STRATEGIC FLOOD RISK ASSESSMENT

Review of Callan Local Area Plan 2019-2025

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1.0 Introduction

SLR Consulting Limited (SLR) has been appointed by Kilkenny County Council to review and update the existing Strategic Flood Risk Assessment[1] in order to inform the Review of Callan Local Area Plan 2019-2025 (LAP).

This report has been produced in line with *The Planning System and Flood Risk Management Guideline for Planning Authorities*[2] and follows the recommended staged approach to flood risk appraisal and assessment.

Strategic Flood Risk Assessments (SFRA) provide an area-wide assessment of all sources of flood risk for the purpose of informing strategic land-use planning decisions. Local Authorities are able to use SFRAs in order to apply the sequential approach, including the Justification Test, allocating appropriate sites for development, and considering how flood risk might be reduced as part of the development plan process.

Potential changes to the risk of flooding within the Callan study area as a result of climate change have also been assessed in line with national guidance in the Climate Change Sectoral Adaptation Plan[3].

Development is often associated with an increase in impermeable surfaces and surface water runoff from a site. This can increase the risk of flooding in areas where there are multiple developments. Development can also alter the conveyance and storage of flood water, which can cause large scale flooding due to the cumulative impact of multiple developments. Guidance is provided on mitigation measures on how surface water should be managed, and the appropriate criteria for review of site specific flood risk assessments.

1.1 Methodology of Flood Risk Assessment

In line with guidance, a staged approach to flood risk assessment has been used for this SFRA.

- Stage 1 (flood risk identification) – considers whether there may be any flooding or surface water management issues related to the study area. Flood Maps produced by the Office of Public Works (OPW) and the South Eastern CFRAM study are primary sources of information, however not all sources of flooding will be considered within these data sources.
- Stage 2 (initial flood risk assessment) is completed where there a potential for flooding has been identified. Stage 2 is a review of available data to appraise the adequacy of existing information and determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. The anticipated flood extent should be assessed, which may include the preparation of flood zone maps.
- Stage 3 (detailed flood risk assessment) is completed where previous stages indicate a potential risk and a lack of data. Stage 3 provides a quantitative appraisal of potential flood risk to the study area, the potential impact on flood risk elsewhere and the effectiveness of any proposed mitigation.

In this instance Stage 3 assessments have not been undertaken as the outstanding problems identified are considered to be localised and best addressed at a site level.

1 Strategic Flood Risk Assessment: Proposed Amendment No. 2 of Callan Local Area Plan 2009-2020, Planning Department of Kilkenny County Council, January 2016
2 The Planning System and Flood Risk Management Guidelines for Planning Authorities, The Office of Public Works, November 2009
3 Climate Change Adaption Plan, Flood Risk Management (2015-2019), 2538_RP/002/E, FRAM Section, Office of Public Works, November 2015

2.0 Baseline Information

2.1 Study Area

Callan is a district town located 10 miles south-west of Kilkenny City, 15 miles from Carrick on Suir, 17 miles from Clonmel and 35 miles from Waterford City. The main commercial area is centred on the principal street of Bridge Street / Green Street, which runs north to south with West Street / Mill Street as a secondary axis.

The LAP includes the high density area of the town as well as area of open fields and agricultural land in the south east, west and north east quadrants of the study area. A zone map from the LAP is presented in Appendix 01, which also shows the extent of the study area.

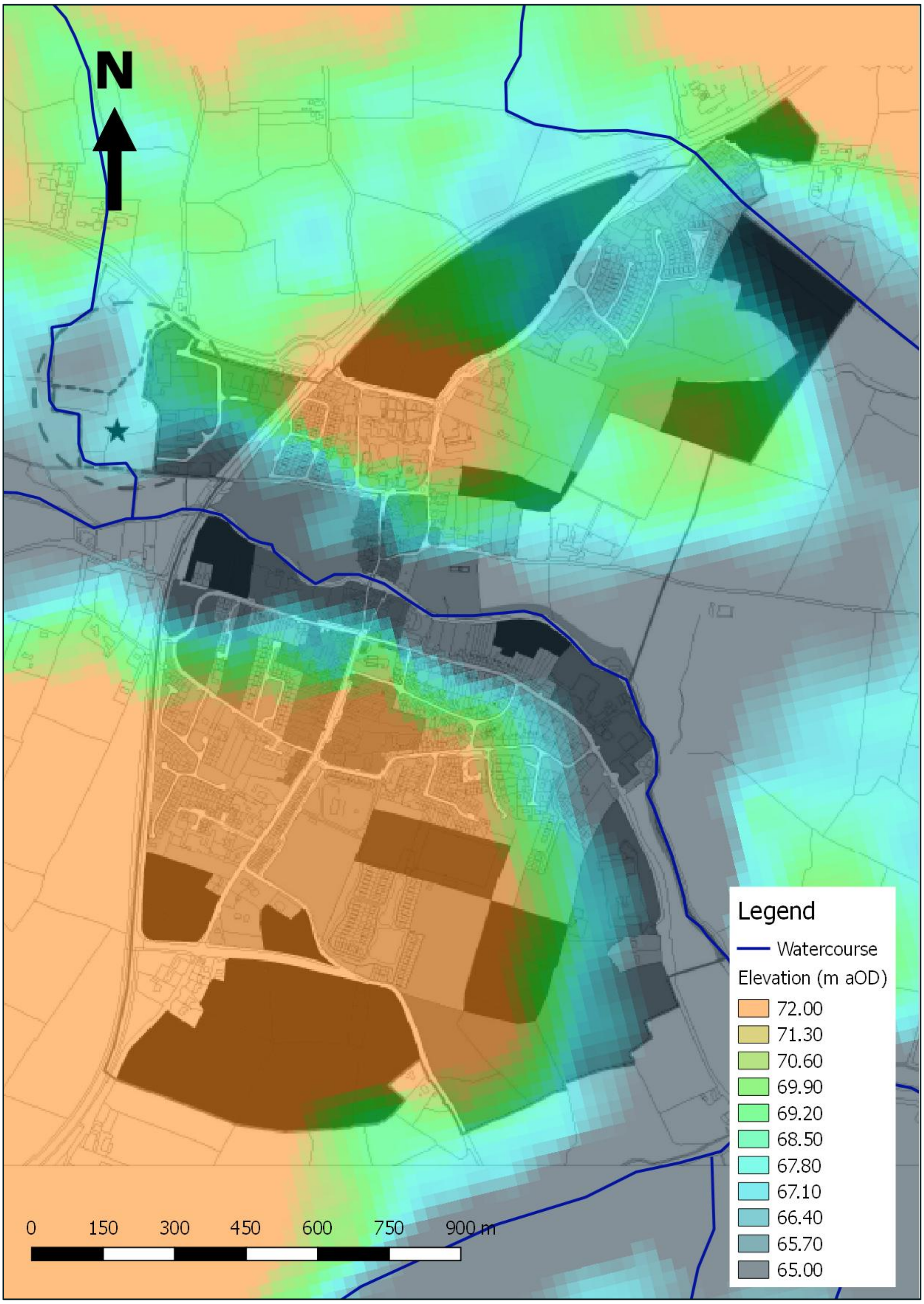
2.2 Topography

Satellite altimetry has been accessed from European Environment Agency[4] for Callan and the surrounding area, and is presented in Figure 2-1 below. This indicates that ground levels in Callan slope towards the course of King's River, which is indicated to be at an elevation of approximately 65maOD.

The northern part of developed Callan is indicated to be in a local topographic high elevated approximately 72maOD. The south of Callan is also indicated to be at a similar elevation. At the southern end of the study area the elevation slopes towards the east and south reflecting the course of the King's River.

4 Copernicus Land Monitoring Service – EU-DEM, European Environment Agency, December 2007

Figure 2-1
Topography of Callan and Surrounding Area

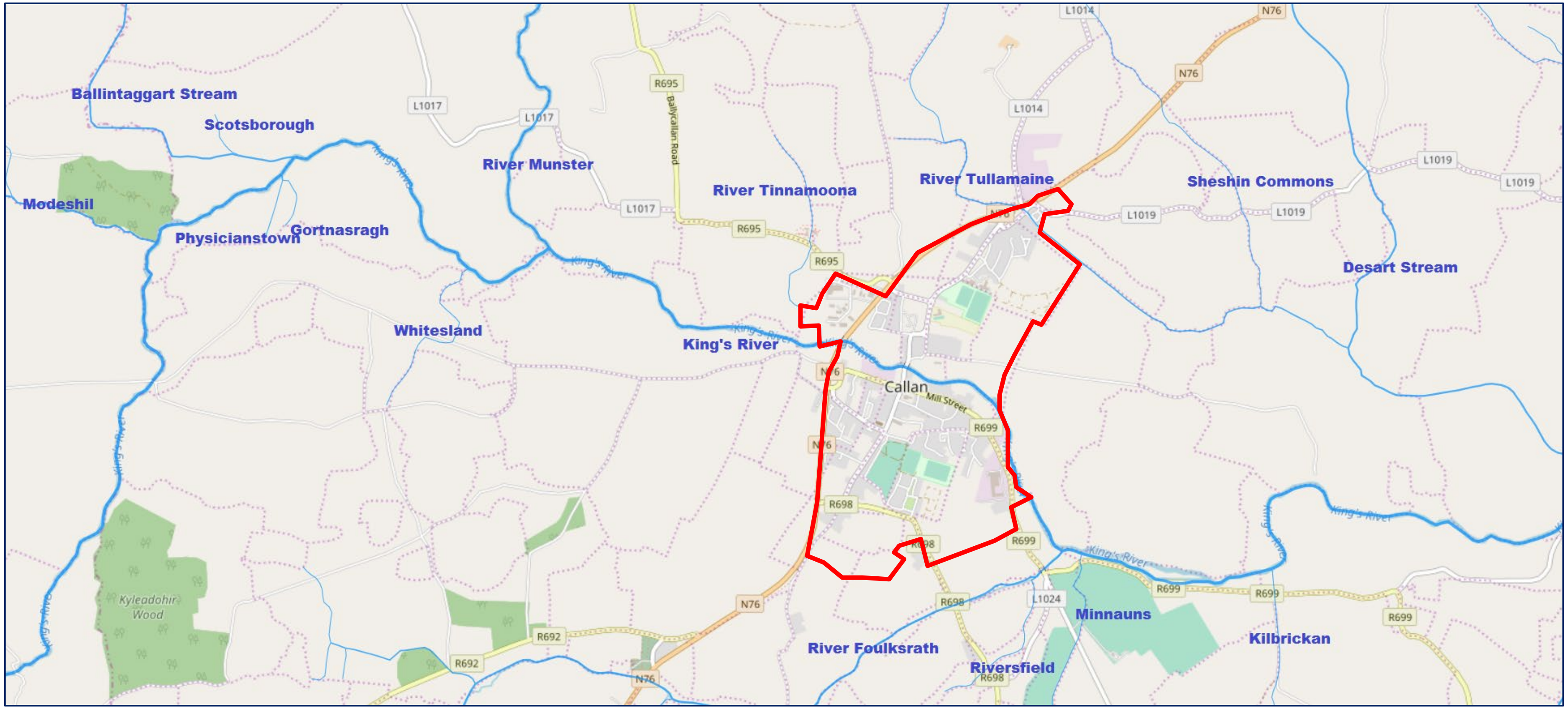


2.3 Hydrological Features

The Environmental Protection Agency (EPA) has published a national rivers dataset, which shows the route of river waterbodies across Ireland5. An extract of Callan and the surrounding area is presented in Figure 2-2.

5 Environmental Protection Agency Maps, GIS Service, Environmental Protection Agency, Accessed July 2018

Figure 2-2
EPA River Water Bodies in Callan and Surrounding Areas



Contains EPA data © EPA (2018)

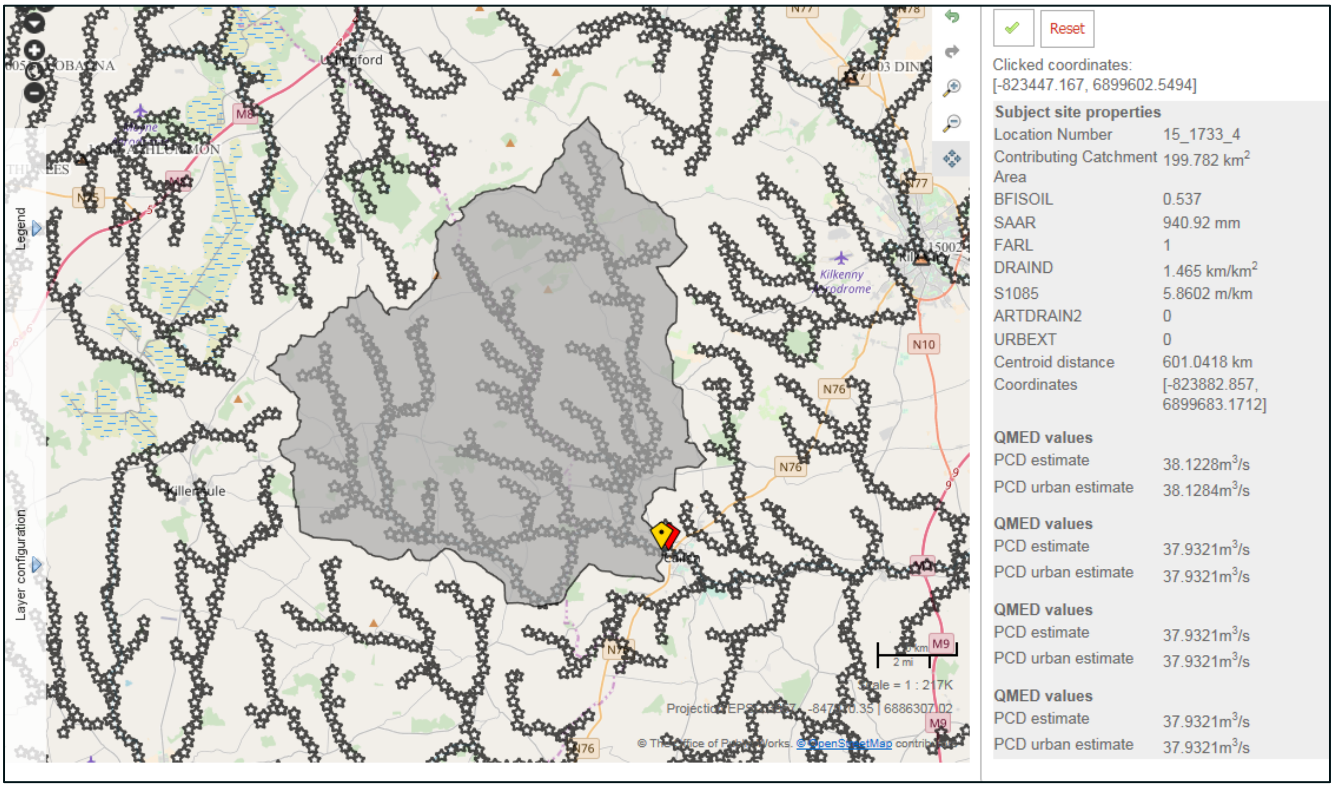
2.3.1 King's River

The King's River Catchment is shown in Figure 2-3 and is approximately 200km^2 as it enters the study area[6]. The King's River has a number of tributaries through a rural area, predominantly consisting of agricultural land use.

The river is underlain by bedrock of limestone and calcareous shale, which is overlain by alluvial deposits. Outside of the main channel, superficial deposits consist of till derived from sandstones and shales. The catchment characteristics indicate a moderate river baseflow suggest some flow from groundwater out of the limestone bedrock.

The King's River enters Callan flowing east through the centre of the study area and passes beneath the N76 and Lower Bridge Street to the North of Mill Street.

Figure 2-3
King's River Catchment



A major tributary of King's River is the River Munster, which flows south to the confluence located approximately 2km west (upstream) of Callan.

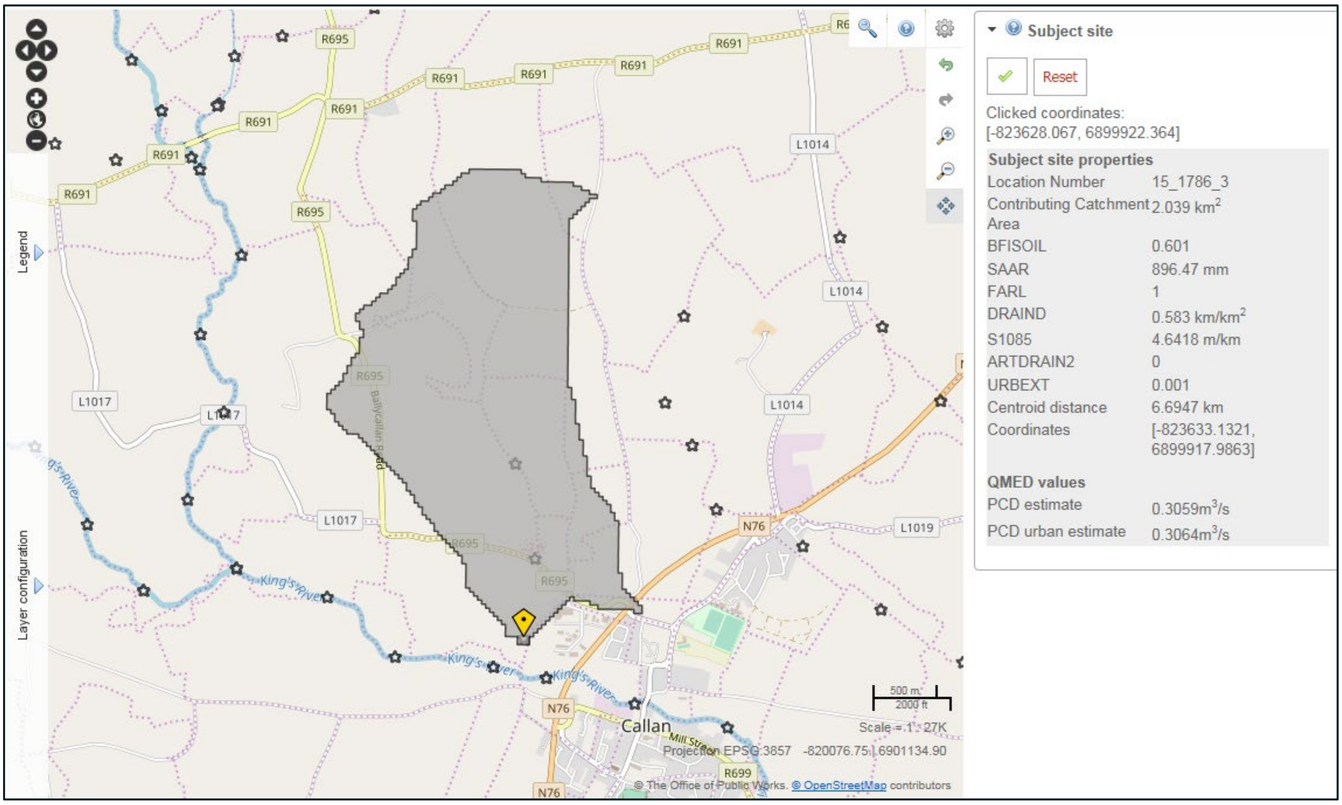
6 FSU Web Portal, Office of Public Works & HydroNET BV, HydroLogic BV, Accessed August 2018

2.3.2 River Tinnamoona

One minor tributary, the River Tinnamoona, enters the King's River adjacent to study area. This is a minor watercourse with a limited upstream catchment that drains an area with agricultural, wood land and natural grassland land uses. The approximate contributing catchment area is $2km^2$.

The river channel is underlain with limestone bedrock, which is overlain by superficial till deposits derived from sandstones and shales.

Figure 2-4
River Tinnamoona Catchment

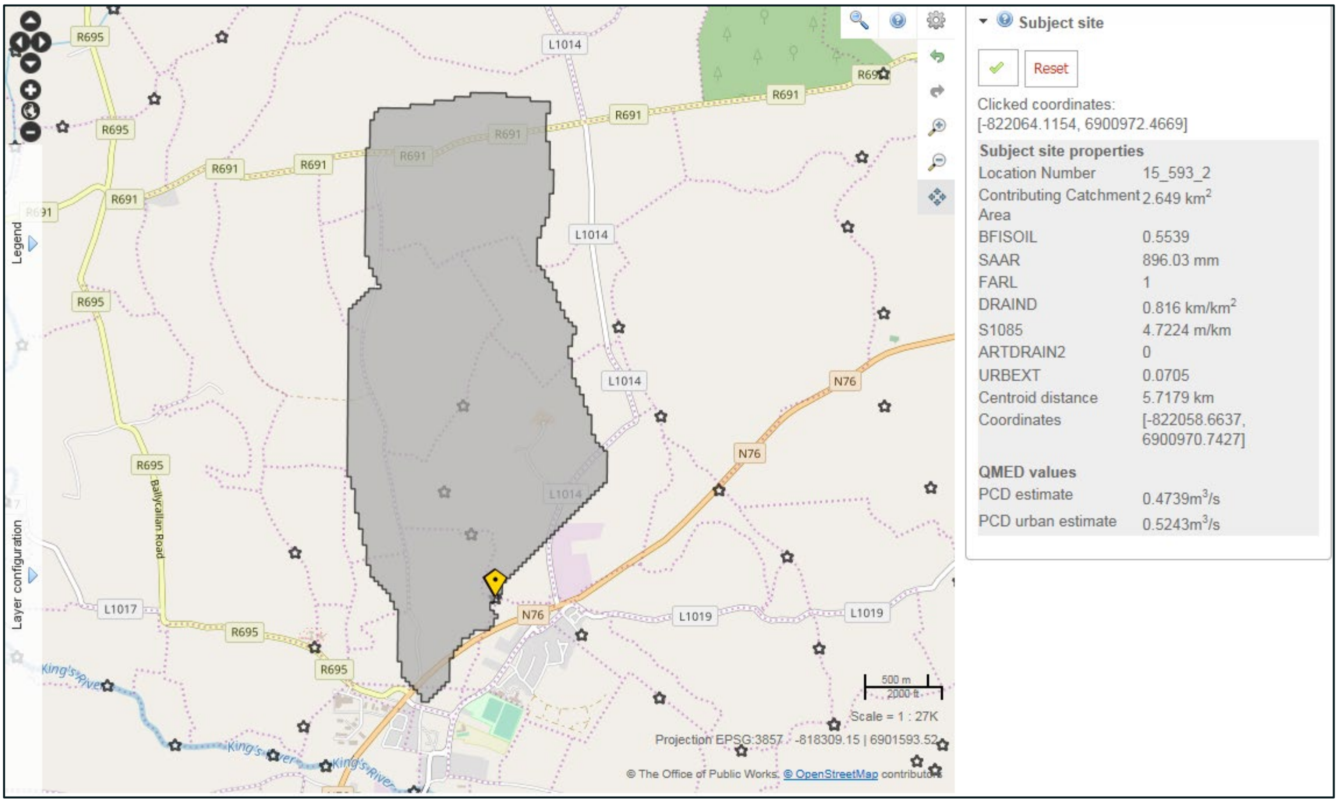


2.3.3 River Tullamaine

The River Tullamaine is indicated to pass through the northern part of the study area. This watercourse is shown on maps to rise around 2km north of the study area and flows east through Callan. The total contributing upstream catchment area is 2.6km^2 from a mainly rural catchment with agricultural, wood land and natural grassland land uses with a few minor roads.

The estimated flow within the River Tullamaine is indicated to be small.

Figure 2-5
River Tullamaine Catchment



2.4 Geological / Hydrogeological Characteristics

The study area is predominantly underlain by the Aghmacart Formation, a dark shaly limestone.[7] The very northern area of the study area is underlain the Crosspatrick Formation another type of limestone. A third type of limestone the Waulsortian Limestones (unbedded lime-mudstone) underlies the southern third of the study area.

This solid geology is overlain by till deposits with alluvium present along the course of the King's River.

Several fault lines dissect the study area: one runs north south through the centre of study area, and two more orientated east west separate the different geological units.

7 Geological Survey Ireland Spatial Resources, Geological Survey Ireland Department of Communications, Climate Action & Environment, Accessed July 2018

The Aghmacart and Crosspatrick Formations are indicated to be *"Locally Important Aquifers"* with the bedrock having moderate productivity (i.e. moderate local permeability). The Waulsortian Limestones are a *"Regionally Important Aquifer*" with productivity due to karstic characteristics.

Groundwater contour mapping[7] indicates that groundwater levels are at approximately 70 to 80m above Ordnance Datum (aOD) beneath the study area. This indicates that groundwater is within less than 10m of the ground surface.

2.5 Flood Defence Infrastructure

OPW mapping, included in Appendix 02, indicate that there are some fluvial defences along King's River in the centre of the developed area of Callan. All defences are indicated to provide a 10 year standard of protection. This means that they should prevent flooding for all events up to and including the 10% (1 in 10) annual exceedance probability (AEP) event.

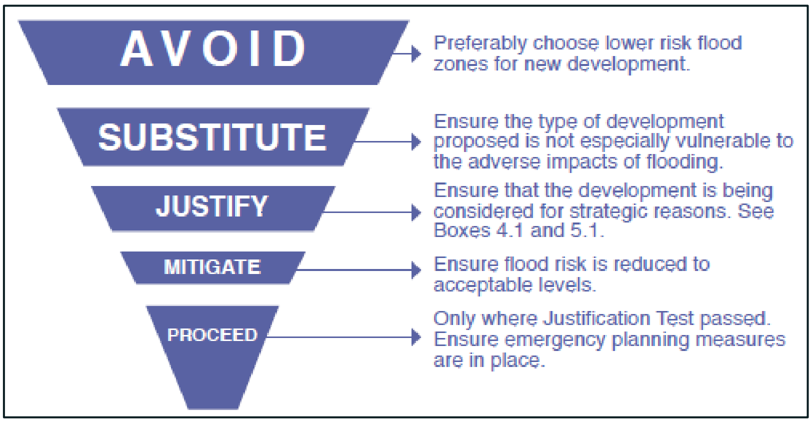
The defences are predominantly located on the north side of the river near Bridge Street and consist of a mixture of flood walls and earth embankments. To the south of the river there is one small embankment to the north of Callan Camphill Community (east of Bridge Street). These were constructed as part of the Callan Flood Alleviation scheme in 2011.

3.0 Outline of the Sequential Approach

3.1.1 Sequential Approach

The sequential approach as outlined in the Planning System and Flood Risk Management is a tool for directing development towards land that is at low risk of flooding. Figure 3-1 sets out the philosophy of the sequential approach and the hierarchy method that should be employed.

Figure 3-1
The Planning System and Flood Risk Management Guidance Figure 3.1: Sequential approach principles in flood risk management



This would involve;

- Avoiding development in higher risk area,
- Substituting vulnerable development types in higher risk area for less vulnerable uses,
- Justifying why development in higher risk area cannot be avoided or substituted,
- Mitigating the flood risk where development of higher risk areas is deemed to be justified, and
- Proceeding with development only once appropriate mitigation is agreed.

In summary, proposed development should ideally not be located in areas of flooding but if the development area is at risk of flooding than it should be of a lower vulnerability to the adverse impacts of flooding. Vulnerability classifications of different types of development are outlined in Table 3.1 of the Planning System and Flood Management Guidance.

The sequential approach should be applied to all stages of the planning and development management process.

3.1.2 Flood Zones

Flood zones are the classification of the areas in relation to the likelihood of flooding from rivers and the sea or coastal flooding. They are defined as:

- *Flood Zone A* ***(high probability)*** - where the probability of flooding from rivers and the sea is highest (annually greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding);
- *Flood Zone B* ***(medium probability)*** – where the probability of flooding from rivers and the sea is moderate (annually between 0.1% or 1 in 1,000 year and 1% or 1 in 100 and between 0.1% or 1 in 1,000 and 0.5% or 1 in 200 for coastal flooding);

- *Flood Zone C **(low probability)*** – where the probability of flooding from rivers and the sea is low (annually less than 0.1% or 1 in 1,000 for both rivers and coastal flooding). Flood Zone C covers all areas of the plan which are not in Zones A or B.

Guidance outlines the importance of natural floodplains for the storage and conveyance of flood water as part of flood risk management. In the recommendations for inclusion in a "city level" SFRA it states that areas of natural floodplain should be identified.

3.1.3 Vulnerability versus Flood Zone

Unless the development is in Flood Zone C, or the development is of a water compatible vulnerability class, the justification test must be applied. Guidance on where the justification test should be applied is indicated in Table 3-1.

Table 3-1
Matrix of Vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test (Table 3.2 of The Planning System and Flood Risk Management Guidance for Planning Authorities)

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

3.2 Justification Test

The justification test has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in moderate or high flood risk areas. There are two processes that make up the test:

- **Plan-making Justification Test***:* which is used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding;
- **Development Management Justification Test**: which is used at the planning application stage where it is intended to develop land at moderate or high risk of flooding.

Development Management Justification Test

The justification test states that the following criteria must be satisfied for development which may be vulnerable to flooding and would not generally be appropriate as set out in Table 3-1:

"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 reasonable possible;

(iii) The development proposed includes measures to ensure that residual risk 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."

4.0 Flood Risk Assessment

This report has been prepared in accordance with the advice and requirements prescribed in current best practice documents relating to management of flood risk in development published by the Construction Industry Research and Information Association (CIRIA)[8].

There are a number of potential sources of flooding and these include:

- Flooding from the sea or tidal flooding;
- Flooding from rivers or fluvial flooding;
- Flooding from sewers, surface water and overland flow;
- Flooding from groundwater;
- Flooding from reservoirs, canals, and other artificial sources; and
- Flood from infrastructure failure.

Flood risk from each of these potential sources is discussed below.

4.1 Flooding from the Sea or Tidal Flooding

Callan is located circa 45km away from the coast and King's River does not have any tidal influences. As such flooding from this source is not considered a risk to Callan and therefore is not discussed further within this SFRA.

Conclusion of Stage 1

Due to there being no tidal influence estuarial flooding (an interaction of tidal and fluvial flooding) is also not of concern to the development of Callan.

4.2 Flooding from Rivers or Fluvial Flooding

4.2.1 Data Sources

CFRAM Mapping

In 2011 the national CFRAM (Catchment Flood Risk Assessment and Management) programme began with the OPW as the lead agency for flood risk management in Ireland. The OPW are also the national competent authority for the EU Floods Directive.

The CFRAM programme consists of three parts:

- Preliminary Flood Risk Assessment (PFRA): 2011
- The CFRAM Studies and parallel activities: 2011- 2015
- Implementation and Review: 2016 onwards

EU member states were required under the Flood Directive[9] to undertake a national PFRA by 2011 which identifies areas where significant risk exists or might be considered likely to occur. The OPW published the

8 CIRIA Report C624, Development and flood risk: guidance for the construction industry

9 Directive 2007/60/EC of the European Parliament and of the Council of 23rd October 2007 on the assessment and management of flood risk: Official Journal L288/ 27-34

National Preliminary Flood Risk Assessment, Overview Report[10] which identified areas for further assessment (AFA's) to take place through the CFRAMs. Callan was identified as a "Possible Area for Further Assessment" with final CFRAM flood mapping published by the OPW in December 2016.

Flood Maps produced by the OPW as part of the South Eastern CFRAM for the study area are presented in Appendix 01. The mapping includes three fluvial flood events, and the mapped zones are defined as:

- **Low Probability** – land where the probability of flooding from rivers has between an indicative 1 in a 1000 and 1 in 100 change of being exceeded in any given year. This is also referred to as an Annual Exceedance Probability (AEP) of between 0.1% and 1% and therefore has the same definition as Flood Zone B;
- **Medium probability** – land where the probability of flooding from rivers has between a 1 in 100 (1%AEP) chance of occurring or being exceeded in any given year and 1 in 10 chance (10% AEP). This therefore has the same definition as Flood Zone A;
- **High Probability** – land where the probability of flooding from rivers exceeds a 1 in 10 chance of occurring or being exceeded in any given year. This is the 10% AEP and is used to identify areas of natural floodplain.

Areas of the map outside of the coloured flood extents have a less than 1 in 1,000 (0.1%AEP) chance of flooding from rivers in any given year and therefore indicate Flood Zone C.

Flood Maps Webservice

The OPW have published a Flood Maps Webservice[11] which includes historical flood data, present day anticipated flood extents, and two (mid and high end) future scenarios, which although not specifically time-bound could be taken to represent possible futures for 2100. The flood zones present areas where the annual probability of flooding exceeds 10%, 1% and 0.1% AEP.

Mineral Alluvium Soil Mapping

Mineral Alluvium Soil Mapping completed in May 2006 by Teagasc, Geological Survey of Ireland, Forest Service and the EPA, indicates where alluvial soils are located. This can provide an indication of historical flooding as alluvium is predominantly deposited by fluvial flood events.

4.2.2 Stage 1: Flood Risk Identification

The sources all indicate that there is a risk of fluvial flooding within the study area and therefore Stage 2 is required.

4.2.3 Stage 2: Initial Flood Risk Assessment

King's River

Primary Sources of Data

As outlined in Section 2.3.1, King's River passes through the centre of the study area. Fluvial flooding along the river is a primary source of flooding in Callan and there are multiple records of past flood events along the river[10].

The CFRAM mapping, included in Appendix 02, indicates that land up to approximately 150m north and 50m south of King's River are at risk of fluvial flooding. There are two areas which are outside of the projected flood

10 The National Preliminary Flood Risk Assessment (PFRA) Overview Report, 2019/RP/001/D, Flood Relief & Risk Management Division Engineering Services Office of Public Works, March 2012

11 Office of Public Works Flood Maps Webservice, www.floodmaps.ie, accessed July 2018

extent but which could become islands (i.e. surrounded by flood water) during extreme (0.1% AEP) flood events. One area is located to the north of the river and east of the N76 where there is a grass field that contains a local high point. The second is a band of woodland along the western boundary of the West Coast Business Park.

CFRAM mapping indicates that the flood envelope does not significantly increase in extent for more extreme (lower probability) events. This is due to the course of the river being sunken relative to the surrounding areas. For example Mill Street is elevated circa 20m above the centreline of the King's River.

Secondary Sources of Data

The OPW Flood Maps Webservice indicates a similar area of land that is at risk of flooding from the King's River through the centre of Callan.

The historical flood data indicates recurring flooding along the King's River. All events recorded do however predate the installation of the flood alleviation scheme, which was constructed in 2011.

The Teagasc soils and subsoils maps were created in May 2006 and classify the subsoils of Ireland into 16 themes. Alluvium is deposited during flood events and can therefore indicate areas that have flooded in the past. An extract of the subsoils mapping is presented in Figure 4-1 and shows alluvial deposits either side of the King's River through Callan.

Figure 4-1
Extract of Subsoils Map

The mapping indicates that the areas of made ground (the developed areas of Callan) encroach into the area of alluvium along King's River. This suggests that some of the developed area of Callan is on land at risk of fluvial flooding.

Flood Zone Mapping

Flood Zones are defined in Section 3.1.2 and can be used as tool for flood risk management within the planning process as well as emergency planning.

The CFRAM mapping is the most recent and reliable data of flooding for the study area and is therefore used to determine flood zones in deference to other sources. The CFRAM Mapping can be seen in Appendix 02.

The 10% AEP modelling identifies land that is at a very high risk of flooding and should be considered as natural floodplain. Flood defences within the developed area ensure that the 10% flooding does not extend outside of the channel area. However, in the west (including the south section of the 2014 amendment to the plan boundary), and east there are no flood defences and the floodplains cover a larger area.

The sequential approach identifies that only water-compatible development is appropriate within this area. However, even if development is water compatible particular consideration should be given to the impact on flood storage and conveyance. Development in these areas should be limited in order to follow the philosophy of "leaving space for water".

Flood Defences

CFRAM mapping indicates that there are flood defences present in Callan near Lower Bridge Street where is crosses King's River. These are predominantly a series of embankments and walls located on the northern bank. There is one limited flood defence wall located on the south side of the river.

All the flood defences are indicated to provide a standard of protection for the 10% AEP; this provides a marginal amount of protection to Lower Bridge Street and Mill Street.

River Tinnamoona

River Tinnamoona is a tributary of the King's River and flows along the western boundary of the area added to the plan boundary in 2014.

For all events modelled as part of CFRAM the River Tinnamoona is anticipated to remain within channel for much of its length and does not represent a significant risk of flooding to the study area. However, backwater effects from the confluence with the King's River result in the extent of flooding from the King's River to increase further north around the River Tinnamoona. This should be considered in conjunction with flooding from the King's River for any development in the western extension zone of the LAP.

River Tullamaine

The River Tullamaine passes through the northern area of the study area. At this point the Tullamaine has a limited catchment and flows passing through the study area are typically modest.

Primary Sources of Data

The section of the River Tullamaine that passes through Callan is included in CFRAM mapping. The area indicated to be at risk of fluvial flooding from the River Tullamaine in Callan is extremely small. All modelled flood events are indicated to remain within channel through much of the town. There is an area indicated to be a risk of flooding immediately to the north west of the study area. This is located to the west of N76 and is likely due to a restriction to flows through a culvert under the road. This throttles fluvial flows and effectively provides some flood protection to the existing development and the proposed areas of development that are downstream, immediately to the east. In the event that the culvert beneath the N76 were to become blocked levels in the River Tullamaine would likely rise to the elevation of the N76 and inundate the road. The water would pool in a small topographic low at the junction with Kilkenny Road. If water levels continue to rise, the most likely flow pathway would be along Kilkenny Road and on to Castletobin where some houses could be at risk of external flooding. However, anticipated depths of flooding would be very shallow and therefore unlikely to exceed the freeboard between finished floor levels and the external areas. Due to the limited upstream catchment the extent of flooding is likely to be limited.

Secondary Sources of Data

Records of past flood events are presented on mapping on the OPW flood maps webservice[11]. The past floods layer does not include any record of flooding in Callan from the River Tullamaine. It is also noted that the base mapping does not include the course of the Tullamaine extending as far north west as indicated by the EPA river network mapping discussed in Section 2.2.

The Teagasc soils and subsoils show that there are some deposits of alluvium in the northeast of the study area along the indicated course of the River Tullamaine. This does not extend further upstream or into the already developed area of Callan.

Conclusion of Stage 2

Flooding from the River Tullamaine is possible in the north of the study area. The maximum extent of flooding is however limited and does not extend into areas of current or proposed development. Therefore no further stages of flood risk assessment are considered necessary as part of this SFRA.

Development in the vicinity of the River Tullamaine and to the east of the already developed area should have a site specific flood risk assessment and make reference to the CFRAM mapping. An easement of 8m should be left along the channel of the River Tullamaine to provide access for channel maintenance.

Blockage of the culvert that allows the River Tullamaine to pass beneath the N76 should be regularly maintained and debris removed in order to reduce the chance of the culvert becoming blocked.

4.3 Flooding from Sewers, Surface Water and Overland Flow

Overland flow is generated when rainfall exceeds the infiltration capacity of the ground. Where there is high intensity rainfall large amounts of overland flow can be created, which follow topographic gradients. The water pools in natural hollows and low-lying areas or behind buildings, creating areas of flooding. Surface water flooding is managed within urban areas through the use of drainage systems. When these systems exceed the drainage capacity or become blocked it can result in surcharging and significant flooding.

There is little to no data indicating issues of surface water flooding or drainage capacity exceedance within the study area.

A review of topographical data for the area[4], which is presented in Figure 4-2(north) and Figure 4-3 (south) indicates there are three areas which are potentially vulnerable surface water flooding due to the presence of local topographic lows.

Where development replaces permeable ground, there can be an increase in overland flow from the site resulting in an increase in flood risk down-gradient. Sustainable urban drainage systems (SuDS) should be included in all new development in order to provide attenuation and mitigate the changes as a result of the development.

Conclusion of Stage 1

The topography around Callan indicates that there is potential for surface water flooding in several areas of Callan. There is no data available on the capacity and condition of the drainage infrastructure through Callan and this should be considered in any site specific flood risk assessment. A site specific flood risk assessment is required for all sites located within the areas identified as being vulnerable to surface water flooding.

Figure 4-2
Indicative surface water pathways and areas vulnerable to surface water flooding (north of study area)

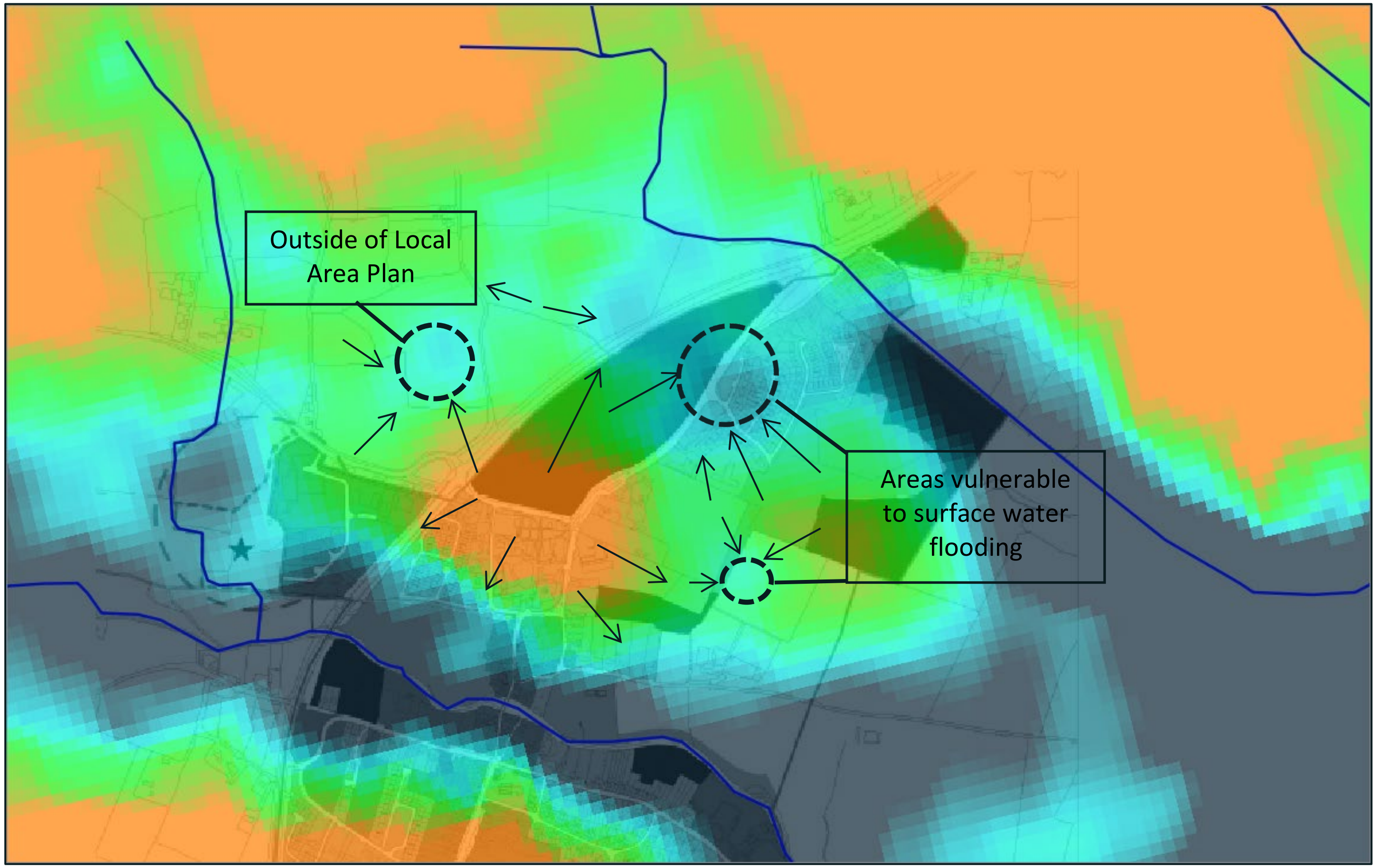
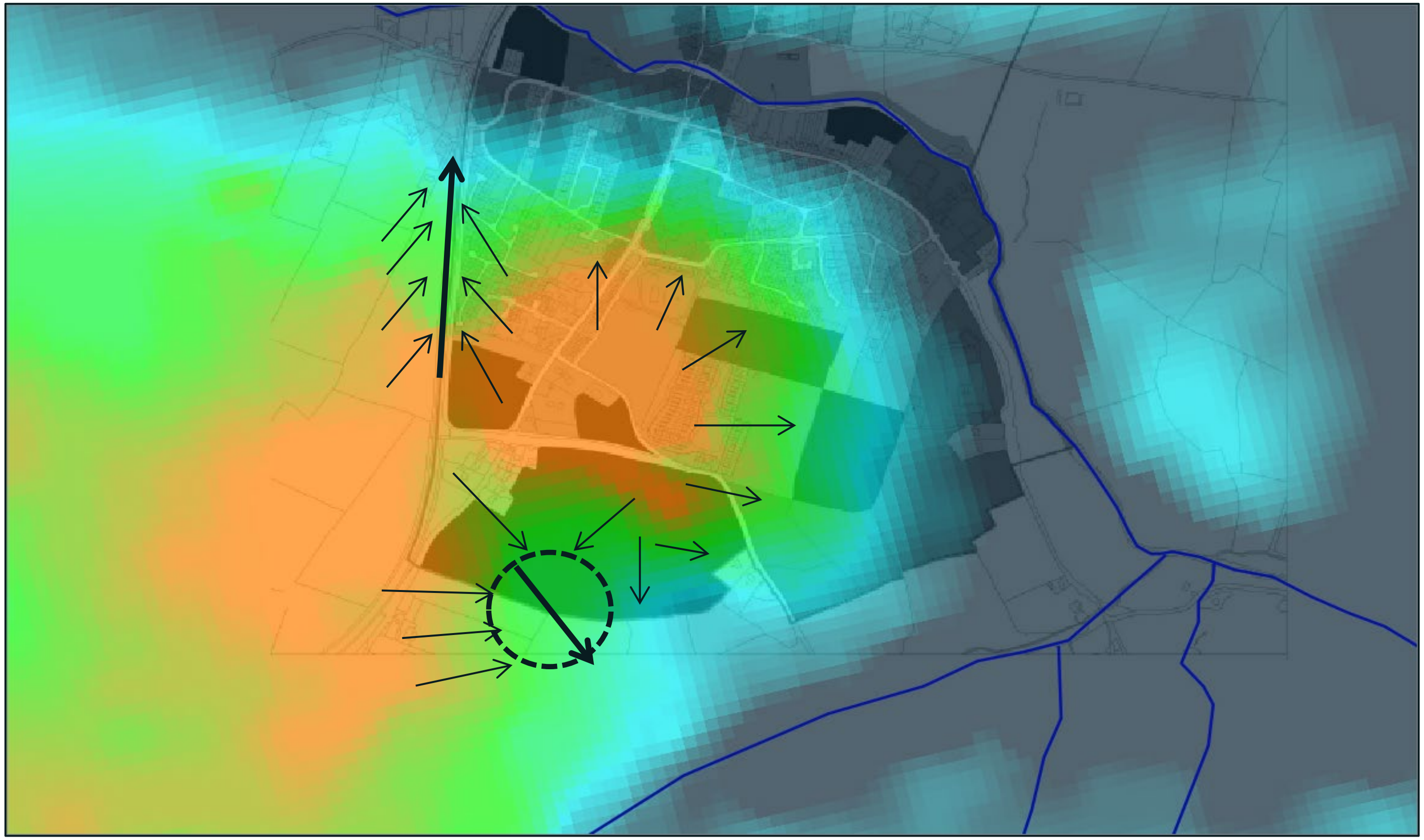


Figure 4-3
Indicative surface water pathways and areas vulnerable to surface water flooding (south of study area)



4.4 Groundwater Flooding

Groundwater flooding occurs when water naturally stored below ground meets the ground surface. Groundwater flooding is often a local phenomenon as a result of local geological features such as karst features, rapid changes in topography and dry valley systems. Water levels typically rise slowly but flooding can remains for an extended period of time. The risk of groundwater flooding is therefore predominantly associated with damage to property rather than a risk to life.

Groundwater flood risk, and in particularly groundwater flooding from karstic aquifers, is a poorly understood form of flooding and historical records, flood risk studies and reports are often lacking.

Stage 1 Flood Risk Identification

As discussed in Section 2.4, the bedrock was identified to consist of limestone which has a very low primary permeability (i.e. through pore spaces) albeit with very high secondary permeability in certain directions via karst systems. There are only a few karst features identified in geological mapping within the vicinity of Callan. Overall the limestones are identified as having moderate permeability indicated by its local importance as an aquifer.

Groundwater contours[7] indicate that groundwater extends to within 10m of the ground surface and therefore has the potential to interact with development.

There are no reports relating to assessment of groundwater flooding either for Callan or Kilkenny County. There are also no indications on historic issues of groundwater flooding in Callan.

The Preliminary Flood Risk Assessment (PFRA)[12] for groundwater flooding in Ireland states that the primary mechanism for groundwater flooding in Ireland is where the bedrock aquifer consists of low or very low aquifer storage with high transmissivity. This can result in a rapid rise in groundwater levels as there is insufficient void space available to accept recharge along with an inability for groundwater to flow away sufficiently quickly.

Subsoil groundwater flooding typically occurs in floodplains consisting of permeable deposits are in hydraulic continuity with rivers and rising levels in the push into the aquifer causing groundwater emergence. This is linked to fluvial flooding.

Only one karst feature is indicated on mapping alongside King's River. However, this below the identified level of development

Furthermore, the PFRA does not identify as Kilkenny County as having any record of groundwater flooding or turlough (karst generated lakes) in the vicinity of Callan.

Conclusion of Stage 1

The risk of groundwater flooding in Callan is not considered significant, although for sites within the Local Plan Area with subterraneous structures and adjacent to King's River where observed karstic spring features have been recorded it should be considered as part of site specific FRA. Fluvial flooding is likely to be of greater concern in these areas; however, groundwater flooding could pose a significant secondary source of flooding low lying areas including those that are defended.

4.5 Flooding from reservoirs, canals, and other artificial sources

There are no reservoirs, canals or other significant artificial sources in the vicinity of Callan and therefore the flooding from these sources is not considered further in this SFRA.

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12 Preliminary Flood Risk Assessments Groundwater Flooding, Office of Public Works, Mott MacDonald, June 2010

Conclusion of Stage 1

Flooding from this source is considered negligible no further stages of flood risk assessment are required.

4.6 Flood from infrastructure failure

Zones of proposed new development are not afforded protection from the flood defences along the King's River and no other infrastructure has been identified, which the failure of would result in flooding in Callan.

Conclusion of Stage 1

Flooding from this source is considered negligible no further stages of flood risk assessment are required.

4.7 Overview of Potential Sources of Flooding

Fluvial flooding from King's River is the largest source of flooding within Callan. CFRAM mapping included in Appendix 02 indicates the areas of the town which are at risk of flooding from this source. The risk from all potential sources of flooding within Callan are summarised in Table 4-1.

Table 4-1
Summary of Potential Sources of Flooding in Callan

Source of Flooding		Risk of Flooding in Callan
Flooding from the sea or tidal flooding		Negligible
Flooding from rivers or fluvial flooding	King's River	Yes – High risk along river bank
	River Tinnamoona	Very Low
	River Tullamaine	Yes – Very Low in Study Area
Flooding from sewers, surface water and overland flow		Yes –Insufficient data to scope out
Flooding from groundwater		Low
Flooding from reservoirs, canals, and artificial sources		Negligible
Flooding from Infrastructure		Negligible

5.0 Impacts of Climate Change

Flood risk is anticipated to increase as a result of climate change. Projected[13] impacts for Ireland include;

- Seal level rise of between 18cm and 59cm this century;
- More intense storms and rainfall events;
- Increased likelihood and magnitude of river and coastal flooding; and
- Increased storm surges.

With respect to this assessment and the Callan study area only changes in the intensity of rainfall events and the magnitude of river flooding are of direct relevance.

Different global emission scenarios show variation in the positions of climate change by the end of the century; however predictions of likely change in the near future (next 20-30 years) are more consistent.

The precautionary approach should be adopted when considering the potential effects of climate change due to the high level of uncertainty.

Guidance on climate change is provided by OPW in the Climate Change Sectoral Adaptation Plan[14]. Allowances for climate change were determined in 2007 at the beginning of the implementation of the CFRAM programme and include a mid-range future scenario (MRFS) and high-end future scenario (HEFS). The MRFS represents a general average of the future climate and the HEFS a more extreme future based on the upper end of the range of projections of future climatic conditions and the impact on drivers to flood risk. The allowances are set out in Table 5-1.

Table 5-1
Climate Change Adaption Plan Table 3:1 Allowances in Flood Parameters for the Mid-Range and High-End Future Scenarios

Parameter	MRFS	HEFS
Extreme Rainfall Depths	+20%	+30%
Peak Flood Flows	+20%	+30%
Mean Sea Level Rise	+500mm	+1000mm
Land Movement	-0.5mm/year[1]	-0.5mm/year[1]
Urbanisation	*No General Allowance – Review on a Case by Case Basis*	*No General Allowance – Review on a Case by Case Basis*
Forestation	*-1/6 Tp*[2]	*-1/3 Tp*[2] *+10% SPR*[3]

Note 1: Applicable to the southern part of the country only (Dublin – Galway and south of this)
Note 2: Reduction in the time to peak (Tp) to allow for potential accelerated runoff that may arise as a result of drainage of afforested land
Note 3: Add 10% to the Standard Percentage Runoff (SPR) rate: This allows for temporary increased runoff rates that may arise following felling of forestry.

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13 The EPA & Climate Change, Responsibilities, challenges and opportunities, 2011 Update, http://www.epa.ie/pubs/reports/climatechange/The%20EPA%20and%20Climate%20Change%20-%202011%20Update.pdf
14 Climate Change Adaption Plan, Flood Risk Management (2015-2019), 2538_RP/002/E, FRAM Section, Office of Public Works

These allowances do not represent a specific projection and model outcomes but are potential 'representative' futures. They are not specifically time-bound and are considered in guidance to present possible futures through to around 2100.

5.1 Flooding from Rivers or Fluvial Flooding

Modelling of the MRFS and HEFS are provided by the OPW and are created using rainfall parameters outlined above. Extracts of the results are presented for Callan in Figure 5-1 and Figure 5-2 below. Climate change is not indicated to significantly the extent of fluvial flooding in Callan. However, there is a higher probability of flooding for areas that are in the 'present day' flood zones.

Figure 5-1
Extract Flood Mapping for the Mid-Range Future Scenario

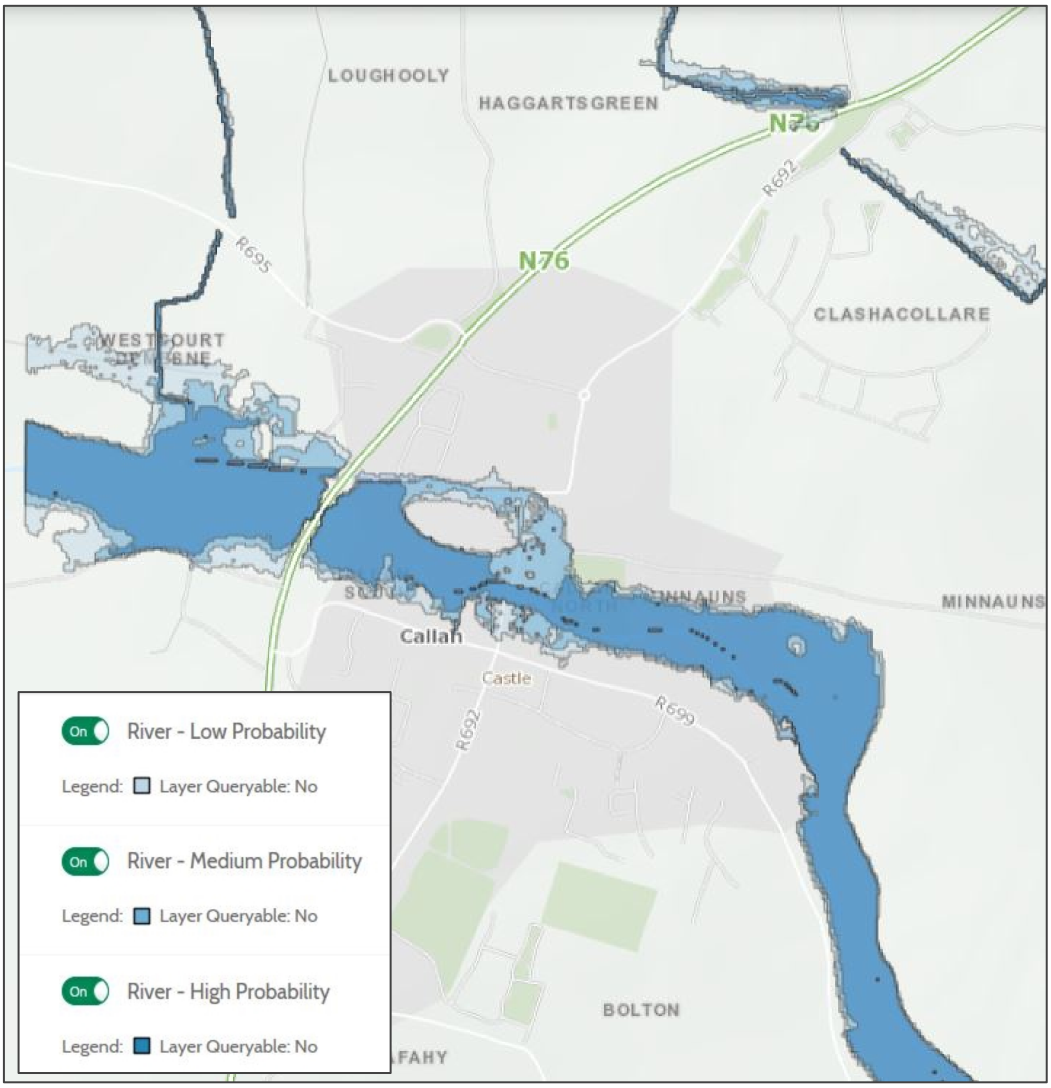
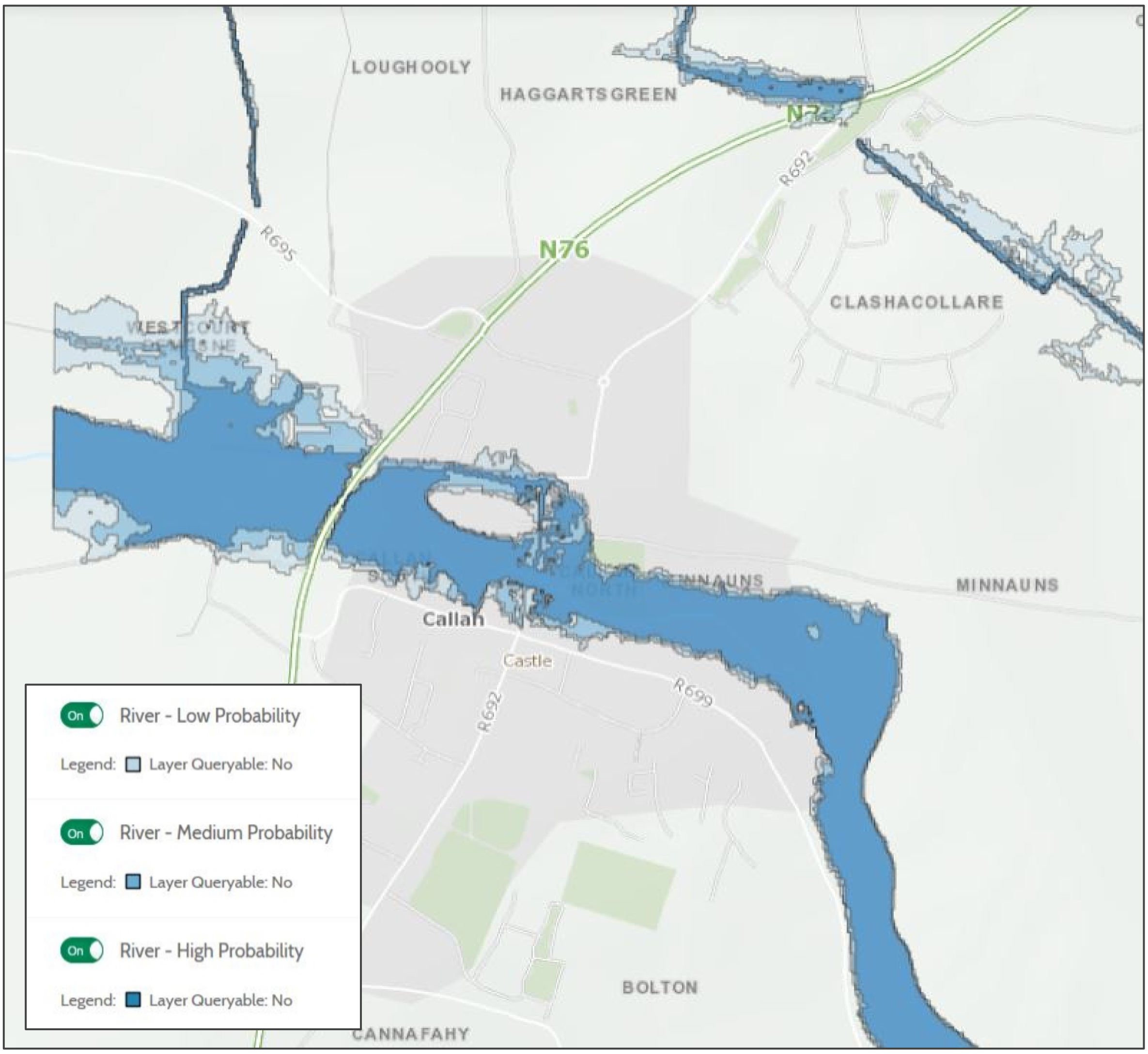


Figure 5-2
Extract Flood Mapping for the High-End Future Scenario



5.2 Flooding from Sewers, Surface Water and Overland Flow

As outlined above climate change is anticipated to cause more intense rainfall events. High intensity storms result in increased surface water runoff rates due to rainfall intensity exceeding the infiltration capacity of the ground. As a result, there will be an increase in overland flow and surface water entering the sewer system.

As discussed in Section 4.3, there is no data on the capacity or condition of Callan drainage infrastructure. However, upgrades to the drainage infrastructure, which will inevitably be needed to accommodate the growth of the town will also have to include extra capacity to manage the increase in surface water flows.

Site specific drainage design should incorporate SuDS to minimise the impact of development on the drainage network and should include a 20% uplift in rainfall depth. The route of floodwater due to exceedance should be assessed for a 30% uplift in rainfall depth to ensure that neither the proposed development nor off-site areas are at risk of flooding from this scenario.

5.3 Groundwater Flooding

Overall the impact on groundwater including fractured aquifers as a result of climate change is thought to be less significant than for surface water features. Climate change predictions indicate that winter rainfall in Ireland is likely to increase and winter recharge will therefore be higher. However, the trend of shorter more intense rainfall will offset some of the change.

The risk of present day groundwater flooding was assessed to be low in the Callan area. Climate change is not anticipated to significantly alter the flood risk from groundwater sources.

6.0 Surface Water Management

As discussed above, development can result in an increase in impermeable coverage causing increased surface water runoff from a site. This can increase the risk of off-site flooding. Climate change is also anticipated to result in more frequent high intensity storms, which will also increases the risk of surface water flooding.

Incorporation of Sustainable Urban Drainage Systems (SuDS) into the design of a new development can help mitigate the impact of the development on surface water flooding and will reduce the capacity of required public drainage infrastructure. SuDS can also provide benefits in water quality, ecology, and amenity. As such national guidelines encourage the use of SuDS over traditional drainage systems.

The SuDS Manual[15] provides a strong reference for the application of SuDS into development and gives greater detail on the concepts presented in Appendix B of The Planning System and Flood Risk Management Guidelines for Planning Authorities[2].

The drainage hierarchy should be applied to the selection of a suitable drainage discharge:

1. **Infiltration:** surface water runoff from a development should be infiltrated to ground if possible. Due to the underlying limestone geology opportunities for infiltration may be limited in the Callan area;
2. **Discharge to a Watercourse:** if infiltration is not feasible developers should aim to discharge to any local watercourse at a controlled rate;
3. **Discharge to a Surface Water Sewer**: where infiltration is not feasible and there is no watercourse on or adjacent to the site but there are public surface water sewers available, surface water should be gradually released from the site to those; and
4. **Discharge to Combined Sewer**: the final option is for gradual release to the combined public sewer. This should only be allowed where all other options are not practicable.

Whatever the receptor for discharge is, on-site attenuation should be provided to control and store excess flows and allows the gradual release of surface water at an acceptable rate. Developments should aim towards achieving greenfield runoff rates however this may not be practicable. An allowable discharge rate of 5l/s is considered to be the minimum feasible discharge rate for small sites without incurring significant maintenance issues.

15 Report C753, The SUDS Manual, CIRIA, November 2015

7.0 Application of the Sequential Approach for Local Action Plan

7.1 Review of Development Areas

A zoning map of development areas outlined within the LAP is included in Appendix 01. The SFRA has identified potential fluvial risk along the King's River and to a lesser extent the River Tullamaine. This potential risk of flooding from these sources is indicated to increase in the future as a result of climate change. The full sequential approach as outlined in Section 3.0 above must be applied to development alongside these watercourses.

The zones of development at risk of flooding have been numbered on the zoning map in Appendix 01 and their vulnerability classification and the flood zones that such development is appropriate to are presented in Table 7-1. The vulnerability classification of some of the proposed land uses will be dependent on details of precisely what is proposed. For example community facilities could be either a less vulnerable or water compatible development dependent on the nature of plans.

Table 7-1
Application of the Sequential Approach for proposed development zones adjacent to King's River

Zone Number	Proposed Land Use of Zone	Potentially Significant Flood Sources	Vulnerability Classification	Application of Sequential Approach	Justification Test Required? (Y/N)
1	Open Space	Fluvial – King's River	Water Compatible	Appropriate in all flood zones	No
2	Community Facilities	Fluvial – King's River	Less Vulnerable	Appropriate in Flood Zones B and C, Justification test required for Flood Zone A	Yes
3			Water Compatible	Appropriate in all flood zones	No
4	General Business	Fluvial – King's River	Less Vulnerable	Appropriate in Flood Zones B and C, Justification test required for Flood Zone A	Yes

Zone Number	Proposed Land Use of Zone	Potentially Significant Flood Sources	Vulnerability Classification	Application of Sequential Approach	Justification Test Required? (Y/N)
5	Industrial	Fluvial – King's River	Less Vulnerable	Appropriate in Flood Zones B and C, Justification test required for Flood Zone A	Yes
6	Industrial	Fluvial – King's River and River Tinnamoona	Less Vulnerable	Appropriate in Flood Zones B and C, Justification test required for Flood Zone A	Yes
7	Agriculture	Fluvial – King's River	Less Vulnerable	Appropriate in Flood Zones B and C, Justification test required for Flood Zone A	Yes
8	Development Objective Area	Fluvial – King's River	Unknown – Development Objective Area	-	-
9	Open Space	Fluvial – River Tullamaine	Water Compatible	Appropriate in all flood zones	No
10	Residential	Fluvial – River Tullamaine	Highly Vulnerable	Appropriate in Flood Zone C, Justification Test required for Flood Zone A and B	Not for majority of the zone, development in the north would require FRA and Justification Test

7.2 Site Specific Flood Risk Assessment

In accordance with the OPW document "*The Planning System and Flood Risk Management*[16]" a site specific flood risk assessment should be undertaken in all situations where the local authority considers there is a risk of flooding. Based on the findings of this SFRA this should be interpreted as;

- Any 'major' development;
- Any development that is located fully or partly within Flood Zones A and B;
- Any other development within 200m of the main channel of King's River;
- Development located adjacent to River Tinnamoona; and
- Development located adjacent to Tullamaine River or within 50m to the south of this channel (eastern side of the study area)

As a minimum this should involve a Stage 1 assessment (flood risk identification) undertaken by an appropriately qualified flood risk specialist. Where identified as appropriate more detailed Stage 2 and Stage 3 assessment of specific risk sources and mechanism will be required. In particular these assessments should consider the potential increases in fluvial flooding as a result of climate change or the blockage of structures.

16 The Planning System and Flood Risk Management, Guidelines for Planning Authorities, Office of Public Works, 2009

8.0 Conclusions

SLR Consulting Limited (SLR) was appointed by Kilkenny County Council to review and update the existing Strategic Flood Risk Assessment[1] in order to inform the Review of Callan Local Area Plan 2019-2025 (LAP). This report has been produced in line with *The Planning System and Flood Risk Management Guidelines for Planning Authorities*[2] and follows the recommended staged approach to flood risk appraisal and assessment.

A broad range of potential sources of flooding have been considered as part of the Stage 1: Flood Identification of the Flood Risk Assessment. Where this high level review concludes that a source is potentially present in the area this has been carried through for a more detailed "Stage 2" assessment. Stage 3 would comprise of additional detailed qualification of risk. In this instance Stage 3 assessments have not been undertaken as the outstanding problems identified are considered to be localised and best addressed at a site level. Potential changes to the risk of flooding within the Callan study area as a result of climate change have also been assessed in line with national guidance in the Climate Change Sectoral Adaptation Plan[3].

The most significant risk of flooding within the study area of the Callan LAP is from fluvial sources. Three water courses have been identified as passing through or adjacent to the study area: King's River, River Tinnamoona and River Tullamaine.

The land within the LAP at greatest risk of flooding is adjacent to the King's River, which has floodplains of approximately 150m north and 50m south of the centre of the watercourse. Flood defences installed in 2011 as part of the Callan Flood Alleviation Scheme provide protection for up to and including the 10% annual exceedance probability (AEP) flood event. However outside of the already developed area, there are no flood defences and some zones of proposed development contain land with an annual probability of fluvial flooding of greater than 10% AEP.

River Tinnamoona, a tributary of King's River, runs adjacent to the north western zone of development. The upstream catchment of this river is small and rural, and therefore anticipated flows are small. Mapping indicates for much of the length flood events up to and including the 1% AEP will remain in channel. However, backwater effects from the confluence with the King's River could result in flooding to the south of this area.

Within the proposed zones of development in the north of the study area, the River Tullamaine is indicated to remain within channel for events up to and including the 0.1% annual exceedance probability. An easement of 8m should be provided to allow access to the channel for maintenance. A blockage of the culvert allowing the River Tullamaine to pass beneath the N76 could result in shallow flooding on N76, Kilkenny Road and Castletobin (road).

There is limited data available for assessing the risk of flooding from sewers, surface water, and overland flow. However, assessment of topographic data indicates that there are several areas that could be vulnerable to surface water flooding. The capacity and condition of drainage infrastructure in Callan has not been available for this SFRA and therefore the magnitude risk of flooding in these locations cannot be assessed. A site specific flood risk assessment should be completed in these zones.

All other sources of flooding including tidal, groundwater, from reservoirs, canals and artificial sources, and infrastructure failure have been assessed and scoped out of this SFRA.

The potential impact of climate change has been considered for all potential sources of flooding in the Callan area. Fluvial and groundwater flood risks are not anticipated to significantly increase as a result of climate change. Increases in high intensity rainfall are anticipated to increase the risk of surface water or overland flowing and the exceedance of surface water drainage networks. New development should include sustainable urban drainage systems (SuDS), which are designed with an uplift for climate change. This should help mitigate the impacts on Callan.

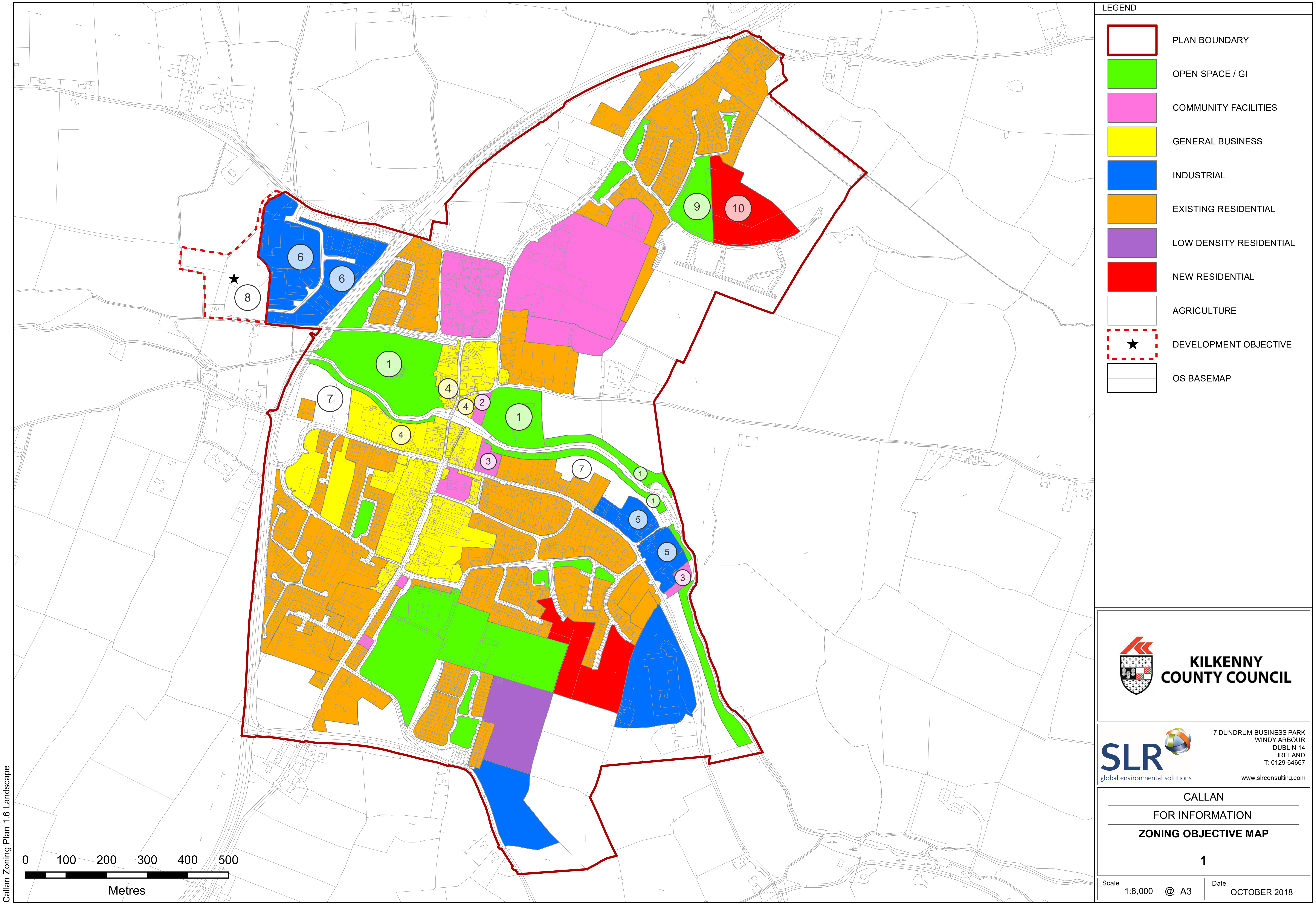
The sequential approach has been assessed for each of the zones of development and presented in Table 7-1 on the suitability of the proposed land use of these zones. Development in all zones located adjacent to any of these watercourses would require a site specific flood risk assessment.

Development close to the King's River should be avoided and the land kept as natural floodplain. Development in these zones may be appropriate outside of the 10% AEP flood extent, however such development must be subject to the justification test and a site specific flood risk assessment would be necessary for any development to demonstrate how flood risk would be controlled.

This SFRA is based on currently available data and in accordance with its status as a "living document" will be subject to modification with the publication of new maps and plans.

APPENDIX 01

Local Action Plan Zoning Map



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CALLAN

FOR INFORMATION

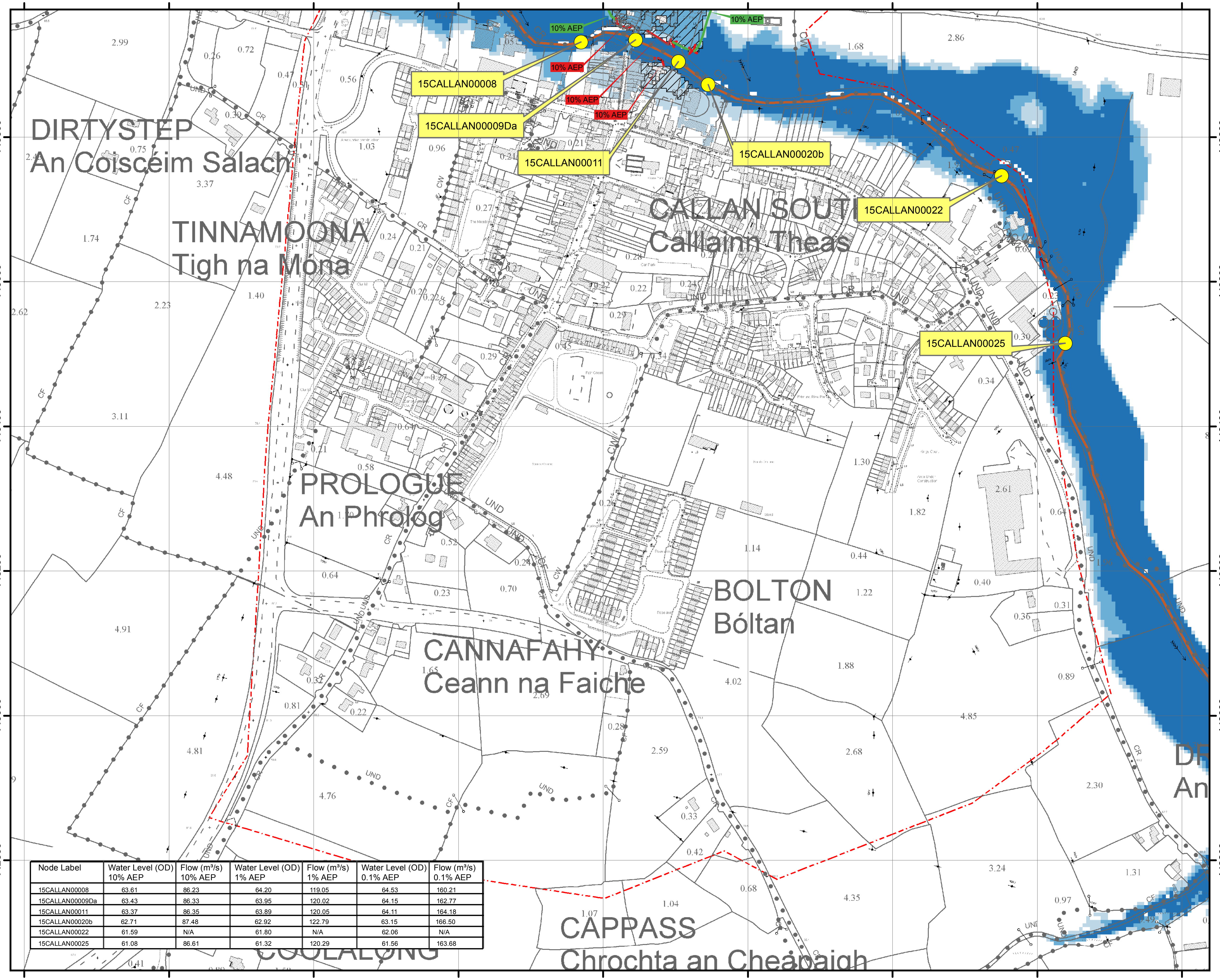
ZONING OBJECTIVE MAP

1

Scale	Date
1:8,000 @ A3	OCTOBER 2018

APPENDIX 02

Office of Public Works CFRAM Maps



Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
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15CALLAN00009Da	63.43	86.33	63.95	120.02	64.15	162.77
15CALLAN00011	63.37	86.35	63.89	120.05	64.11	164.18
15CALLAN00020b	62.71	87.48	62.92	122.79	63.15	166.50
15CALLAN00022	61.59	N/A	61.80	N/A	62.06	N/A
15CALLAN00025	61.08	86.61	61.32	120.29	61.56	163.68

Callan

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

Legend

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

FINAL

REV:	NOTE:	DATE:

SOUTH EASTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

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Map:
Callan Fluvial Flood Extents

Map Type: EXTENT
Source: FLUVIAL
Map Area: HPW
Scenario: CURRENT
Drawn By : C.C. Date : 21 July 2016
Checked By : E.H. Date : 21 July 2016
Approved By : S.P. Date : 21 July 2016
Drawing No. :
O15CAL_EXFCD_F0_02
Map Series : Page 2 of 5
Drawing Scale : 1:5,000 @A3

Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
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15KING01878	64.10	76.47	64.62	107.56	65.02	145.79
15CALLAN00001	63.92	80.32	64.45	110.21	64.85	147.91
15CALLAN00003D	63.94	86.23	64.50	119.81	64.89	162.58
15MILKA00001	64.02	8.04	64.53	8.81	64.93	8.95
15PAWL00181	68.45	0.23	68.53	0.42	68.69	0.75
15PAWL00171	68.13	N/A	68.26	N/A	68.52	N/A
15PAWL00126	65.08	N/A	65.22	N/A	65.38	N/A
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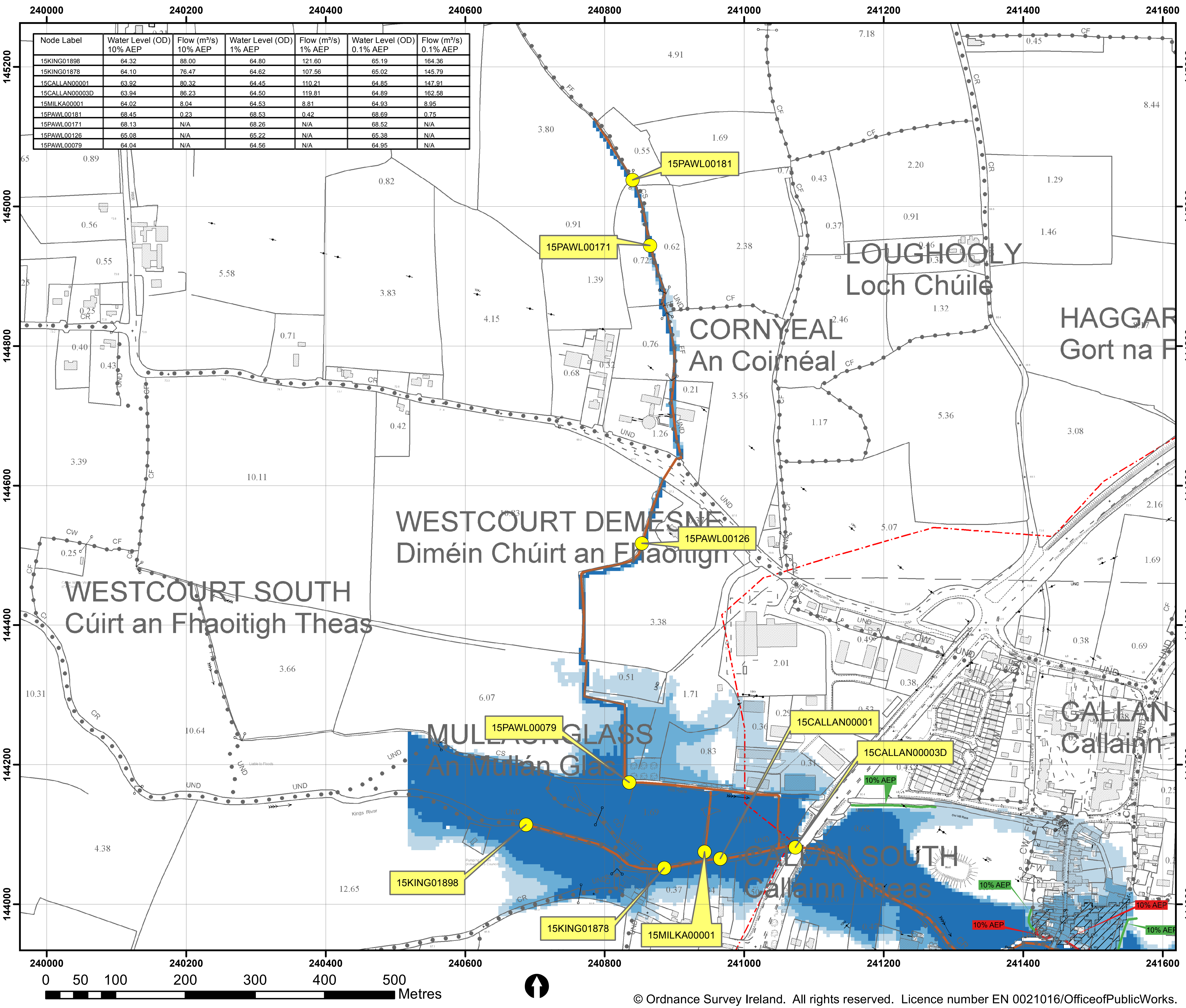

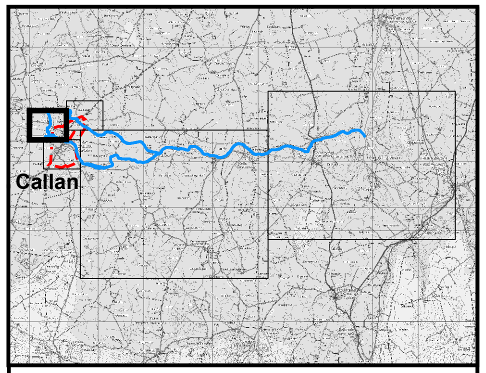

IMPORTANT USER NOTE:
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Legend

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

FINAL

REV:	NOTE:	DATE:
01	Amendments to Node Table.	20/12/16

SOUTH EASTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

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Map:
Callan Fluvial Flood Extents

Map Type:	EXTENT
Source:	FLUVIAL
Map Area:	HPW
Scenario:	CURRENT
Drawn By : C.C.	Date : 22 December 2016
Checked By : E.H.	Date : 22 December 2016
Approved By : S.P.	Date : 22 December 2016

Drawing No. :
O15CAL_EXFCD_F0_01

Map Series : Page 1 of 5

Drawing Scale : 1:5,000 @A3

Node Label	Water Level (OD) 10% AEP	Flow (m^3/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m^3/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m^3/s) 0.1% AEP
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15SHEA00476	66.75	N/A	67.01	N/A	67.18	N/A
15SHEA00444	66.51	0.85	66.84	1.61	67.03	2.80
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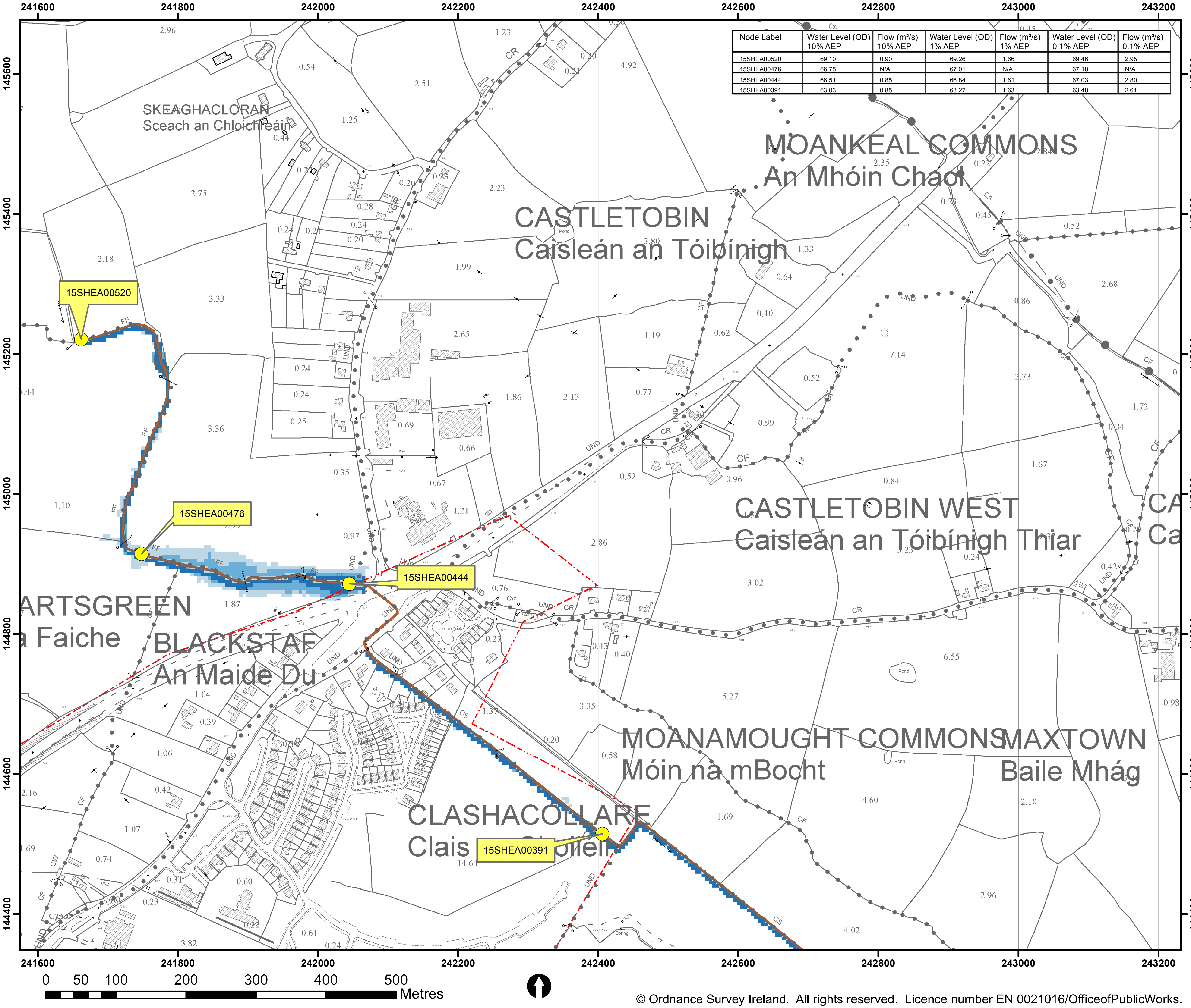

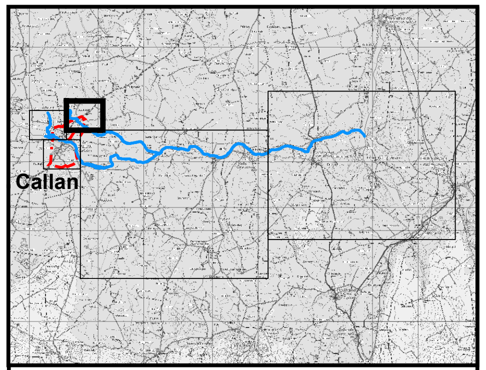

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01	Amendments to Node Table.	20/12/16

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Map:
Callan Fluvial Flood Extents

Map Type: EXTENT
Source: FLUVIAL
Map Area: HPW
Scenario: CURRENT
Drawn By : C.C. Date : 20 December 2016
Checked By : E.H. Date : 20 December 2016
Approved By : S.P. Date : 20 December 2016
Drawing No. :
O15CAL_EXFCD_F0_03
Map Series : Page 3 of 5
Drawing Scale : 1:5,000 @A3

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