

Alber Developments Limited

Proposed Residential Development, Rosshill, Galway

Flood Risk Assessment



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Document Control Sheet	
Document Reference	10690-TR05 FRA Rosshill
Report Status	Issued
Report Date	May 2021
Current Revision	P03
Client:	Alber Developments Limited
Client Address:	1 st Floor, Fairgreen House, Fairgreen Rd, Galway, H91 AXK8
Project Number	10690

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Revision	Description	Author:	Date	Reviewed By:	Date	Authorised by:	Date
P03.1	Issued for comment	ML	11/05/2021	CK	13/05/2021	CK	13/05/2021
P03.2	Issued	ML	14/05/2021	CK	14/05/2021	CK	14/05/2021

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1 Introduction

TOBIN Consulting Engineers were appointed in September 2020 to provide engineering and environmental consultancy services for a proposed residential development at Rosshill, in Galway City (Figure 1-1 & Figure 1-2).

This preliminary Flood Risk Assessment (FRA) has been prepared in accordance with a Stage 2 Initial Flood Risk Assessment as defined by the guidelines produced by the Department of Environment, Heritage and Local Government (DoEHLG), *The Planning and Flood Risk Management Guidelines for Planning Authorities, 2009* as follows:

“to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped.”¹

The proposed residential development is located along Rosshill Road, just off the Old Dublin Road (see Figure 1-1). The Galway-Dublin railway line passes along the northern boundary of the site.

The greenfield site pertaining to this application and report, highlighted red in Figure 1-1, is approximately 4.7ha with the overall lands under the applicant’s ownership approximately 10ha in area. Existing ground elevations associated with the proposed development site (redline boundary) vary from approximately 7.01mOD and 20.50mOD.

The aim of this FRA is to appraise the adequacy of existing information¹ to identify the risk, if any, of flooding in relation to the proposed development.

¹ *The Planning and Flood Risk Management Guidelines for Planning Authorities, 2009*



Figure 1-1 - Site Location

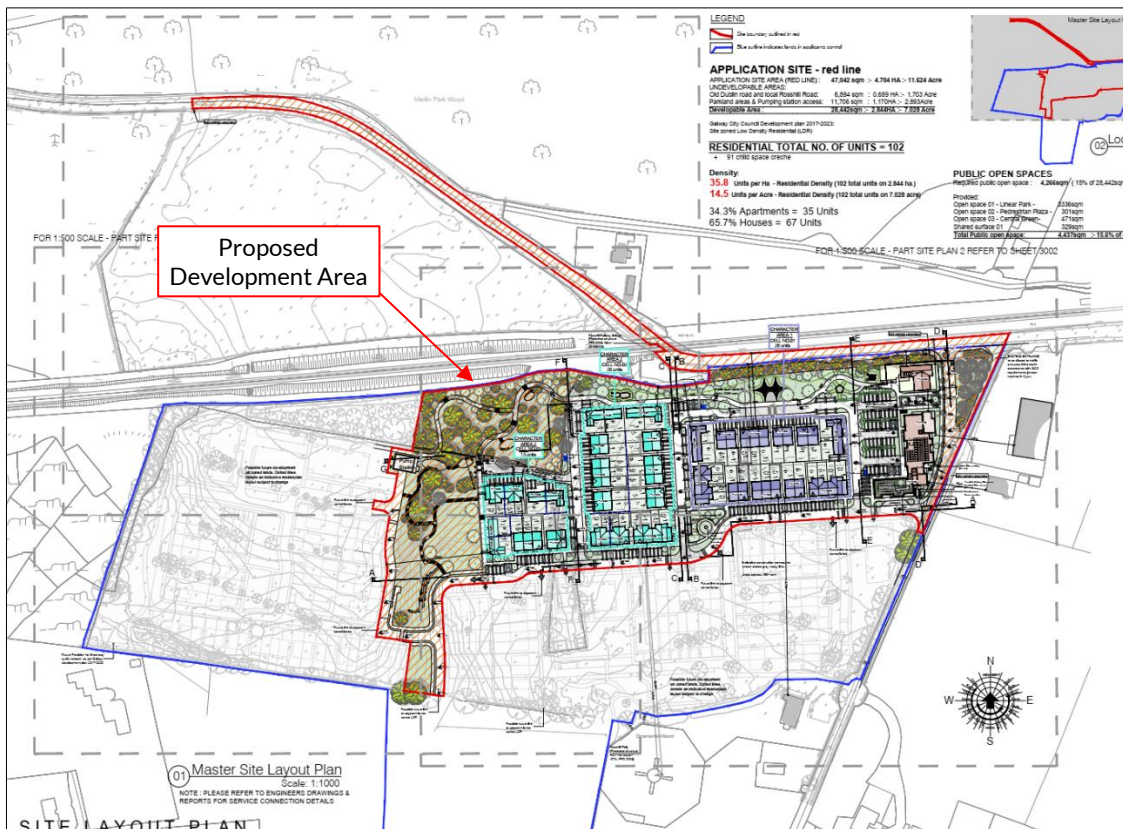


Figure 1-2 - Proposed Site Development Plan

2 Planning & Flood Risk Management Guidelines

This Flood Risk Assessment was carried out for the proposed residential development in accordance with the following plans and guidance documents:

- The Planning System and Flood Risk Management Guidelines (OPW & DOEHLG 2009)
- The Flood Risk Management Climate Change Sectoral Adaption Plan (OPW 2019)
- The Galway County Development Plan 2017-2023
- The Galway City Development Plan 2017-2023

2.1 The Planning System & Flood Risk Management Guidelines

The ‘*The Planning System and Flood Risk Management*’ (PSFRM) guidance document, published in 2009 by The Department of Environment, Heritage and Local Government (DoEHLG) and the Office of Public Works (OPW), aims to ensure that flood risk is considered in development proposals and the assessment of planning applications.

2.1.1 Flood Zones and Vulnerability Classes

The PSFRM Guidelines discuss flood risk in terms of flood zones A, B, and C, which correspond to areas of high, medium, or low probability of flooding, respectively. The extents of each flood zone are based on the Annual Exceedance Probability (AEP) of various flood events.

The PSFRM Guidelines also categorise different types of development into three vulnerability classes based on their sensitivity to flooding.

Table 1 shows a decision matrix that indicates which types of development are appropriate in each flood zone and when the PSFRM Justification Test (Section 2.1.2) must be satisfied. The annual exceedance probabilities used to define each flood zone are also provided.

Table 1 Decision Matrix for Determining the Appropriateness of a Development (PSFRM)

Flood Zone (Probability)	Annual Exceedance Probability (AEP)	Development Appropriateness		
		Highly Vulnerable	Less Vulnerable	Water Compatible
A (High)	<u>Fluvial & Pluvial Flooding</u> More frequent than 1% AEP	Justification Test	Justification Test	Appropriate
	<u>Coastal Flooding</u> More frequent than 0.5% AEP			
B (Medium)	<u>Fluvial & Pluvial Flooding</u> 0.1% to 1% AEP	Justification Test	Appropriate	Appropriate
	<u>Coastal Flooding</u> 0.1% to 0.5% AEP			
C (Low)	<u>Fluvial, Pluvial & Coastal Flooding</u> Less frequent than 0.1% AEP	Appropriate	Appropriate	Appropriate

The PSFRM Guidelines state that ‘dwelling houses’, such as the proposed residential development subject of this flood risk assessment, are classified as “highly vulnerable” in terms of their sensitivity to flooding. Accordingly, the proposed development has been assessed against the 1000-year (0.1% AEP) flood event.

2.1.2 The Justification Test

Any proposed development being considered in an inappropriate flood zone (as determined by Table 1) must satisfy the criteria of the Justification Test outlined in Figure 2-1 (taken from the PSFRM Guidelines).

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

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

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

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

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

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

Figure 2-1 Criteria of the Justification Test

2.2 The Flood Risk Management Climate Change Sectoral Adaption Plan

The Flood Risk Management Climate Change Sectoral Adaptation Plan was published in 2019 under the National Adaptation Framework and Climate Action Plan. This plan outlines the OPW's approach to climate change adaptation in terms of flood risk management.

This approach is based on a current understanding of the potential impacts of climate change on flooding and flood risk. Research has shown that climate change is likely to worsen flooding through more extreme rainfall patterns, more severe river flows, and rising mean sea levels.

To account for these changes, the Adaptation Plan presents two future flood risk scenarios to consider when assessing flood risk:

- Mid-Range Future Scenario (MRFS)
- High-End Future Scenario (HEFS)

Table 2 sets out the allowances for both scenarios.

Table 2 Climate Change Adaptation Allowances for Future Flood Risk Scenarios

Parameter	Mid-Range Future Scenario (MRFS)	High-End Future Scenario (HEFS)
Extreme Rainfall Depths	+ 20%	+ 30%
Peak River Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 0.5 m	+ 1 m

For the purpose of this flood risk assessment, we have assessed the proposed development against the Mid-Range Future Scenario as it represents a likely future scenario.

2.3 Galway County Development Plan (2015-2021)

The current Galway County Development Plan provides a strategic framework for land use planning for 2015 to 2021; whereby all development within the County should adhere to the strategies and policies within. Chapter 8 of the 2015-2021 County Development Plan (CDP) deals with the area of flood risk.

The following are the key policies described in the CDP pertaining to flood risk:

Policy FL 1 *“It is the policy of Galway County Council to support, in co-operation with the OPW, the implementation of the EU Flood Risk Directive (2007/60/EC), the Flood Risk Regulations (SI No. 122 of 2010) and the DEHLG/OPW publication The Planning System and Flood Risk Management Guidelines (2009) (and any updated/superseding legislation or policy guidance). Galway County Council will also take account of the Shannon International and Western Catchment Flood Risk Assessment and Management Studies.”*

Policy FL 4 *“The Council shall implement the key principles of flood risk management set out in the Flood Risk Management Guidelines as follows:*

- (a) Avoid development that will be at risk of flooding or that will increase the flooding risk elsewhere, where possible;*
- (b) Substitute less vulnerable uses, where avoidance is not possible; and*
- (c) Mitigate and manage the risk, where avoidance and substitution are not possible.*

Development should only be permitted in areas at risk of flooding when there are no alternative, reasonable sites available in areas at lower risk that also meet the objectives of proper planning and sustainable development.

Development in areas which have the highest flood risk should be avoided and/or only considered in exceptional circumstances (through a prescribed Justification Test) if adequate land or sites are not available in areas which have lower flood risk.”

A Stage 1 Strategic Flood Risk Assessment (SFRA) was carried out as part of the 2015-2021 Galway County Development Plan. The SFRA notes that the Western CFRAM study identified Galway City as one of the areas for further study. The findings of the CFRAM study are detailed in Section 3.4 of this Flood Risk Assessment report.

2.4 Galway City Development Plan

Section 9.3 of the 2017-2023 Galway City Development Plan deals with the assessment of flood risk.

The key policies in the City Development Plan relevant flood risk assessment are given below:

Support, in co-operation with the OPW, the implementation of EU Flood Risk Directive (2007/60/EC), the Flood Risk Regulations (SI no. 122 of 2010), the DECLG and OPW Guidelines for Planning Authorities, the Planning System and Flood Risk Management (2009), updated/superseding legislation or departmental guidelines and have regard to the findings and relevant identified actions of the future Corrib Catchment Flood Risk Assessment and Management (CFRAM) Study, as the study progresses and incorporate these into the Development Plan, where appropriate.

Have regard to the recommendations of the Strategic Flood Risk Assessment (SFRA) for the Galway City Development Plan 2017-2023 in the assessment of development in identified areas of flood risk (See Figure 2-2).

Restrict the location of structures other than structures with essential links to the waterway and public utilities within 10 metres of the River Corrib in G agricultural zoned lands.

Protect and promote sustainable management and uses of water bodies and watercourses from inappropriate development, including rivers, streams, associated undeveloped riparian strips, wetlands and natural floodplains.

Ensure flood risk is addressed in any future local area plans, framework plans and masterplans in the city and have regard to the findings of the Strategic Flood Risk Assessment for Three Local Area Plans 2012 in the preparation of LAPs for Ardaun, Headford Road area, and Murrrough.

Require a site-specific Flood Risk Assessment (FRA) for planning applications in identified areas at risk of flooding, where appropriate, in accordance with the recommendations of the Strategic Flood Risk Assessment (SFRA) for the Galway City Development Plan 2017-2023.

Facilitate sustainable flood defence and coastal protection works in order to prevent flooding and coastal erosion, subject to environmental, visual and built heritage considerations.

Ensure any proposal aimed at alleviating flooding will be subject to Appropriate Assessment in accordance with Article 6 of the EU Habitats Directive, where appropriate.

Ensure the use of SUDS, sustainable urban drainage systems, wherever practical, in the design of development to reduce the rate and quantity of surface water run-off.

Ensure new development, where appropriate, is designed and constructed to meet the flood design standards outlined under Section 11.27 Flood Risk Management and the recommendations of the Strategic Flood Risk Assessment (SFRA) for the Galway City Development Plan 2017-2023.

Have regard to the findings of the OPW's Irish Coastal Protection Strategy Study (2013) of the west coast.

Continue to protect the coastal area and foreshore and avoid inappropriate development in areas at risk of coastal erosion and/or would cause and escalate coastal erosion in adjoining areas.

Protect and maintain, where feasible, undeveloped riparian zones and natural floodplains along the River Corrib and its tributaries.

The design standards outlined under Section 11.27 Flood Risk Management in the Galway City Development Plan (as referenced above) are as follows:

- *Where development is proposed in identified flood risk areas under Western CFRAM, the type or nature of the development needs to be carefully considered and the potential risks mitigated and managed through on-site location, layout and design of the development to reduce flood risk to an acceptable level.*
- *Development shall have regard to the flood resilient design guidance and flood mitigation measures in the City Council's Strategic Flood Risk Assessment for Galway City Development Plan 2017-2023*
- *In identified flood risk areas, Flood Zone A or B, it will be necessary to carry out a Site-Specific Flood Risk Assessment (FRA), appropriate to the scale and nature of the development and the risks arising. Proposals shall demonstrate appropriate mitigation and management measures in the layout and design of development.*
- *All proposed development must consider the impact of surface water flood risk in drainage design. Consideration should be given in the design of new development to the incorporation of SUDS. The drainage design should ensure no increase flood risk to the site or downstream catchment.*
- *Development proposals in identified flood risk areas shall consider and incorporate the potential impacts of climate change and residual risk into development layout and design.*
- *In areas of identified flood risk all developments including minor works and changes of use should include an appropriate level of FRA. This assessment must demonstrate that the development would not increase flood risk in the context of use, emergency access and infrastructure. Development should demonstrate principles of flood resilient design.*

A Strategic Flood Risk Assessment (SFRA)² was completed by JBA Consulting in 2015 to accompany the City Development Plan. The SFRA largely summarises the recommendations of the OPW's Planning System and Flood Risk Management guidance document. The SFRA Flood Zone mapping (Figure 2-2) was taken from the Western CFRAM Study, which has been reviewed in Section 3.4 of the report.

² Galway City Development Plan, Strategic Flood Risk Assessment, JBA Consulting (December 2015)

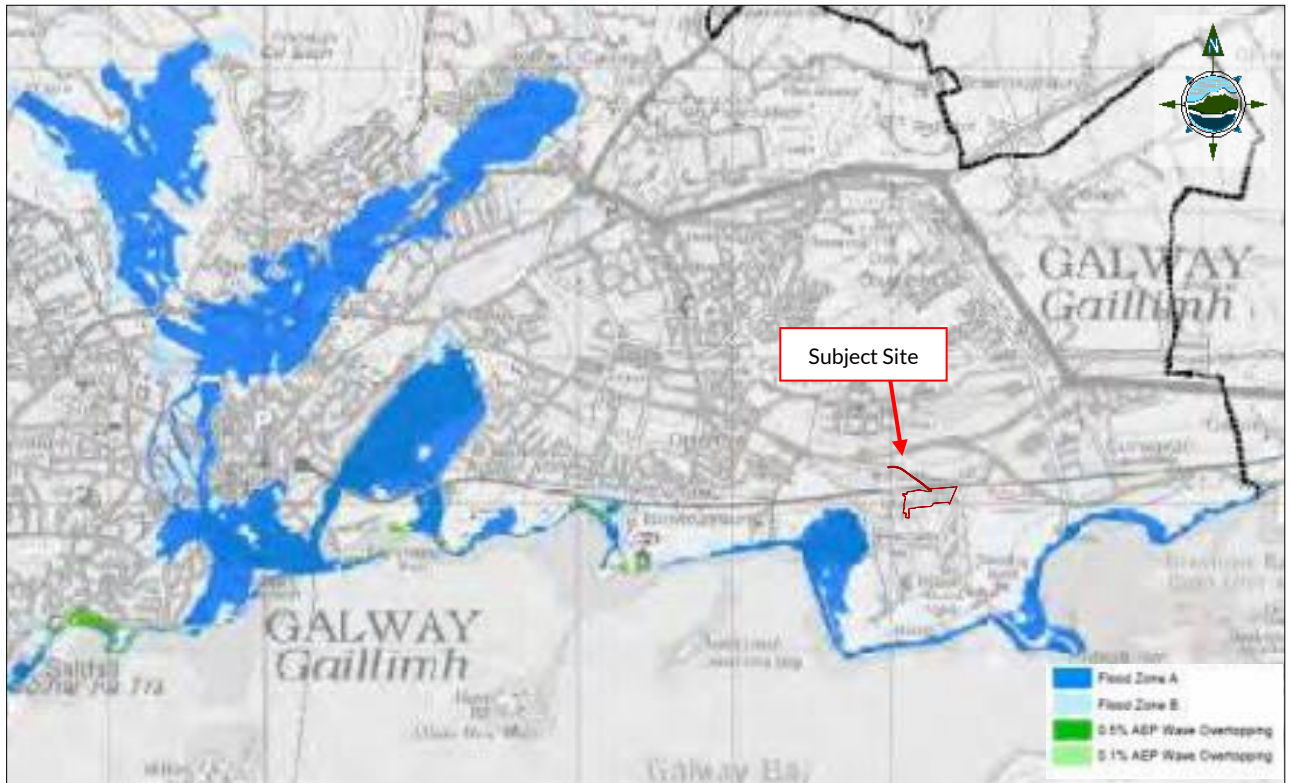


Figure 2-2 - Galway City SFRA Flood Zone Mapping

3 Historical Flooding & Flood Maps

3.1 OPW Flood Maps

Between the years 2004 to 2006 the OPW developed the Flood Hazard Mapping website, www.floodmaps.ie, which provided information about the location of known flood events in Ireland and showed supporting information in the form of reports, photos and press articles about those floods. During this time a huge data collection program was undertaken, visiting over 50 organisations (mainly local authorities and national organisations, eg Waterways Ireland, DoEHLG, and Teagasc) to collect and collate a vast array of information about flooding. The type of information varied from photographs of flood events, to consultants' reports, recordings from gauging stations, eyewitness accounts from staff plus letters from members of the public and minutes of meetings with key officials.

All this information was reviewed, verified, assessed and catalogued to create a National Flood Data Archive. From this the floods were mapped and uploaded to the website. Since 2006, as flood events occurred or as information was submitted to OPW from different sources, including information from the public, new floods and reports were added to the website on an ongoing basis. Past Flood Event information, which has been submitted to and approved by the OPW, is currently accessible for events which occurred pre Autumn 2014. Information on floods that have occurred since then will be uploaded to the website in due course.³

The OPW's online National Flood Hazard Mapping database (floodmaps.ie) does not provide any record of flood events occurring at the proposed development site (see Figure 3-1).



Figure 3-1 – OPW Map of Past Flood Events [National Flood Hazard Mapping database]

³ www.floodmaps.ie

3.2 OPW Preliminary Flood Risk Assessment (PFRA) Maps

In 2009 the OPW produced a series of maps to assist in the development of a Preliminary Flood Risk Assessment (PFRA) throughout the country. These maps were produced from a number of sources. It should be noted that *“the flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location”*⁴ and that the presented flood extents are for the current probability of flooding and exclude any allowance for climate change.

Figure 3-2 provides an overview of the fluvial, coastal, pluvial, and groundwater indicative flood extents in the vicinity of the subject site.

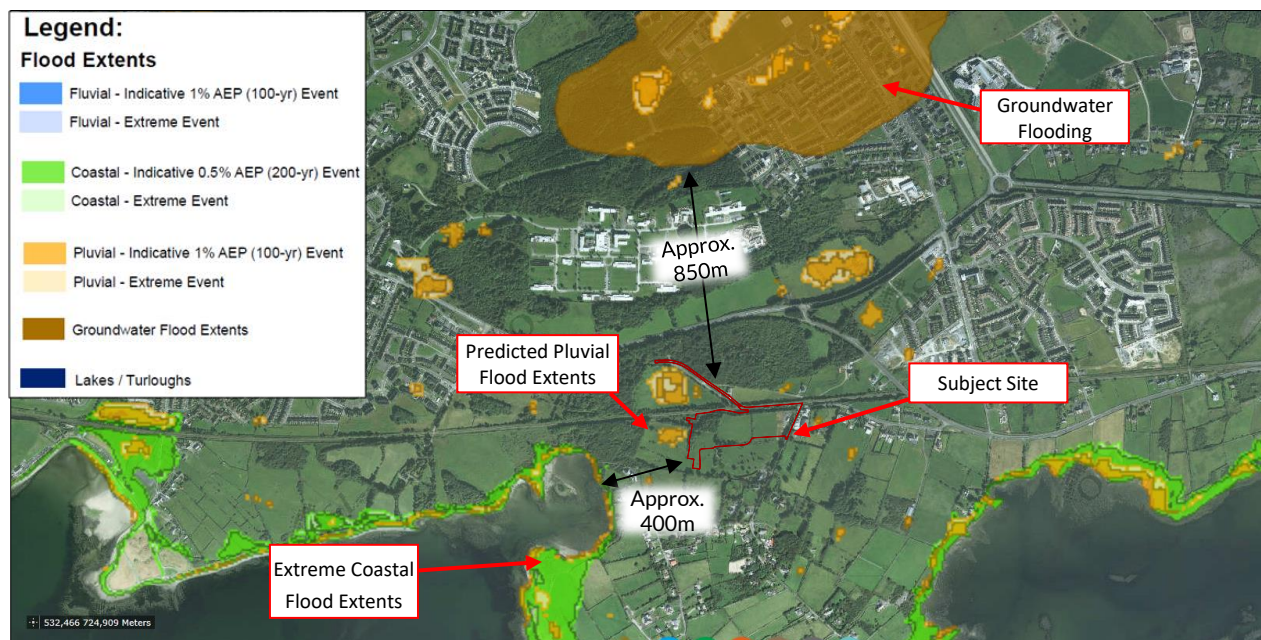


Figure 3-2 - Indicative Flood Mapping from OPW PFRA Study

Fluvial Flood Risk

There are no watercourses in the vicinity of the subject site. As shown in Figure 3-2, the PFRA indicates that the risk of fluvial (river) flooding to the development is minimal and does not identify any areas in the vicinity of the proposed site as being liable to fluvial flooding.

Pluvial Flood Risk

Pluvial modelling was carried out by HR Wallingford in November 2010 as part of the PFRA study. The 100- and 1000-year (1% and 0.1% AEP, respectively) flood extents were generated by analysing 1, 3, 6, and 24-hour rainfall events. The design storm rainfall was applied to the National Digital Terrain Model (DTM) with an allowance for infiltration based on the soil type in the area.

The DTM used for the PFRA study's flood plain mapping was generated from RADAR based technology in 2007 and is stated to have a 5m horizontal resolution (re-sampled to 10m

⁴ The National Preliminary Flood Risk Assessment (PFRA) Overview Report, OPW (March 2012)

resolution) and 0.01m vertical resolution, to a quoted vertical accuracy of 0.5m RMSE⁵. The accompanying report to the PFRA notes that the process *“due to the scale of analysis, has not taken into account local drainage structures such as culverts through embankments or other local drainage that would not be resolved in the DTM at a national scale”*.

The PFRA pluvial flood maps were also adapted by the OPW to show only the extents where the flood depths were greater than 200mm (on the basis that depths lower than this would not cause significant damage given door-step levels above ground level)⁶.

The analysis carried out by HR Wallingford as part of their PFRA study indicates that pluvial flooding (ponding of surface water) is not predicted to occur within the proposed residential development site following an extreme rainfall event (see Figure 3-2).

It was noted that pluvial flooding is predicted immediately to the west of the subject site, in land also owned by the client. Any proposals to develop the adjacent site will be subject to a separate planning application and site-specific flood risk assessment in the future.

Groundwater Flood Risk

As part of the PFRA study indicative groundwater flood mapping was produced by Mott Mac Donald Ltd. A model-based approach to generate groundwater flood extents was not possible due to the lack of available data; therefore, the following methods were used:

- 1) *“The use of existing mapping of past groundwater flood events (e.g., from 1994/95, and late 2009), developed from ground-based observation, aerial photography or satellite imagery and the maximum extents observed”;*
- 2) *“The delineation of flood extents around turloughs based on an assumed height of flooding of 4m above the base elevation of the turlough (the median of observed ranges) using the OPW’s national DTM, with manual adjustment to ensure pragmatic extents”;*
- 3) *“The use of records of past groundwater flood events to validate or adjust the flood extents derived using the other approaches”.*

“It should be noted that due to the absence of a model-based approach, only one set of flood extents were generated, with no specific event probability (although where observed flood data was used, these are likely to represent quite extreme events).”⁶

The PFRA mapping did not indicate any sources of groundwater flooding in the vicinity of the proposed residential development site. The indicative flood mapping shows the proposed site is located approximately 850m from the nearest groundwater flood extents (see Figure 3-2).

Coastal Flood Risk

The PFRA study indicates coastal flood extents in the adjacent Galway Bay. Based on the PFRA flood mapping (Figure 3-2), the proposed development is located approximately 400m outside of the extreme coastal flood event extents. More detailed analysis and mapping of coastal flooding is available from the Irish Coastal Protection Strategy Study and the Western CFRAM Study; refer to Sections 3.3 and 3.4 of this report.

⁵ National Pluvial Screening Project for Ireland (HR Wallingford, November 2012)

⁶ The National Preliminary Flood Risk Assessment (PFRA) Overview Report (OPW, March 2012)

3.3 Irish Coastal Protection Strategy Study

RPS Consulting Engineers, in conjunction with the OPW, undertook a project to develop maps indicating coastal and estuarine areas prone to flooding from the sea. The predicted flood extents which were produced under the Irish Coastal Protection Strategy Study (ICPSS)⁷ are based on analysis and modelling. The project included:

- *“Numerical Modelling of combined storm surges and tide levels which was used to estimate extreme water levels along the coastline”*
- *“Statistical extreme value analysis and joint probability analysis to both historic recorded tide gauge data and data generated by numerical modelling, which allowed an estimation of the extreme water levels of defined annual exceedance probability (AEP) to be established along the coastline Calculation of the extent of the predictive flooding, by comparing calculated extreme tide and surge waters levels along the coast with ground level based on a Digital Terrain Model (DTM)”*
- *“Definition of the plan extent of the predictive floodplain, by use of a Digital Terrain Model (DTM) commissioned by the Office of Public Works”*

The ICPSS flood mapping was produced by combining the results of the surge and tide level modelling, the statistical analysis, and the DTM. The mapping also incorporates future allowances for both mean sea level rise and glacial isostatic adjustment (GIA). The maps have been produced at a strategic level to provide an overview of coastal flood hazard and risk in Ireland, and minor or local features may not have been included in their preparation.⁸

The ICPSS flood mapping for the Mid-Range Future Scenario is shown in Figure 3-3. The proposed development site is located on existing ground with elevations between 7.01mOD and 20.50mOD, 2.45 meters above the estimated 1000-year (0.1% AEP) MRFS coastal flood level in Galway Bay of 4.56mOD (Node W5). The mapping indicates that the proposed development site is not likely to be affected by coastal flooding.

⁷ Irish Coastal Protection Strategy Study, Work Package 9A - Strategic Assessment of Coastal Flooding Extents – Future Scenario

⁸ *“The maps have been produced at a strategic level to provide an overview of coastal flood hazard and risk in Ireland, and minor or local features may not have been included in their preparation. A DTM is used to generate the maps, which is a ‘bare earth’ model of the ground surface with the digital removal of man-made and natural landscape features such as vegetation, buildings, bridges and embankments. The mapping process can show some of these man-made features, such as bridges and embankments, as flooded on the flood maps, when in reality they do not flood.”* [Extract from Irish Coastal Protection Strategy Study, Work Package 9A - Strategic Assessment of Coastal Flooding Extents – Future Scenario]

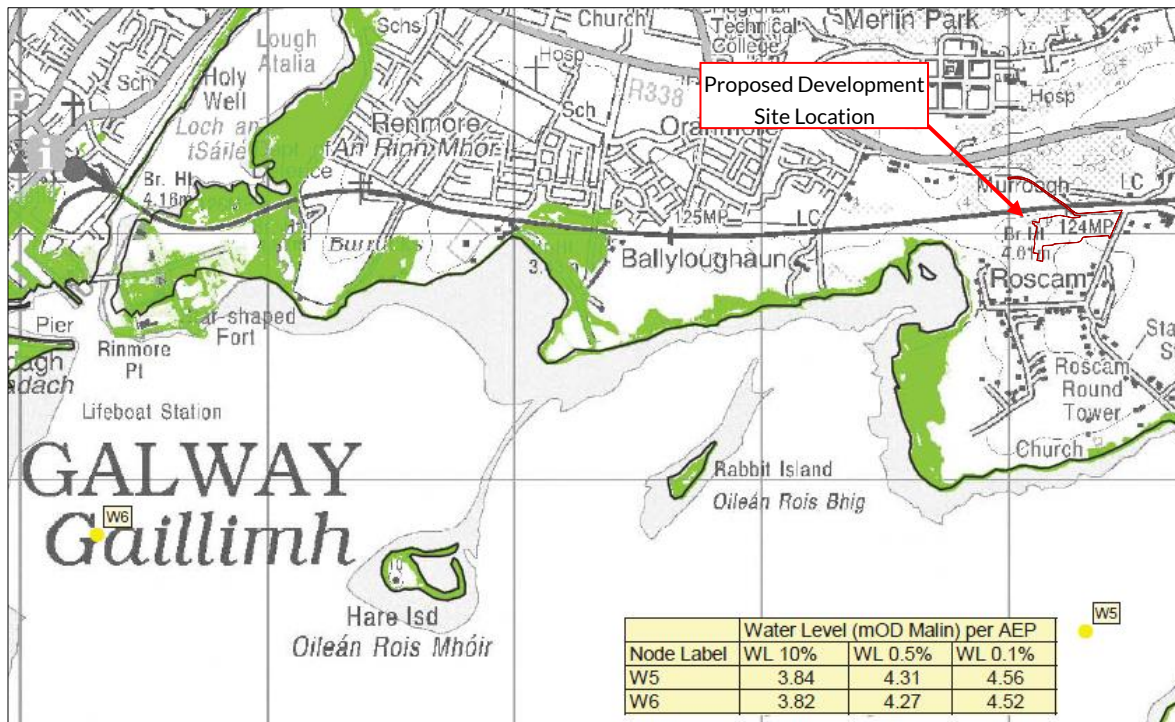


Figure 3-3 – Irish Coastal Protection Strategy Study Flood Extent Mapping

3.4 Western CFRAM Study

As part of the Western Catchment Flood Risk Assessment and Management (CFRAM) programme, hydraulic modelling of Galway Bay and Galway City’s watercourses was carried out by JBA Consulting in 2015. Joint probability analysis was carried out to assess fluvial and coastal flood risk in combination. The final flood extents mapping was published in October 2016.

Fluvial Flood Risk

The predicted fluvial flood extents during the 100- and 1000-year (1% and 0.1% AEP, respectively) Mid-Range Future Scenarios (MRFS) are shown in Figure 3-4.

The CFRAM Study flood mapping (see Figure 3-4) does not identify any fluvial (river) flooding in the vicinity of the proposed site.

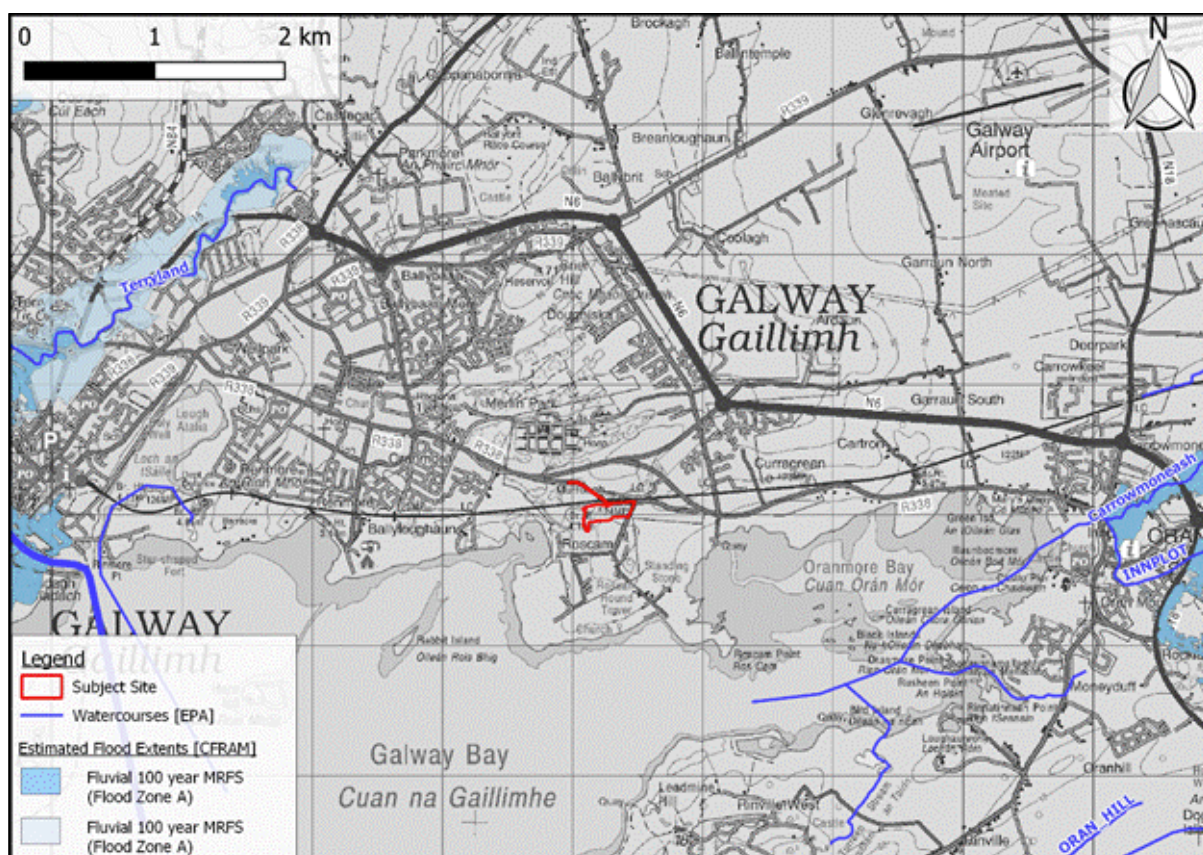


Figure 3-4 – Western CFRAM Study Fluvial MRFS Flood Extents

Coastal Flood Risk

The predicted coastal flood extents during the 100-, 200- and 1000-year (1%, 0.5% and 0.1% AEP, respectively) Mid-Range Future Scenarios (MRFS) are shown in Figure 3-5.

This mapping was produced using a digital terrain model based on a combination of LiDAR and other ground elevation data. The OSI quote the vertical accuracy of LiDAR data as being +/- 25cm.

Based on the results of the CFRAM study (Figure 3-5), the proposed residential development site is unlikely to be affected by flooding during the 1000-year MRFS.



Figure 3-5 - Western CFRAM Study Coastal MRFS Flood Extents

4 Flood Risk Assessment

In accordance with the Planning System and Flood Risk Management Guidelines (discussed in Section 2.1 of this report), the proposed residential development is classified as “highly vulnerable” in terms of its sensitivity to flooding.

The PSFRM guidance document recommends that such developments are constructed in flood zone C, where there is less than a 0.1% Annual Exceedance Probability (AEP) of flooding. Accordingly, the proposed development has been assessed against a 1000-year flood event (i.e. 0.1% AEP).

4.1 Fluvial Flood Risk

There are no rivers or streams evident in the vicinity of the site.

The Western CFRAM Study indicative flood mapping (Figure 3-4) of the area does not indicate the subject site as being liable to fluvial (river) flooding.

4.2 Groundwater Flood Risk

Based on a review of the PFRA study and Geological Survey Ireland (GSI) subsurface mapping of karst features in the area (Figure 4-1), there is no evidence to suggest groundwater flooding at the proposed development site.

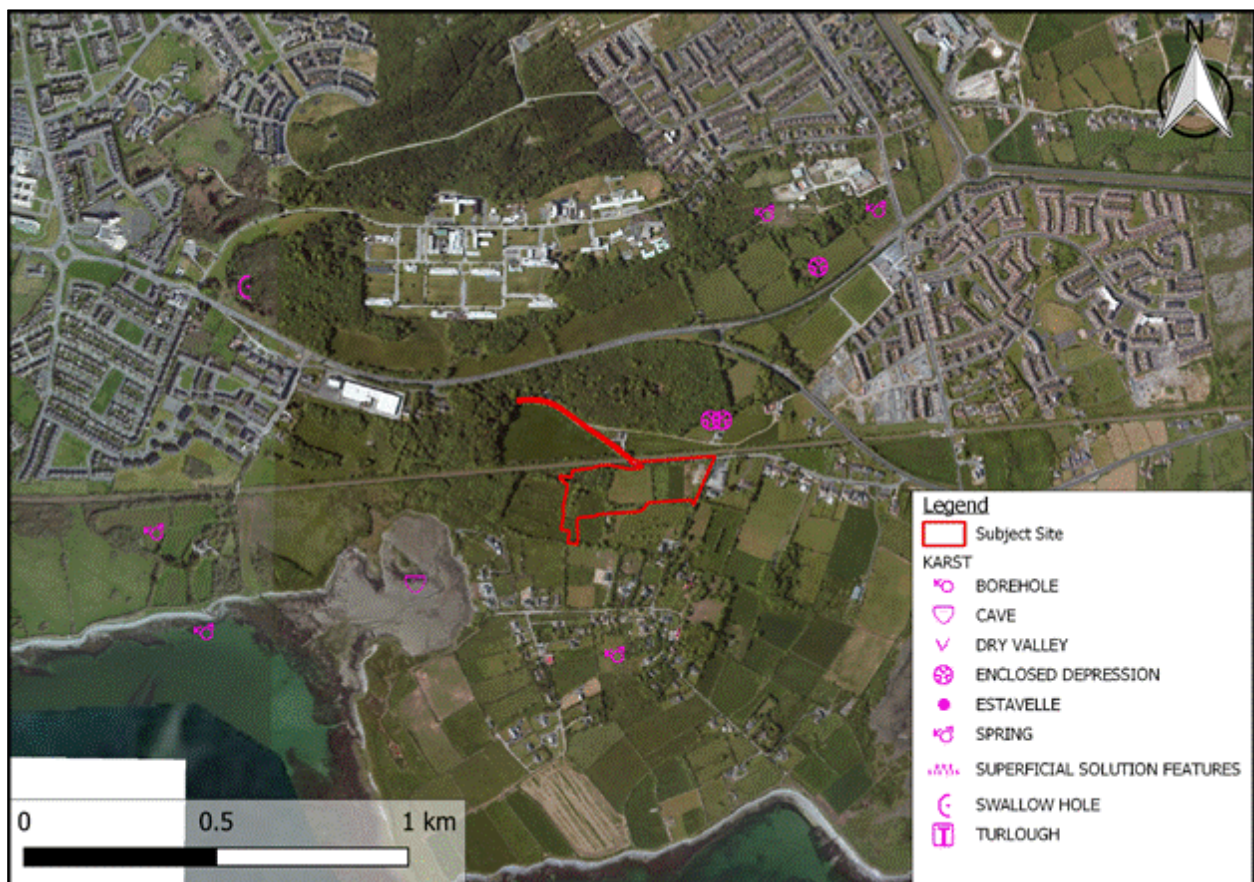


Figure 4-1 - Karst features in vicinity of proposed site [GSI database]

4.3 Pluvial Flood Risk

Pluvial modelling carried out by HR Wallingford as part of the PFRA study indicated that the proposed development is not liable to pluvial flooding, see Figure 3-2.

It was noted that pluvial flooding was predicted immediately to the west of the subject site, within lands owned by the Client. Separate to the current proposal/planning application, any future plans to develop this area will require a separate site-specific FRA.

Mitigation measures proposed by the design team to mitigate future potential pluvial flooding are discussed in Section 4.5.

4.4 Coastal Flood Risk

Due to the proximity of the site to Galway Bay, coastal flooding was considered as a potential source of risk to the proposed development. Modelling of coastal flood risk along the west coast was carried out as part of the Irish Coastal Protection Strategy Study (ICPSS) (see Section 3.3) and the Western CFRAM Study (see Section 3.4).

Based on the coastal flood mapping produced by the Irish Coastal Protection Strategy Study (see Figure 3-3) the subject site is not liable to coastal flooding during a 1-in-1000 year event including allowances for climate change, i.e. the site is located in Coastal Flood Zone C.

Similarly, the Western CFRAM Study (Figure 3-5) also indicates that the subject site is not liable to flooding during a 1000-year event.

A breakdown of the coastal flood level for the 200- and 1000-year events including allowances for climate change, upper 95% confidence interval, and freeboard are summarised in Table 3.

Table 3 Estimated Design Coastal Flood Level

	200-Year Flood 0.5% AEP	1000-Year Flood 0.1% AEP
Flood Level ^{N1}	3.81mOD	4.06mOD
Allowance for 95% Confidence ^{N1}	0.18m	0.18m
Allowance for MRFS Mean Sea Level Rise ^{N2}	0.5m	0.5m
Allowance for MRFS Land Movement ^{N2}	0.03m	0.03m
Design Flood Level	4.49mOD	4.77mOD
Minimum Freeboard ^{N3}	0.30m	0.30m
Design Flood Level + Minimum Freeboard	4.82mOD	5.07mOD

Note 1: Design flood level, and allowance for 95% confidence, is taken from Irish Coastal Protection Strategy Study (ICPSS) (see Section 3.3).

Note 2: Allowance for mean sea level rise and land movement as per the Flood Risk Management Climate Change Sectoral Adaptation Plan (2019) (see Section 2.2). Allowance for land movement was taken as 0.5mm per year for 60 years (Flood Risk Management Climate Change Adaptation Plan, May 2015).

Note 3: Freeboard taken from the Multi-Coloured Manual (2010) produced by the Flood Hazard Research Centre (FHRC), Appendices to Chapter 4: Flood damage to residential properties and related social impacts. The manual indicates damage is incurred for residential properties for flood levels at and above 0.3m below ground floor level.

Existing ground elevations at the site (7.01mOD to 20.50mOD) are 2m or more above the 1000-year design coastal flood level (4.74mOD).

Finished flood levels of the proposed dwellings (15.65mOD or higher) are over 10m above the predicted 1000-year design flood level (4.74mOD).

It is therefore estimated that the risk of coastal flooding to the proposed development are minimal.

4.5 Flood Risk Mitigation Measures

A number of measures were included as part of the proposed development design to mitigate flood risk, and to ensure that the development would not impact the risk of flooding elsewhere.

These measures include:

- Site drainage and storm water storage will be provided to cater for surface water runoff for a design return period 100-year storm event. The storm networks on the western section have been designed to a 1000- year flood event.
- Surface water runoff from the site will be limited to greenfield runoff rates by the proposed surface water management system in accordance with the SUDS design principals.
- The landscaping and topography of the developed site shall provide safe exceedance flow paths in the event of extreme flood events or in the case of a blockage of the drainage system, to minimise risks to people and property.
- In an extreme weather event, overflow from the attenuation tank will exit via a high-level overflow to a detention basin located at the north west corner of the proposed development site. During extreme rainfall events, any surface water runoff which exceeds the underground site drainage capacity shall be permitted to flow through a defined flow path to the detention.

4.6 Impact of the Development Elsewhere

It is predicted that the proposed development will not be at risk from flooding during the 1000-year Mid-Range Future Scenario. Therefore, the development will not affect floodplain storage or obstruct the flow path of any existing watercourses.

As noted in Section 4.5, surface water arising onsite will be managed by a dedicated storm water drainage system designed by TOBIN Consulting Engineers. The site drainage will include measures in accordance with the requirements of SUDS to limit runoff from the development to greenfield runoff rates. On this basis, it is predicted that the proposed development will not contribute towards flood risk elsewhere in the area.

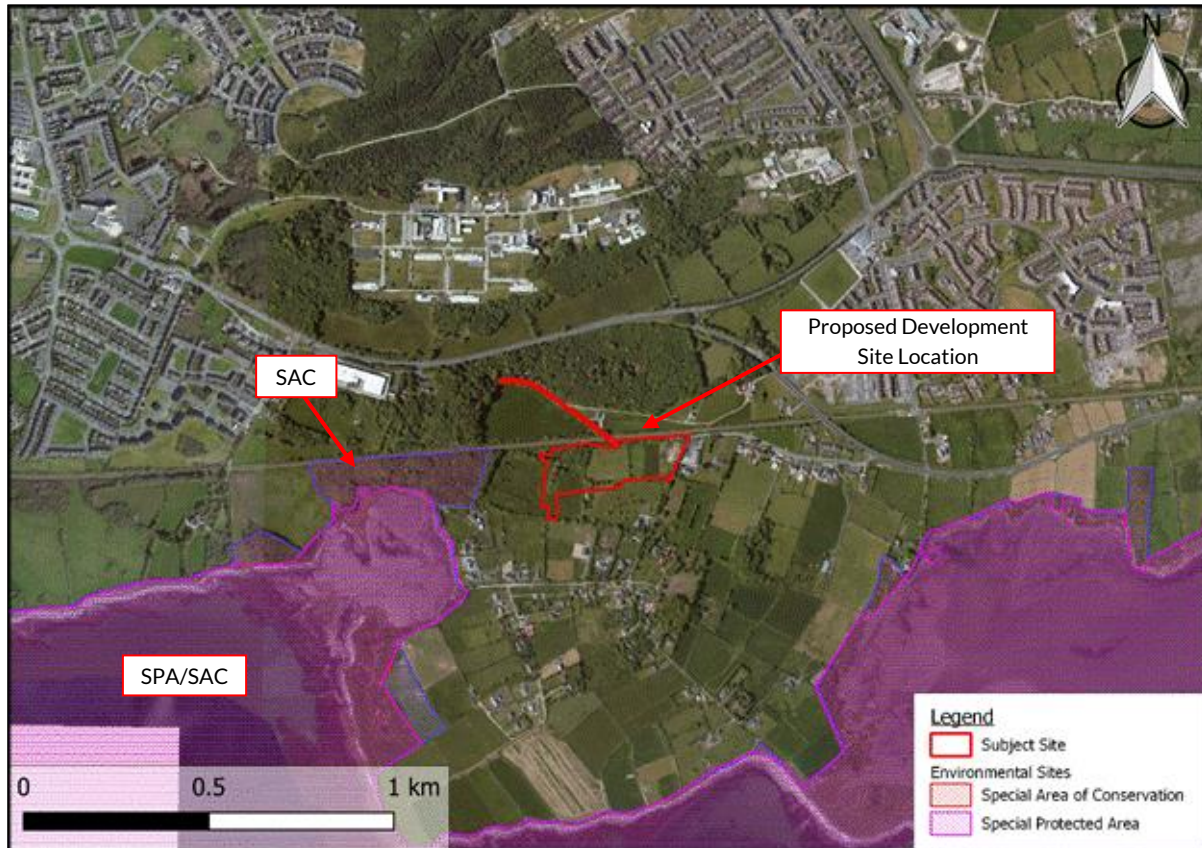


Figure 4-2 – National Parks and Wildlife Services SAC/SPA Mapping

4.7 The Justification Test

With reference to the PSFRM Guidelines, the proposed residential development is classified as “highly vulnerable” in terms of sensitivity to flooding.

Based on the findings of this Flood Risk Assessment, the subject site is located in Flood Zone C, i.e. there is less than a 0.1% Annual Exceedance Probability (AEP) of pluvial/fluvial/groundwater flooding, and less than a 0.5% AEP of coastal flooding.

As the Planning System and Flood Risk Management Guidelines consider residential development appropriate for Flood Zone C, the Justification Test does not need to be applied.

5 Conclusions

TOBIN Consulting Engineers were appointed in May 2019 to provide engineering and environmental consultancy services for the proposed residential development at Rosshill, in Galway City (Figure 1-1 & Figure 1-2).

The Flood Risk Assessment (FRA) undertook a review of:

- OPW Flood Hazard mapping
- OPW Preliminary Flood Risk Assessment (PFRA) Study
- The Planning System & Flood Risk Management (PSFRM) Guidelines
- Flood Risk Management Climate Change Sectoral Adaptation Plan
- Galway County Development Plan (2015-2021);
- Galway City Development Plan (2017-2023);
- Western CFRAM Study;
- Irish Coastal Protection Strategy Study;

With reference to the PSFRM guidelines, the proposed residential development is classified as a “highly vulnerable development” in terms of its sensitivity to flooding. Such developments are considered appropriate within Flood Zone C, i.e. in areas not liable to flooding during a 1000-year (0.1% AEP) Mid-Range Future Scenario (MRFS).

The outcome of the Flood Risk Assessment is summarised as follows:

Fluvial Flooding

Based on the results of the PFRA (Figure 1-1) and Western CFRAM study (Figure 3-4) it is predicted that the subject site is not liable to fluvial (river) flooding during a 1000-year MRFS.

It is therefore estimated that the risk of fluvial flooding to the proposed residential development is minimal.

Groundwater Flooding

Based on a review of the PFRA study relevant groundwater flood mapping and GSI mapping of karst features in the area, there is no evidence to suggest groundwater flooding at the site.

It is therefore estimated that the risk of groundwater flooding to the proposed residential development is minimal.

Pluvial Flooding

Pluvial modelling carried out by HR Wallingford as part of the PFRA study indicated that the proposed site is not liable to pluvial flooding. It was noted that flooding is predicted in the adjacent site to the west (see Figure 3-2); any future plans for this area are outside the scope of this assessment.

A number of mitigation measures have been included as part of the proposed residential development design to minimise associated flood risk, including:

- Site drainage and storm water storage will cater for surface water runoff for a design return period 100-year storm event.

- Surface water runoff from the site will be limited to greenfield runoff rates by the proposed surface water management system in accordance with Sustainable Drainage Systems (SUDS) design principals.
- The landscaping and topography of the developed site shall provide safe exceedance flow paths in the event of extreme flood events or in the case of a blockage of the drainage system, to minimise risks to people and property.
- In an extreme weather event, overflow from the attenuation tank will exit via a high-level overflow to a detention basin located at the north west corner of the proposed development site. During extreme rainfall events, any surface water runoff which exceeds the underground site drainage capacity shall be permitted to flow through a defined flow path to the detention.

It is therefore estimated that the risk of pluvial flooding to the proposed residential development is minimal.

Coastal Flooding

Based on the results of coastal modelling by the ICPSS and Western CFRAM Studies, it is estimated that the subject site is not at risk from coastal flooding during a 1000-year coastal flood event. Existing ground levels at the site (7.01mOD to 20.50mOD) are 2m or more above the estimated 1000-year (0.1% AEP) MRFS coastal flood level of 4.56mOD. Finished flood levels of proposed dwellings (15.65mOD or higher) provide over 11m of freeboard above the extreme coastal flood level.

It is therefore estimated that the risk of coastal flooding to the proposed residential development is minimal.

It is estimated that the overall risk of flooding at the proposed residential development will be minimal, and it is predicted that the development will not increase the risk of flooding elsewhere.

Appendix 1 – Not Used

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