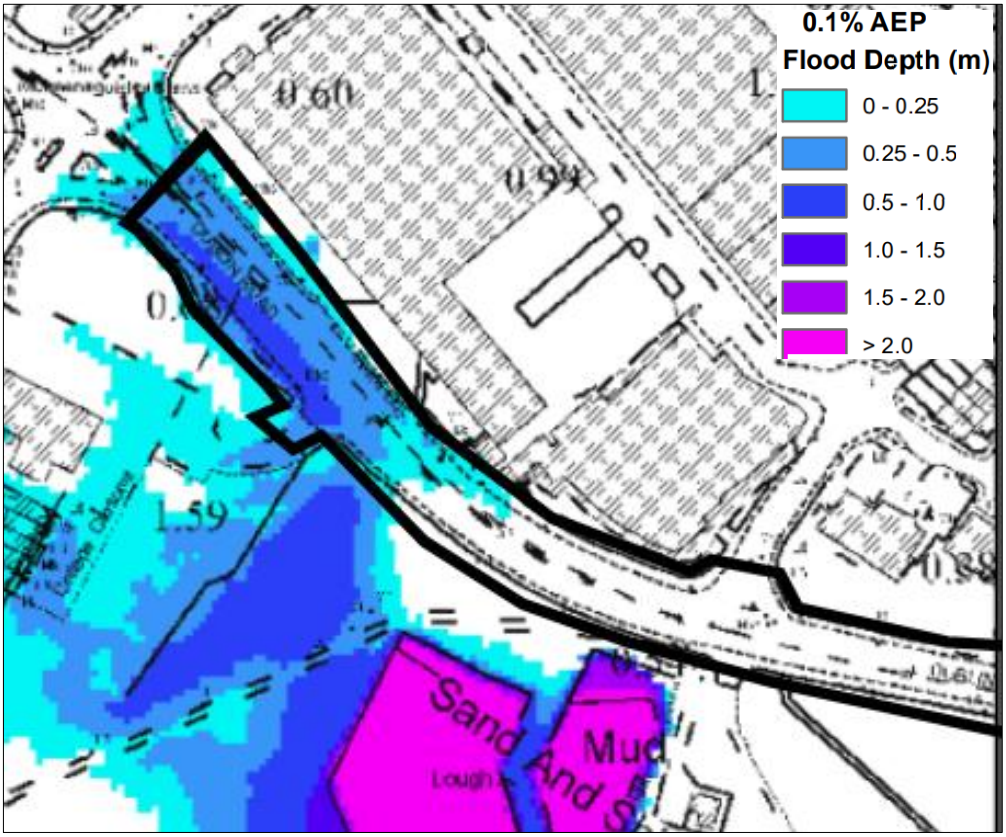

Figure 39:R338 Dublin Road Tidal Flooding

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map, Figure 9. The area is noted as high groundwater vulnerability as per Figure 10. It is likely that the vulnerability rating is indicative of a shallow water table due to the site's proximity to the sea.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.23 Site Compounds

It is anticipated that three construction compounds will be utilised during the construction of the Proposed Scheme, two main compounds located at Galway Harbour Enterprise Park and a satellite compound at Galway Cathedral Car-Park. The Satellite Site Compound is assessed as part of the Scheme Works and will not be assessed any further. The main Site Compounds will be actively used during construction period which may well last longer than one hydrologic year and hence was assessed for any risk of flooding from the following known sources.

Fluvial Flooding

The main Site Compounds is outside the 0.1%, 1% and 10% AEP and is therefore classified as Flood Zone C.

Tidal Flooding

The compound is predominantly outside the flood extents except for the bridge over Lough Atalia (New Docks) falling within the 1:200 year or 0.5% AEP extent and is therefore partially within Flood Zone A as shown in Figure 40.

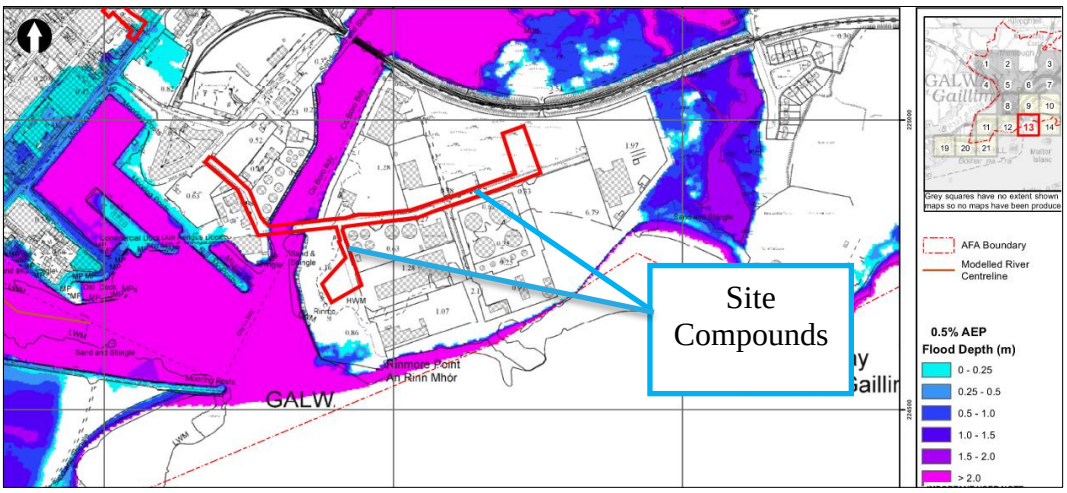

Figure 40 Site Compounds Tidal Flood Extents (0.5% AEP)

As it can be seen in the flood map, the bridge across the Lough Atalia will be submerged by a flood depth of greater than 2.0m during the 0.5% AEP tidal event in which case the entire Galway Harbour will be cut-off.

Groundwater Flooding

Groundwater has not been indicated in this area by the GSI Groundwater Flood Map. The area is noted as high groundwater vulnerability. It is likely that the vulnerability rating is indicative of absence of soil cover rather than a highwater table. However, the groundwater table is likely to be shallow due its proximity to the bay.

Pluvial Flooding

Pluvial Flooding in this area is not indicated in the PFRA map and therefore the risk is deemed to be low.

3.24 Summary of Flood Risk

Table 2: Summary of flood risk to the Work Areas

Location	Source of Flooding				
	Fluvial	**Tidal**	**Groundwater**	**Pluvial**	**Mechanical**
University Road	Low	Low	Moderate	Low	Low
Gaol Road and Galway Cathedral	Moderate	Low	Moderate	Low	Medium
Salmon Weir Bridge	Low	Low	Moderate	Low	Low
Newtownsmith/Waterside	Low	Low	Moderate	Low	Low
St. Vincent's Avenue/Walsh's Terrace	Low	Low	Moderate	Low	Low
Woodquay/Daly's Place/Mary Street	Low	Low	Moderate	Low	Low
Dyke Road/Headford Road	Moderate	Low	Moderate	Low	Low
St. Francis Street/Eglinton Street/Williamsgate Street	Low	Low	Moderate	Low	Low
Bóthar na mBan/St. Brendan's Avenue	Low	Low	Moderate	Low	Low
Prospect Hill	Low	Low	Low	Low	Low
Eyre Square North/Eyre Square East/Eyre Square South	Low	Low	Low	Low	Low
Victoria Place/Merchant's Road/Queen Street	Low	High	Low	Moderate	Low
Forster Street	Low	Low	Low	Low	Low
College Road/Forster Street/Fairgreen Road/Bóthar Uí hEithir Junction	Low	Low	Low	Low	Low
Bóthar Uí hEithir	Low	Low	Low	Low	Low
Fairgreen Road	Low	Low	Low	Low	Low
College Road (to junction with Lough Atalia Road)	Low	Moderate	Low	Low	Low
College Road/Lough Atalia Road Junction	Low	Moderate	Moderate	Low	Low
College Road/Lough Atalia Road to Moneenageisha Junction	Low	Moderate	Moderate	Low	Low
Moneenageisha Junction	Low	Moderate	Moderate	Low	Low
R338 Dublin Road	Low	Moderate	Moderate	Low	Low
Site Compounds (Harbour)	Low	High	Moderate	Low	Low

3.25 Conclusion of Stage 2 - FRA

As summarised in Table 2, there is two locations at high risk of flooding (Flood Zone A) from tidal sources and further seven areas at moderate risk of flooding (Flood Zone B) from fluvial sources in the Proposed Scheme area. Areas at moderate risk from groundwater sources are likely due to the site's proximity to the sea as opposed to a shallow water table and this may require dewatering during construction, as required. The pluvial flood risk at Victoria Place is only a historic and is probably due to undersized drainage pipe or blockage of the system.

The risk of flooding does not suggest progressing to Stage-3 Flood Risk Assessment. However, as outlined in in the preceding sections, some of 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[1].

3.26 Justification Test

A Development Management Justification Test is completed in accordance with the guidelines. This was to ensure the development proposal is not at risk of flooding to itself or does not increase the risk elsewhere. Although 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 whole development area.

The Proposed Scheme has been determined to have satisfied all requirements of the justification test as demonstrated in Table 3.

As flood risks are present is some areas, measures included in the Proposed Scheme design measures are used are outlined in the Section 4 which were used to complete the Justification Test. Some of the measures included:

- Upgraded road drainage system including SUDs,
- Routine maintenance plan of the drainage system,
- Flood risk warning and flood risk awareness system.

Section 4 provides more details of these proposed design measures applied at the areas identified.

[1] Note that flood risk assessments do not take into account the presence of flood defence structures or design measures in place as a residual risk always remains and flood risk is never zero.

Table 3: 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 road corridor is an existing development. The Galway City Development Plan 2017-2023 plans to, "*Implement traffic management and infrastructural changes to facilitate the development of a public bus network in accordance with the Galway Transport Strategy (GTS).*" This development achieves this purpose by providing enhanced public transport network to Galway City.	Yes
2	The proposal has been subject to an appropriate flood risk assessment that demonstrates:		
2(i)	The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;	The FRA completed demonstrated that the Proposed Scheme does not increase the existing risk of flooding to itself or elsewhere. Standard SUDs measures in the form tree pits, oversized pipes and attenuation tanks) are also provided to improve on the existing situation outlined in Section 4.	Yes
2(ii)	The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;	The development proposal includes upgraded drainage system and additional green area where available to reduce the existing risk of flooding. The development proposal consisted of SUDs in the form of tree pits, bioretention areas and catchpits to reduce the risk further and improve the discharge quality. Any net increase in impermeable area was compensated by creating additional green area. Therefore, no overall increase in flooding to the site or elsewhere is expected.	Yes
2(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	The existing flood warning system and routine drainage inspection maintenance plan will be in place to reduce the residual risk to acceptable level. For fluvial sources, the development proposal is designed to include upgraded drainage system with additional gullies to collect surface water from foot paths and carriageway to connect to new surface water network. The development proposal will also contain flood resilient construction methods and materials.	Yes

No.	Criteria	Response	Criteria Satisfied?
2(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 Proposed Scheme will facilitate good urban growth through a provision of high-quality pedestrian, cycle, and public transport corridor. This is in line with the Galway City Development Plan objectives which states, "Support the improvement of access for public transport, pedestrian and cyclists to and within major employment areas and institutions." The development is in keeping with the landscape and visuals of Galway city.	Yes

4 Proposed Scheme Design Measures

4.1 Flood Risk Areas

There were nine flood risk areas identified along the proposed routes sections of work that spanned from University Road to College Road.

- Area 1: Gaol Road and Galway Cathedral Car Park (Satellite Compound) lie within Flood Zone B (between 1 in 100 and 1 in 1000-year fluvial flood extents,
- Area 2: Dyke Road/Headford Road (1 in 1000 fluvial extent)/Defended Area
- Area 3: Victoria Place/Merchant's Road/Queen Street lies within Flood Zone A (1 in 200-year tidal flood extents),
- Area 4: College Road (to junction with Lough Atalia Road) within Flood Zone B (between 1 in 200 and 1 in 1000-year tidal flood extents),
- Area 5: College Road/Lough Atalia Road Junction within Flood Zone B (between 1 in 200 and 1 in 1000-year tidal flood extents),
- Area 6: College Road/Lough Atalia Road to Moneenageisha Junction within Flood Zone B (between 1 in 200 and 1 in 1,000-year tidal flood extents),
- Area 7: Moneenageisha Junction within Flood Zone B (between 1 in 200 and 1 in 1000-year tidal flood extents),
- Area 8: Dublin Road within Flood Zone B (between 1 in 200 and 1 in 1000-year tidal flood extents),
- Area 9: Main Site Compounds (Galway Harbour) in part is in Flood Zone A from tidal sources

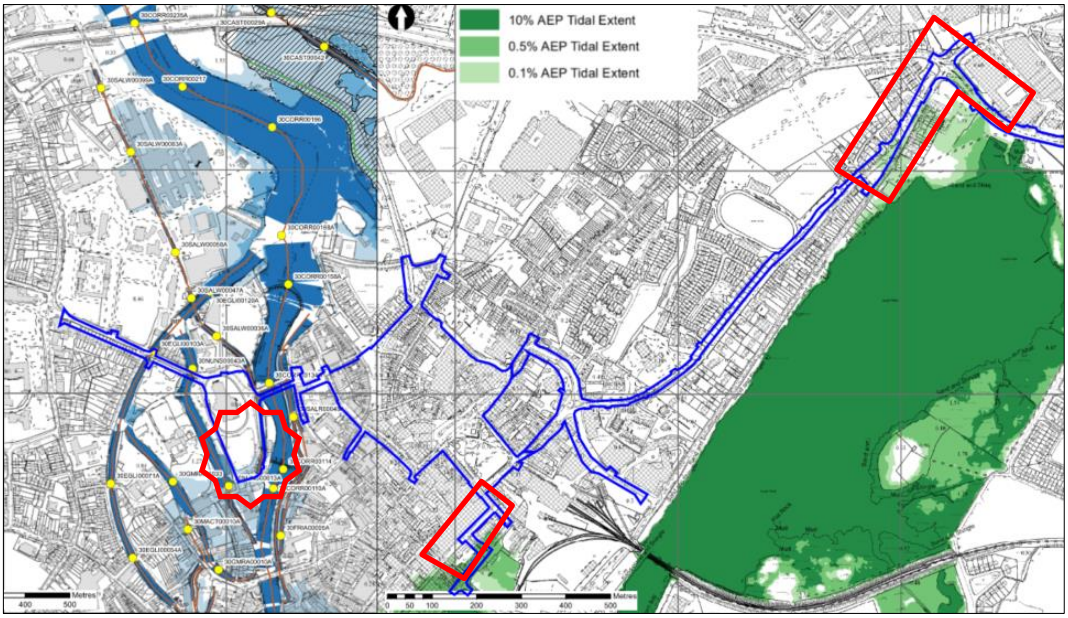

Figure 41: Full fluvial and tidal flood risk sites (shown in red)

Design measures applied to each of these areas is outlined below:

4.2 Area 1: Gaol Road and Galway Cathedral

The flood depth for the Gaol Road/Cathedral work area varies from 0.0 to 0.25m for the 0.1% AEP as shown in Figure 42.

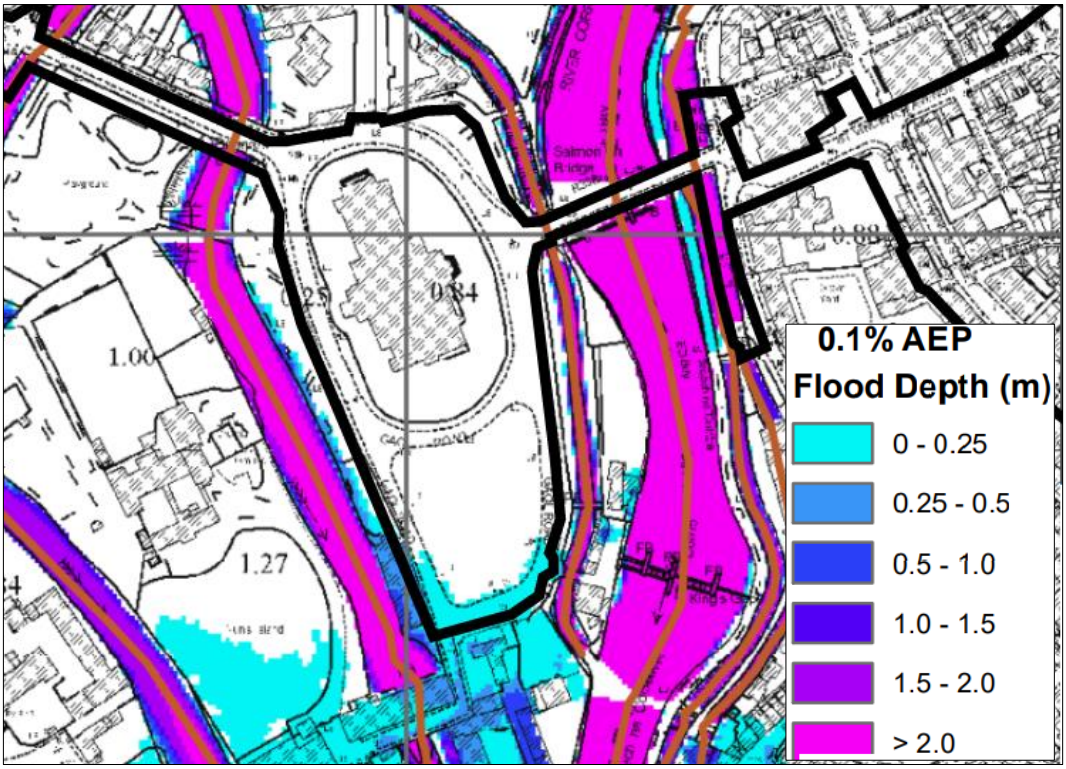

Figure 42 Gaol Road/Galway Cathedral Area

No material change is proposed to the existing road to mitigate against fluvial flood risk. However, the following design solutions are included to mitigate the risk from surface water drainage:

- Upgraded the surface water drainage system with additional gullies and relocated existing ones for efficiency,
- Provided additional green area,
- Provided adequate space for post flood draining and cleaning.

4.3 Area 2: Dyke Road/Headford Road

This is a defended area by means of the Dyke Road embankment. This embankment provides a flood protection of up to the 1% AEP from the River Corrib. The condition of the embankment is described as “fair”. The risk of flooding in this area dependent on this defence being maintained on an ongoing basis.

To mitigate against pluvial flooding, the following design solutions are included:

- Upgraded surface water drainage system, additional gullies provided and relocated existing ones as required,
- New gullies provided to collect surface water from footpaths, cycle tracks and carriageway and connected to oversized pipe and a flow control structure (a hydrobrake) to attenuate flows form any impermeable area.
- Surface water outfall to the Corrib River in the vicinity of the Dyke Road embankment avoided,
- Provided additional green area.

4.4 Area 3: Victoria Place/Merchant's Road/Queen Street

The flood depth on these areas varies from 0.5m to 1.0m during the 0.1% AEP tidal event as shown in

Figure **43**. A maximum flood depth of 1.0m is inaccessible for passenger cars, but emergency vehicles can ford through if their exhaust is at higher level. There is no physical flood protection scheme in place yet. Until such scheme is in place, this area will continue to be at high risk of flooding from tidal sources from 0.5%AEP event.

The strategy to mitigate the impact of flooding in this section of the works is by avoiding construction during high tide. Galway City Council's tidal warning system will be used to warn construction personnel and other road users.

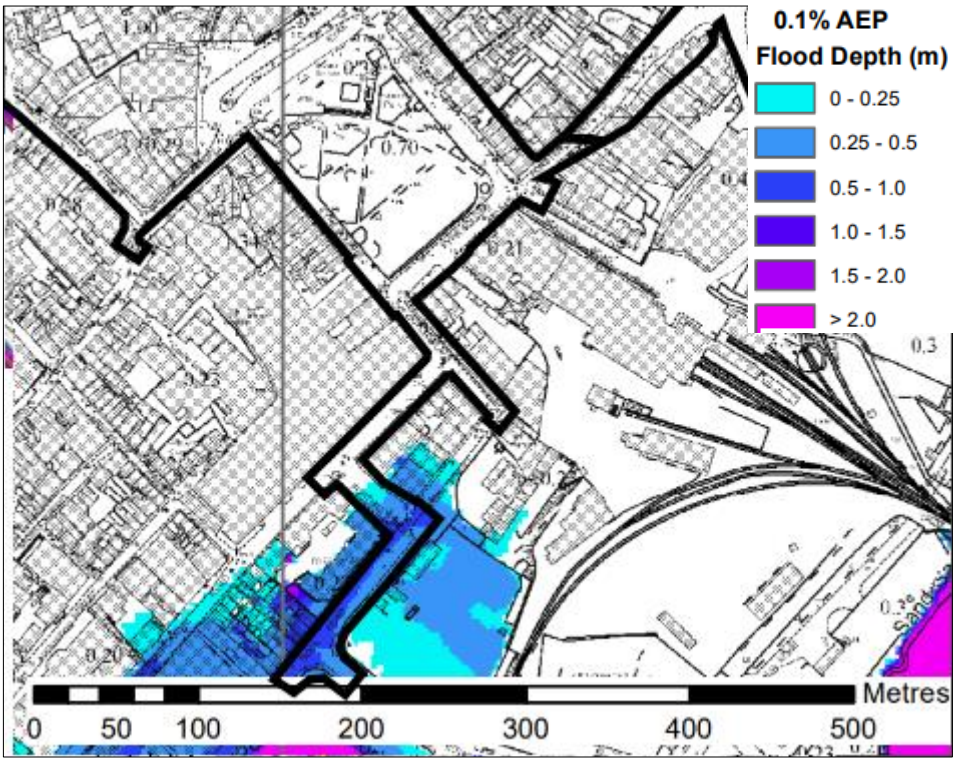

Figure 43 Tidal Flood Depth – Victoria Place/Merchant's Road/Queen Street

4.5 Area 4: College Road/Lough Atalia Road Junction

The flood depth on these areas varies from 0.5m to 1.0m during the 0.1% AEP tidal event as shown in Figure 44.

Measures for surface water management included in the design are:

- Upgraded drainage system with additional gullies,
- No net increase in impermeable surface,
- Provided attenuation tank: Volume = 279m^3
- Provided adequate space for post flood draining and cleaning

Additional measures that will be in place to mitigate the impacts of tidal flooding is the tidal warning issued by Galway City Council in advance of high tides so that construction during such periods is avoided.

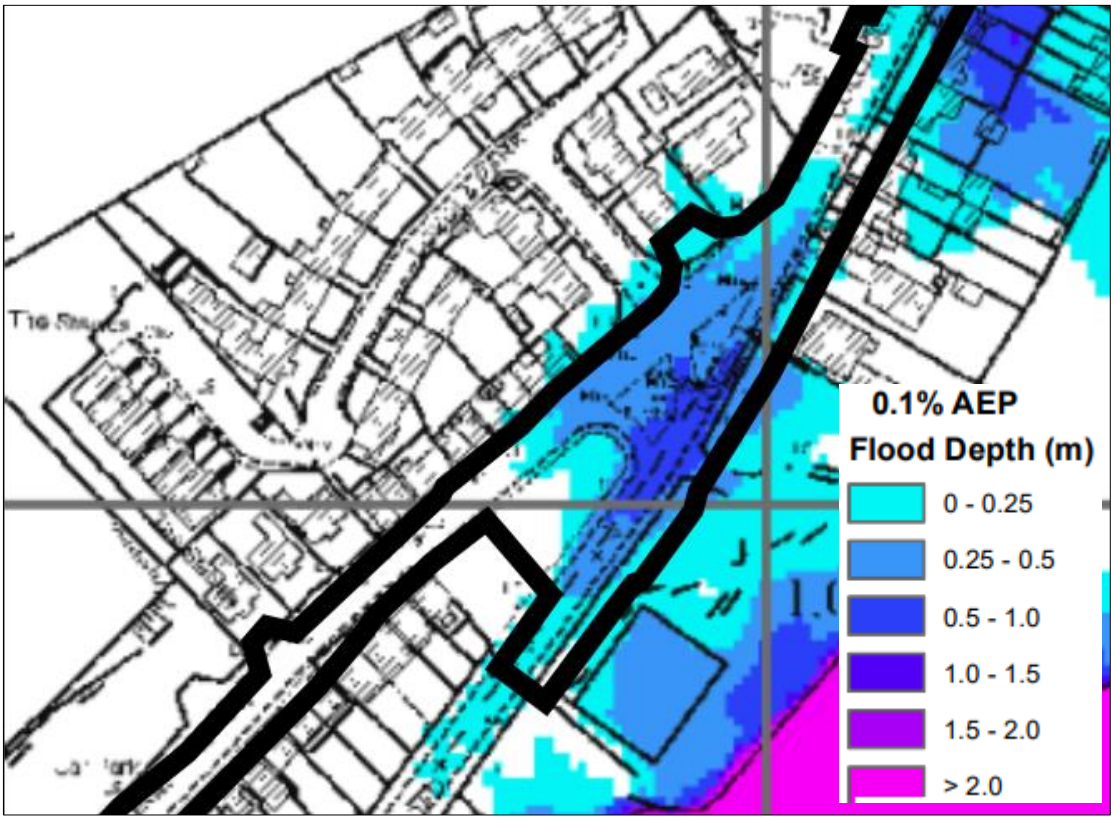

Figure 44 Tidal Flood Depth - College Road/Lough Atalia Road Junction

4.6 Area 5: College Road/Lough Atalia Road to Moneenageisha Junction

The flood depth on these areas is less than 0.5m during the 0.1% AEP tidal event as shown in Figure 45.

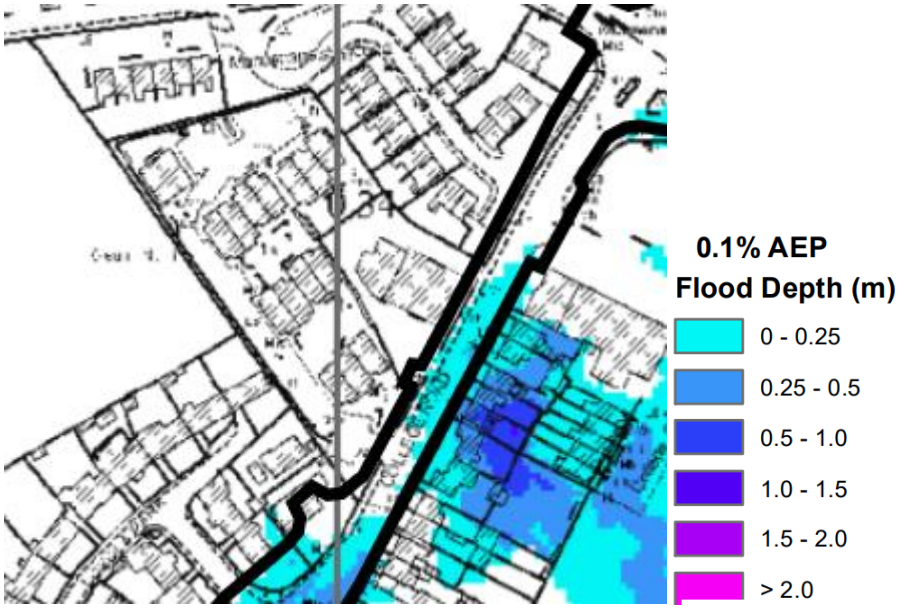

Figure 45 Tidal flooding College Road/Lough Atalia Road to Moneenageisha Junction

Design measures for surface water management included in the design are:

- Upgraded drainage system to speed up drainage,
- New gullies to collect surface water from footpaths, cycle tracks and carriageway and connected to oversized pipes and a flow control structure (hydrobrake) to attenuate flows form any increase in impervious area.

Additional measures that will be in place to mitigate the impacts of tidal flooding is the tidal warning issued by Galway City Council in advance of high tides so that construction during such periods is avoided.

4.7 Areas 6, 7 and 8: Moneenageisha Junction/Dublin Road

The flood depth on these areas is between 0.0 to 1.0m during the 0.1% AEP tidal event as shown in Figure 46.

Design measures for surface water management applied in this area include:

- Upgraded drainage system including additional gullies to speed up drainage
- New gullies to collect surface water from footpaths, cycle tracks and carriageway and piped via a flow control structure (hydrobrake) to attenuate flows before discharge to the sea,
- Provided adequate space for post flood draining and cleaning.

Additional measures that will be in place to mitigate the impacts of tidal flooding is the tidal warning issued by Galway City Council in advance of high tides so that construction during such periods is avoided.

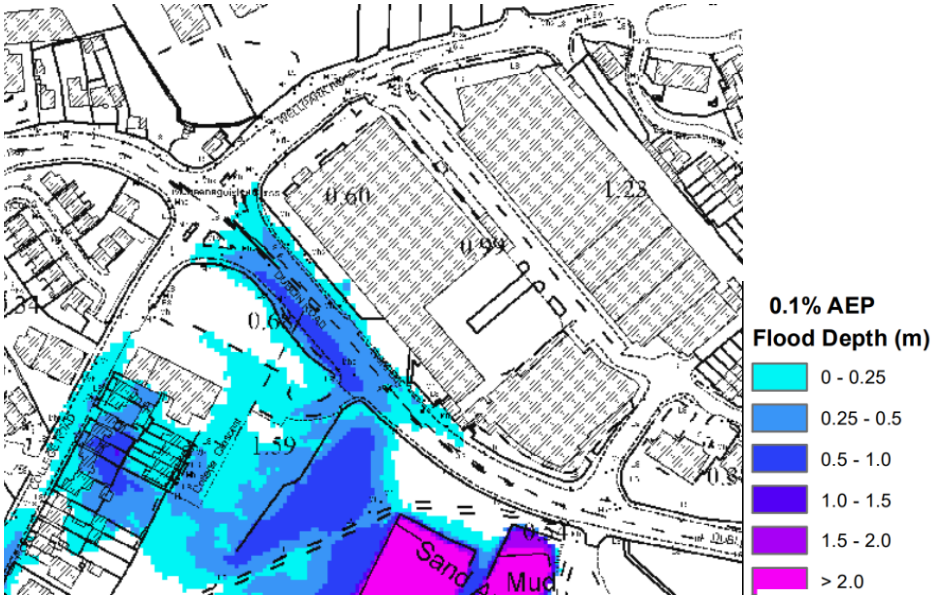

Figure 46 Tidal flooding at Moneenageisha Junction

4.8 Areas 9: Main Site Compound

The flood depth across the bridge over Lough Atalia reaches to a maximum 2m for the 0.5% AEP tidal event. The site is only for a temporary use during construction and design measures may not be justified. The main Site Compounds will be cut off until the high tide subsides which will result in the disruption of the works. The road will be allowed to flood with advance warning given to the road user by Galway City Council.

5 Conclusion

This FRA was carried out as part of the Planning Application for the proposed Bus Connects Galway: Cross-City Link (University Road to Dublin Road.

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

- Area near Goal Road, Galway Cathedral and Dyke Road are within Flood Zone B from fluvial source.
- Sections of Victoria Place/Merchant's Road/Queen Street are identified as being in Flood Zone A, at risk from tidal source. This section is also at moderate risk from pluvial flooding.
- Sections of the works from College Road/Lough Atalia Road to the Moneenageisha Junction and work areas on Dublin Road are within Flood Zone B from tidal source.

- The risk of flooding from groundwater source was determined as moderate. However, this 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 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 road profile and does not increase the risk of flooding elsewhere. However, as sections of the area are situated in flood risk zones, the proposal includes drainage design measures including upgrade of the surface water drainage system with additional (or relocated) gullies, additional green area where there is a net increase in impervious area, and attenuation systems via SUDs including tree pits, bioretention areas and catchpits, oversized pipes, and an attenuation tank at College Road/Lough Atalia Road.

There remains a residual risk to sections of the Study Area from tidal sources. The worst impacted area are at Victoria Place and at the junction of College Road/Lough Atalia Road form the 0.5% AEP tidal event reaching a maximum depth of 0.5m to 1.0m OD. Access to the main Site Compounds, located at Galway Harbour Enterprise Park, may also be hampered as the bridge over Lough Atalia will be submerged for the 0.5% AEP tidal event. However, the interruption is expected to be brief until the high tide subsides. The Contractor will maintain awareness of tidal event and weather forecasts from Galway City Council and Met Eireann as appropriate during construction, as is standard practice.

In conclusion, this FRA has demonstrated that the risks relating to flooding to the Proposed Scheme are moderate and can be managed for during construction and operation of the Proposed Scheme and therefore comply with DoEHLG / OPW.