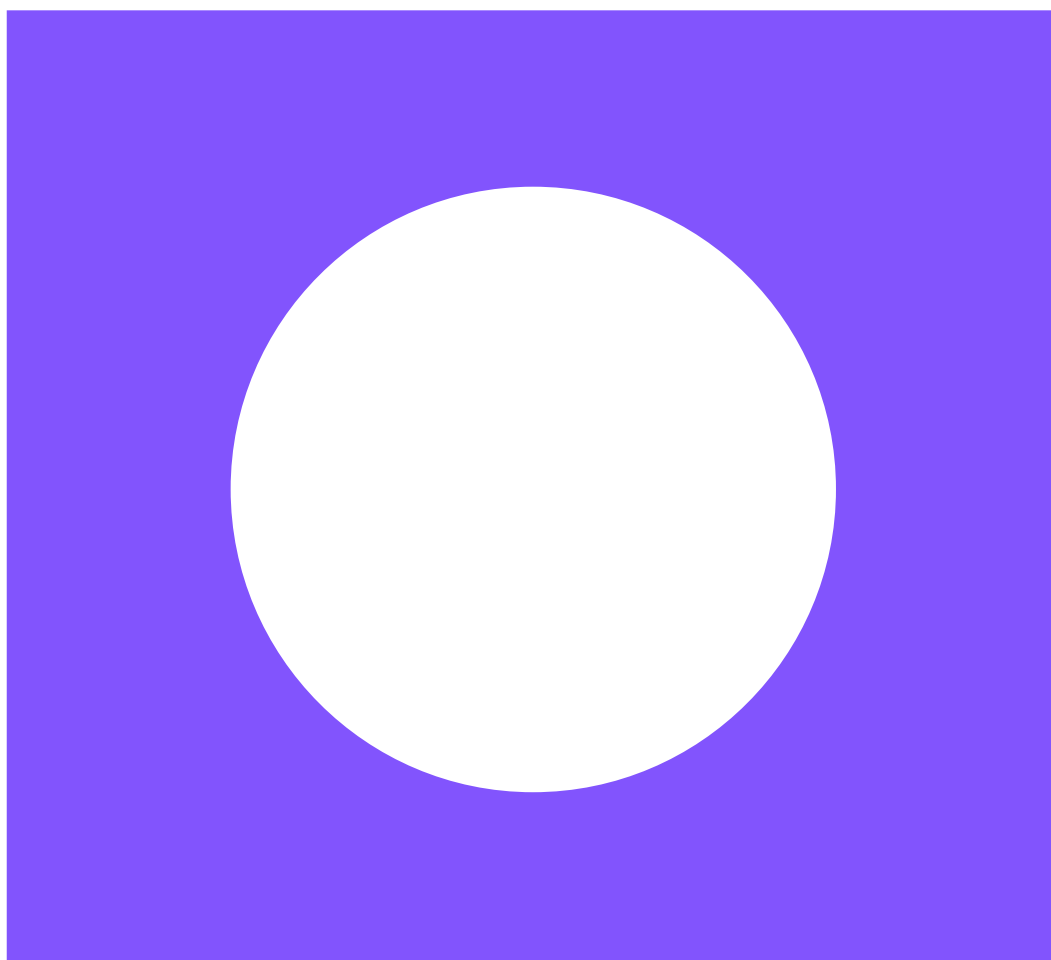




Bassaleg Bridge Detailed Design

Flood Consequences Assessment

September 2025

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Bassaleg Bridge Detailed Design

Flood Consequences Assessment

September 2025

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1 Introduction

Mott MacDonald Limited (Mott MacDonald) has been commissioned by Newport City Council to undertake the detailed design of a new bridge structure to replace the “Old Bassaleg Bridge”, which crosses the River Ebbw in Newport, Wales. The Old Bassaleg Bridge has been closed to vehicles since August 2021 as a result of severe structural deficiencies arising from the scour of its western pier. The proposed new bridge (“New Bassaleg Bridge”) will comprise of precast prestressed reinforced concrete, and provide both pedestrian and vehicular access from Forge Mews to Viaduct Way. The New Bassaleg Bridge will be constructed immediately upstream of the Old Bassaleg Bridge, which will be removed following construction for the new bridge.

1.1 Scope

This Flood Consequences Assessment (FCA) has been prepared for the purpose of satisfying the planning requirements for the proposed development in relation to flood risk; namely Planning Policy Wales (Welsh Government, 2024) and Technical Advice Note 15: Development, flooding and coastal erosion (TAN 15) (Welsh Government, 2025).

Section 6 of TAN 15 states that:

“The prime objective of a Flood Consequences Assessment is to develop a full appreciation of:

- The risk and consequences of flooding on the development; and*
- The risk and consequences (i.e. the overall impacts) of the development on flood risk elsewhere”*

The latest revision of TAN 15 issued in March 2025 (Welsh Government, 2025) supersedes the 2004 edition of TAN 15 on ‘Development and flood risk’ (Welsh Assembly Government, 2004) and the 1998 release of TAN 14 on ‘Coastal Planning’ (Welsh Office, 1998). As such, the latest TAN15’s remit incorporates coastal erosion, which has been given due consideration within this FCA.

TAN 15 is supported by:

- The Wales Flood Map, consisting of the Flood Map for Planning (NRW, 2025a) and Flood Risk Assessment Wales (FRAW) Mapping (NRW, 2025b).
- ‘Flood Consequences Assessments: Climate change allowances’ (Welsh Government, 2021a); and
- Planning Policy Wales (Welsh Government, 2024).

1.2 Sources of information

The assessment contained within this FCA has been informed by the sources listed in Table 1.1.

Table 1.1: Sources of information

File Name	Citation	Access date
Planning Policy Wales Technical Advice Note 15 (TAN 15): Development, flooding and coastal erosion	(Welsh Government, 2025)	May 2025
Planning Policy Wales Technical Advice Note 15 (TAN 15): Development and flood risk	(Welsh Assembly Government, 2004)	June 2025

File Name	Citation	Access date
Planning Guidance (Wales) Technical Advice Note 14 (TAN14): Coastal planning	(Welsh Office, 1998)	June 2025
Planning Policy Wales (PPW) Edition 12	(Welsh Government, 2024)	May 2025
Guidance: Climate change allowances and flood consequence assessments	(Welsh Government, 2021a)	June 2025
National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in Wales	(Welsh Government, 2021b)	June 2025
Future Wales – the National Plan 2040	(Welsh Government, 2021c)	June 2025
National Coastal Erosion Risk Management (NCERM) Map	(NRW, 2024)	June 2025
Newport Local Development Plan 2011 – 2026	(Newport City Council, 2015a)	June 2025
Newport Local Flood Risk Management Plan	(Newport City Council, 2015b)	June 2025
South East Wales – Strategic Flood Consequence Assessment (Stage 1)	(JBA, 2022)	July 2025
Natural Resources Wales (NRW) Flood Map for Planning (FMfP)	(NRW, 2025a)	May 2025
NRW Flood Risk Assessment Wales Map	(NRW, 2025b)	May 2025
1m Digital Terrain Model (DTM) Light Detection and Ranging (LiDAR) data	(Welsh Government, 2023)	May 2025
NRW Recorded Flood Extents dataset	(NRW, 2025c)	May 2025
NRW Flood Defence Structures	(NRW, 2025d)	June 2025
British Geological Survey (BGS) GeoIndex Map	(BGS, 2020)	June 2025
LandIS Soilscales Viewer	(Cranfield University, 2025)	June 2025
Flooding from reservoirs dataset	(NRW, 2023)	June 2025
Canal and River Trust: Our canal & river network	(Canal & River Trust, 2025)	May 2025
NRW Flood Warning and Alert Areas	(NRW, 2025e)	June 2025
Different types of flood risk	(NRW, 2025f)	June 2025
100119581-MMD-XX-XX-RP-GT-0002 P01 – Bassaleg Bridge Ground Investigation Report (GIR) / Geotechnical Design Report (GDR)	(Mott MacDonald, 2025a)	June 2025
100119581-MMD-XX-XX-RP-FL-0004 P01 – Proposed Bassaleg Bridge – Drainage Strategy Report	(Mott MacDonald, 2025b)	June 2025
100119581-MMD-XX-XX-RP-FL-0003 P01 – Bassaleg Bridge Detail Design Hydraulic Modelling Technical Report (Appendix C)	(Mott MacDonald, 2025c)	July 2025
BS 8533:2017 Assessing and managing flood risk in development. Code of practice	(British Standards Institution, 2017)	June 2025
NRW Local Model Manager	(NRW, 2025g)	June 2025
Bassaleg Bridge & River Ebbw Topographical Survey Data and Report	(Infomap Surveys Ltd, 2024)	July 2025
Tredeggar Park Phase 1 – Proposed Site Levels	(Fairhurst Group LLP, 2016)	July 2025
NRW Modelling blockage and breach scenarios	(NRW, 2021)	July 2025

Source: Various sources as stated above. Collated by Mott MacDonald Ltd. 2025.

1.3 Assessment limitations

The information presented within this report is dependent upon the accuracy and reliability of the supplied information, correspondence, and data available to Mott MacDonald, at the time of the assessment (see Section 1.2). Any third parties developing any design should not rely on assumptions made in this report but should satisfy themselves in that regard.

This report includes an assessment of the predicted effects of climate change over the lifetime of the development. The assessment of the effects of climate change is based on guidance provided by Welsh Government (Welsh Government, 2021a) in place at the date of this report. These recommendations may change in the future, increasing the extent of predicted effects, and we would recommend that further advice is sought should this occur during the lifetime of the project.

The assessment presented within this report assumes a 75-year design life for the development, while the new bridge design life, in accordance with DMRB standards, is 120 years. Despite this difference, both design lives fall within the same climate change epoch (2080s) as defined by Welsh Government guidance. Therefore, the same fluvial flow uplift has been applied in the hydraulic modelling study completed to support this FCA. However, it should be noted that the 2080s epoch only begins halfway through the DMRB design life, and no guidance currently exists for assessing climate change impacts beyond this period. As such, there is uncertainty in the accuracy of climate change predictions for the full 120-year design life extending to 2145.

Refer to Section 8 of the Hydraulic Modelling Technical Report (Mott MacDonald, 2025c), which is included in Appendix C of this FCA, for all assumptions and limitations relating to the hydraulic modelling undertaken to inform and support this FCA (Mott MacDonald, 2025c).

Mott MacDonald has followed accepted procedure in providing the services, but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, Mott MacDonald takes no liability for and gives no warranty against actual flooding of any property (client's or third party) or the consequences of flooding in relation to the performance of the service. This FCA has been prepared for the purposes of supporting a planning application for the proposed development to replace the Old Bassaleg Bridge only.

2 Site and development description

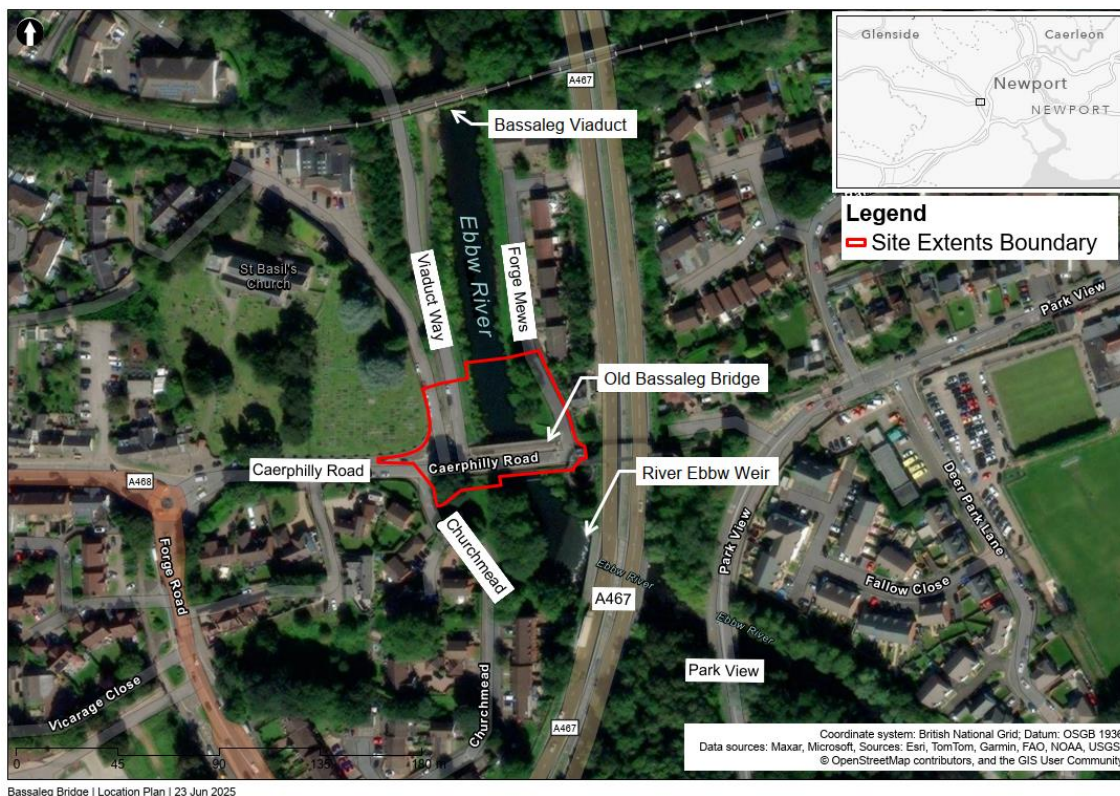
This section defines the site, summarises it along with the surrounding area, and outlines details of the proposed development.

2.1 Site summary

The New Bassaleg Bridge will be located between Forge Mews and Viaduct Way, Bassaleg, Newport, crossing the River Ebbw at Grid Reference ST 27840 87060. The New Bassaleg Bridge will be located to the north (upstream) of the Old Bassaleg Bridge. The Old Bassaleg Bridge structure is currently understood to trap and accumulate debris, which can lead to blockages and restrict the natural flow of water within the River Ebbw. These obstructions demand additional maintenance requirements to manage the risk of this debris increasing flood risk upstream.

The site, as shown in Figure 2.1, encompasses both Old Bassaleg Bridge and the New Bassaleg Bridge and corresponds to the redline boundary defined in the planning application for the proposed developments. For the purposes of this assessment, the area within the site extents boundary will be referred to as “the Site”.

Figure 2.1: Site extents boundary (“the Site”)



Source: As stated in the figure, with additional labels inserted by Mott MacDonald Ltd. 2025.

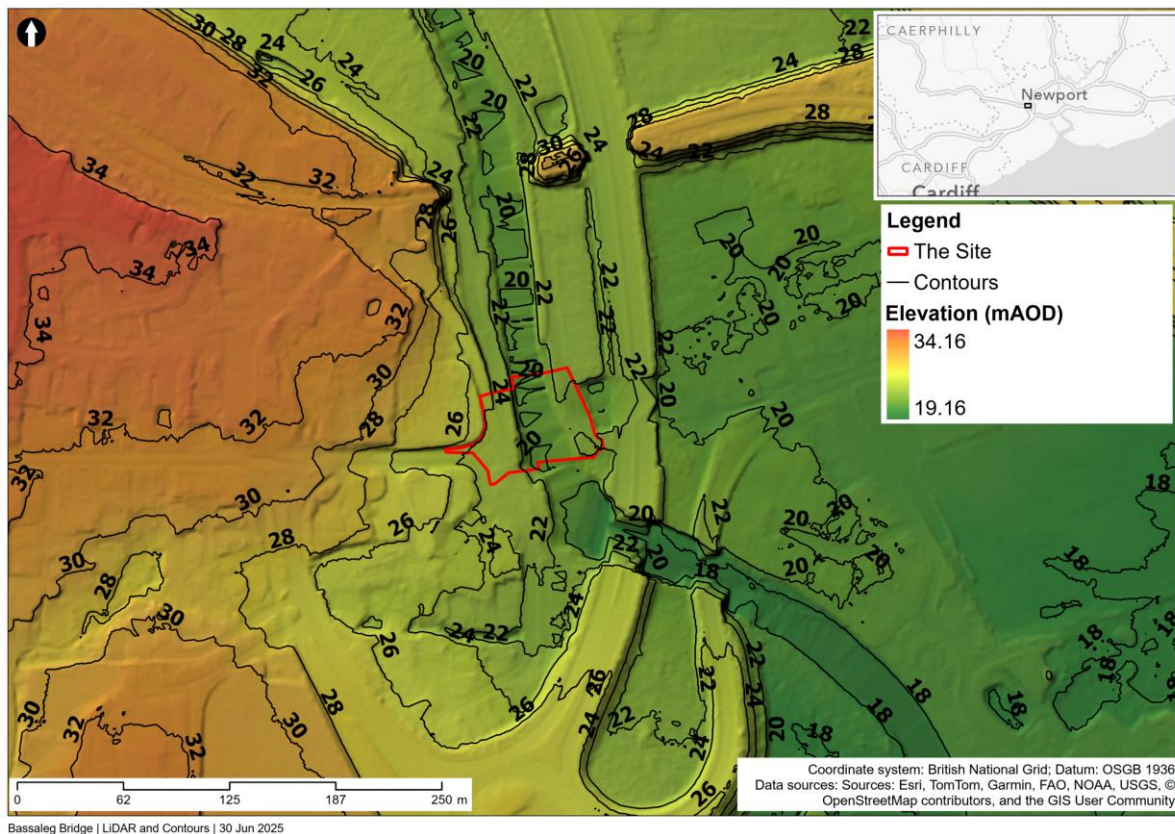
Appendix A.5 shows the existing utilities within and around the Site. These include a water main which runs underneath the old bridge, a gas pipe immediately downstream of the old bridge that crosses the river, surface water drainage running along Forge Mews and Viaduct Way, and a foul sewer running along a section of Forge Mews.

2.2 Site topography

The 1m Digital Terrain Model (DTM) derived from Light Detection and Ranging (LiDAR) data (Welsh Government, 2023) indicates that ground elevations within the Site (and adjacent to the river) range between approximately 22 to 24 metres Above Ordnance Datum (mAOD), as depicted in Figure 2.2. The topographic survey conducted in November 2024 (Infomap Surveys Ltd, 2024) is in generally aligns with LiDAR data in the location of the Site.

Existing plan and elevation drawings are presented in Appendix A.1, which detail the latest topographic levels referenced to Ordnance Datum.

Figure 2.2: Site elevations based on LiDAR



Source: As stated in the Figure. Additionally, contains 1m DTM LiDAR data produced by Welsh Government, 2023. Additional labels inserted by Mott MacDonald Ltd. 2025.

2.3 Soils and geology

According to the British Geological Survey (BGS) Online GeoIndex Mapping (BGS, 2020), the underlying geological strata expected within the area of the Site are as follows:

- **Bedrock Geology:** The bedrock within the Site is part of the Raglan Mudstone Formation, consisting of red mudstones and silty mudstones with calcretes and sandstones.
- **Superficial Deposits:** The superficial deposits underlying the Site are alluvium, consisting of clay, silt, sand and gravel which is described as ‘the unconsolidated detrital material deposited by a river, stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope’.

- **Hydrogeology:** Rock unit is part of the 'Pridoli Rocks (undifferentiated)' with a low productivity aquifer and limited groundwater

The LandIS Soilscape Viewer (Cranfield University, 2025) also provides information regarding the type of soil and its properties. According to the viewer, the area underlying the Site consists of 'Slightly acid loamy and clayey soils' with impeded drainage.

2.4 Watercourses, water bodies and structures

Both the new and old bridges span the River Ebbw, which converges with the River Usk near its estuary and ultimately discharges into the sea approximately 5km to the southeast of the Site. Reaches of the River Usk and River Ebbw are tidally influenced, however the tidal limit of the River Ebbw is located approximately 2km downstream of the site.

Approximately 150m upstream of the new bridge location lies the Bassaleg Viaduct. Downstream, at a distance of approximately 70m, lies the River Ebbw Weir. Immediately downstream of the weir, the River Ebbw is crossed by two bridges that carry the A467 and Park View (road).

Just downstream of the site, there is an offtake for a historic leat that diverts water from the river just upstream of River Ebbw Weir.

Based on NRW's Flood Defence Structures dataset, a fluvial flood defence embankment, approximately 95 metres in length is situated along Forge Mews (NRW, 2025d). NRW's Flood Defence Structures dataset also shows the indicative location of three "simple" culvert openings and a culvert screen situated to the south of the Site (NRW, 2025d).

2.5 Development proposal

2.5.1 Overview

The New Bassaleg Bridge will provide access across the River Ebbw, between Forge Mews and Viaduct Way and will replace the Old Bassaleg Bridge. The new bridge will also provide a shared verge for pedestrians and cyclists (active travel) which will be designed in accordance with Active Travel Act Guidance (ATAG).

The new bridge will carry a two-way single-lane carriageway of 7.5m width. On the north side of the carriageway, there will be a 0.6m wide verge for maintenance and on the south side, there will be a 3.5m wide verge for shared cycle and pedestrian use. Vehicle containment will be provided on both sides of the carriageway.

The junction between Caerphilly Road, Station Approach, Viaduct Way and Churchmead will be realigned to improve junction safety and create provisions for the active travel verge to be continued off the bridge structure.

The existing water main that runs underneath the existing bridge will be diverted across the new bridge, and the foul and surface water networks will remain as existing, with localised changes as needed.

Figure 2.3 and Figure 2.4 show visualisations of the of the new bridge.

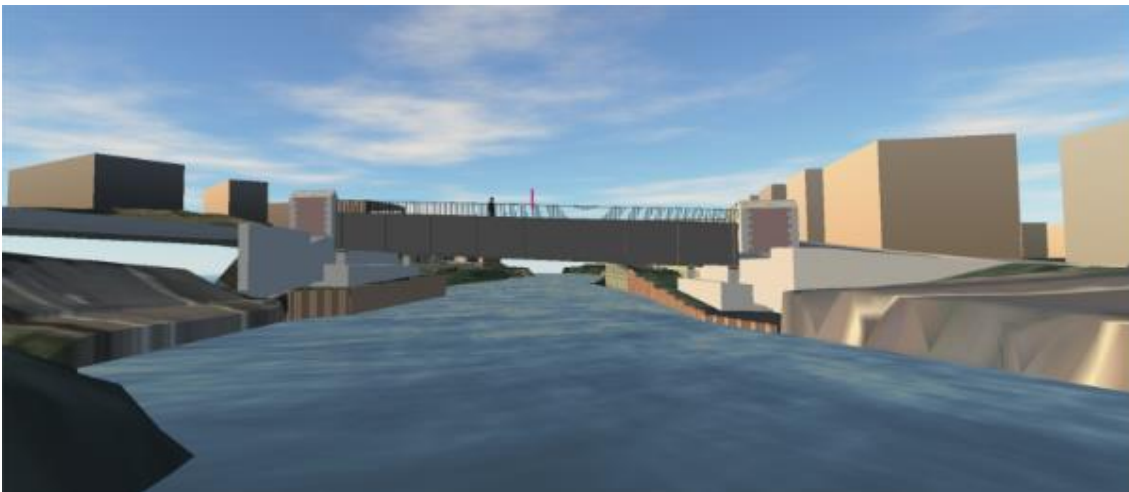
The proposed structural layout, in relation to the existing topographic level data referenced to Ordnance Datum, is shown in Appendix A.2. Further details of the proposed development, including proposed elevations and sectional views with levels referenced to Ordnance Datum, are provided in Appendix A.3, A.4, A.5.

Figure 2.3: Plan view of the New Bassaleg Bridge



Source: Visualisation produced on Infracore by Mott MacDonald Ltd. 2025.

Figure 2.4: Upstream view of the New Bassaleg Bridge



Source: Visualisation produced on Infracore by Mott MacDonald Ltd. 2025.

Note: The above visualisations do not include the update to replace sheet pile walling with block stone scour protection, in accordance with the latest design.

2.5.2 Design considerations

The new bridge is required to be located in close proximity to the existing structure to maintain highway continuity, meaning the design has been heavily influenced by local site constraints. For example:

1. The road carriageway level was largely fixed at both ends of the structure due to the proximity and elevation of existing infrastructure in the area that the bridge ties into. This significantly limited the opportunity to raise the bridge level beyond that proposed.
2. The positioning of the west abutment was influenced by several factors:
 - a. Underground services – The bridge foundation had to be offset from a 1.2m diameter sewer located beneath Viaduct Way (at a depth of 5 m) to avoid affecting this key drainage asset.
 - b. Road alignment and turning requirements – To minimise the bridge span and associated costs, it was design such that the turning for the junction with Viaduct way was off the footprint of the bridge.
 - c. Construction access – Viaduct Way provides the primary access to approximately 200 homes. To mitigate disruption during construction, the bridge was offset from the road to maximise available working space and reduce road closures requirements as far as practicable.

Maintenance requirements also influenced the bridge form, ruling out alternative designs that could have reduced construction depth but posed long-term access or durability challenges.

The new structure has been designed as a single-span bridge, eliminating the in-channel pier present in the existing bridge. The new bridge design also addresses an issue with the western opening on the existing bridge (smaller of the two openings) which is deemed to pose a notable blockage risk due to its size and less favourable geometry.

The new bridge is expected to reduce the risk (occurrence) of blockage or debris accumulation, and in turn reduce the flow restriction locally.

It should be noted that the overall cross-sectional flow area under the new bridge is estimated to reduce from current (for the existing bridge) 63m² to 53m² (i.e. approximately a 16% reduction). Albeit the 63m² area estimated for the existing bridge includes a scour hole that has developed adjacent to its western pier, which is estimated to account of 7% of the overall flow area (approximately 4.5m²). Similarly, the flow area for the new bridge (53m²) is based on a reinstated bed level of 18.6mAOD, which over time is expected to reduce via natural scour. If it were to be reduced by 600m (i.e. to the top of the scour protection at 18mAOD) this would increase the potential flow area by 9m², 53m² to 62m², which would be comparable to the existing bridge with the scour hole.

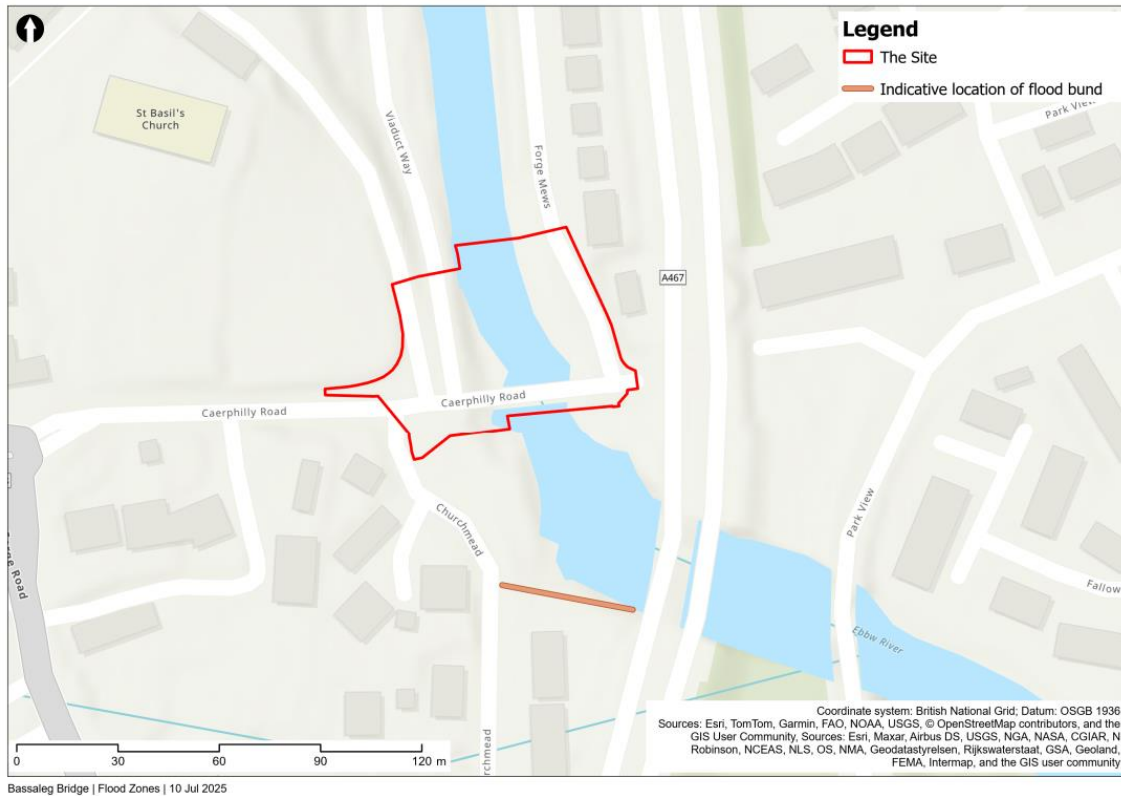
A hydraulic modelling study has been undertaken to inform, support, and assess the design of the New Bassaleg Bridge. In addition to the Hydraulic Modelling Technical Report (Mott MacDonald, 2025c) provided in Appendix C, which includes all assumptions and limitations, a summary of the modelling is also presented in Section 5.2 of this FCA.

2.5.3 Flood bund

While the new bridge should help reduce the risk (occurrence) of blockage, it does have the potential to increase flood risk downstream. To help mitigate the risk of flooding downstream, a flood bund / wall has been incorporated into the proposals as a mitigation measure. As shown in Figure 2.5, the bund is situated downstream of the old bridge along Churchmead and will have

a crest level of 22.5mAOD, which has been derived from the hydraulic modelling study (See Section 5.2 for further details and Hydraulic Modelling Technical Report (Mott MacDonald, 2025c) provided in Appendix C) and will tie into higher ground along Churchmead and the A467.

Figure 2.5: Indicative location of flood bund



Source: As stated in the figure, with additional labels inserted by Mott MacDonald Ltd. 2025.

It is understood that the flood bund can be constructed as permitted development under Part 2, Schedule 2, Class A of the Town and Country Planning (General Permitted Development) Order 1995, and therefore, it does not form part of the planning application for the proposed development. As such, the bund does not form part of the assessment of the proposed development within this FCA (and is excluded from the formal site boundary). However, as it is deemed as required mitigation to satisfy the requirements TAN15, analysis of this bund is included within this FCA.

3 Planning policy

This section presents the details of the relevant national and local flood related guidelines applicable to the proposed development.

3.1 Technical Advice Note 15 and the Flood Map for Planning

TAN 15 (Welsh Government, 2025) provides detailed guidance to support the appropriate consideration of flood and coastal erosion risks in both plan-making and development management decisions. It establishes a framework for assessing risks from rivers, sea, surface water, and coastal erosion, supporting the policies set out in Planning Policy Wales (Welsh Government, 2024) and Future Wales: The National Plan 2040 (Welsh Government, 2021c). The key aim of TAN 15 is to steer development away from high-risk areas.

TAN 15 reflects the core principles of the National Strategy for Flood and Coastal Erosion Risk Management in Wales (Welsh Government, 2021b) that adopts a risk-based approach in respect of development in areas at risk of flooding and coastal erosion.

3.1.1 Form of development

TAN 15 recognises two key forms of development, defined as follows:

- **New Development:** Any development on greenfield land.
- **Redevelopment:** Any development on previously developed land as defined in Planning Policy Wales.

The ability to avoid or minimise risk when undertaking development varies according to the type of development proposed. As detailed in Section 2.5, the proposed development primarily involves the replacement of the old bridge with a new bridge structure. As such, the proposed development is considered to be classified as **'Redevelopment'** in terms of TAN15.

3.1.2 Vulnerability classification

TAN 15 classifies developments under one of the three following flood risk vulnerability categories, as shown in Table 3.1.

Table 3.1: TAN 15 Vulnerability classification

Vulnerability category	Types
Highly vulnerable development	● All residential premises (including hotels, Gypsy and Traveller sites, caravan parks and camping sites). ● Schools and childcare establishments, colleges and universities. ● Hospitals and GP surgeries. ● Especially vulnerable industrial development (e.g. power generating and distribution elements of power stations, transformers, chemical plants, incinerators), and waste disposal sites. ● Emergency services, including: ambulance stations, fire stations, police stations, command centres, emergency depots. ● Buildings used to provide emergency shelter in time of flood.
Less vulnerable development	● General industrial, employment, commercial and retail development. ● Transport and utilities infrastructure. ● Car parks. ● Mineral extraction sites and associated processing facilities (excluding waste disposal sites).

Vulnerability category	Types
	- Public buildings including libraries, community centres and leisure centres (excluding those identified as in Highly Vulnerable category and emergency shelters). - Places of worship. - Cemeteries. - Equipped play areas. - Renewable energy generation facilities (excluding hydro generation)
Water compatible development	- Boatyards, marinas and essential works required at mooring basins. - Development associated with canals. - Flood defences and management infrastructure. - Open spaces (excluding equipped play areas). - Hydro renewable energy generation.

Source: Adapted from Section 9 of TAN 15, 2025.

As a form of transport infrastructure, the proposed development could be classed as ‘less vulnerable development’ in terms of TAN 15. However, Section 9.4 of TAN 15 states:

“Water compatible developments include developments which are required to be located near water by virtue of their nature, and developments that are resilient to the effects of occasional flooding.”

As such, the parts of the proposed development could be classed as ‘water compatible development’ since it is situated near water by its very nature.

However, based on professional judgement and adopting a precautionary approach for the purposes of this assessment, the proposed development has been classed as ‘less vulnerable development’ in terms of TAN15.

3.1.3 Lifetime of development

TAN 15 requires that a FCA includes an assessment of the flood risk and consequences over the lifetime of the proposed development. TAN 15 states:

“Generally, it is appropriate to think of new dwellings as having a lifetime of 100 years. Lifetimes for other types of development will vary, but 75 years is considered a reasonable rule of thumb’.”

Based on current climate change guidance assessments (Welsh Government, 2021a), percentage increases in peak river flow for the central (25% uplift) and upper end (70% uplift) allowances for the 2080s epoch within the Severn River Basin District have been adopted within this assessment. Specifically, the central allowance has been used to assess the potential impact of climate change as part of a FCA including the assessment of flood consequences on third parties and to inform design levels. The upper end allowance has been used to assess the risk of exceedance flows to inform mitigation measures to improve the long-term resilience of the development.

3.1.4 Coastal erosion

The approach outlined in TAN 15 seeks to “ensure that coastal erosion is accorded appropriate consideration within the planning system”. Section 8.7 of TAN 15 advises against developments in areas at risk of being impacted by coastal erosion over the lifetime of the development. Section 12.9 of TAN 15 further emphasises that planning authorities must fully assess coastal erosion risk when making decisions on development proposals in coastal areas. Applicants are required to provide evidence demonstrating that the proposed site can be developed without risk of coastal erosion throughout its lifetime. Planning authorities must be convinced of the

robustness of this evidence before granting planning permission. TAN 15 guidance states that developments should not be permitted in areas shown to be at risk of erosion in the ‘National Coastal Erosion Risk Management’ (NCERM) Map (NRW, 2024).

The NCERM Map indicates that the Site is not within an area at risk of coastal erosion (present-day and in the future).

3.1.5 Flood Map for Planning

The Flood Map for Planning (FMfP) is one of two components that make up the Wales Flood Map.

Section 4 of TAN 15 states:

“The Flood Map for Planning is the starting point for consideration of flood risk in the planning system. The map uses flood zones to indicate the degree to which land is at risk of flooding from rivers, the sea, surface water and small watercourses. This TAN outlines the actions that should be taken when considering development in the different flood zones.”

Figure 1 of TAN 15, which has been reproduced in Table 3.2 outlines the definitions for the various flood zones introduced by TAN 15 (and as presented on the FMfP). The FMfP does not take the presence of flood defences into account and displays predicted future flood risk with an allowance made for climate change from a 1961-1990 baseline over a 100-year lifetime of development under the central climate change estimate.

Table 3.2: Definition of Flood Map for Planning Zones

Zone	Flooding from rivers	Flooding from the sea	Flooding from surface water and small watercourses
1	Less than 1 in 1000 (0.1%) (plus climate change) chance of flooding in a given year		
2	Less than 1 in 100 (1%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate	Less than 1 in 200 (0.5%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.	Less than 1 in 100 (1%) but greater than 1 in 1000 (0.1%) chance of flooding in a given year, including climate change.
3	A greater than 1 in 100 (1%) chance of flooding in a given year, including climate change.	A greater than 1 in 200 (0.5%) chance of flooding in a given year, including climate change.	A greater than 1 in 100 (1%) chance of flooding in a given year, including climate change.
TAN 15 Defended Zones	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from rivers of 1:100 (plus Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from rivers of 1:100 (plus climate change and freeboard).	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from the sea of 1:200 (plus climate change and freeboard).	Not applicable.

Source: Adapted from Figure 1 of TAN 15, 2025.

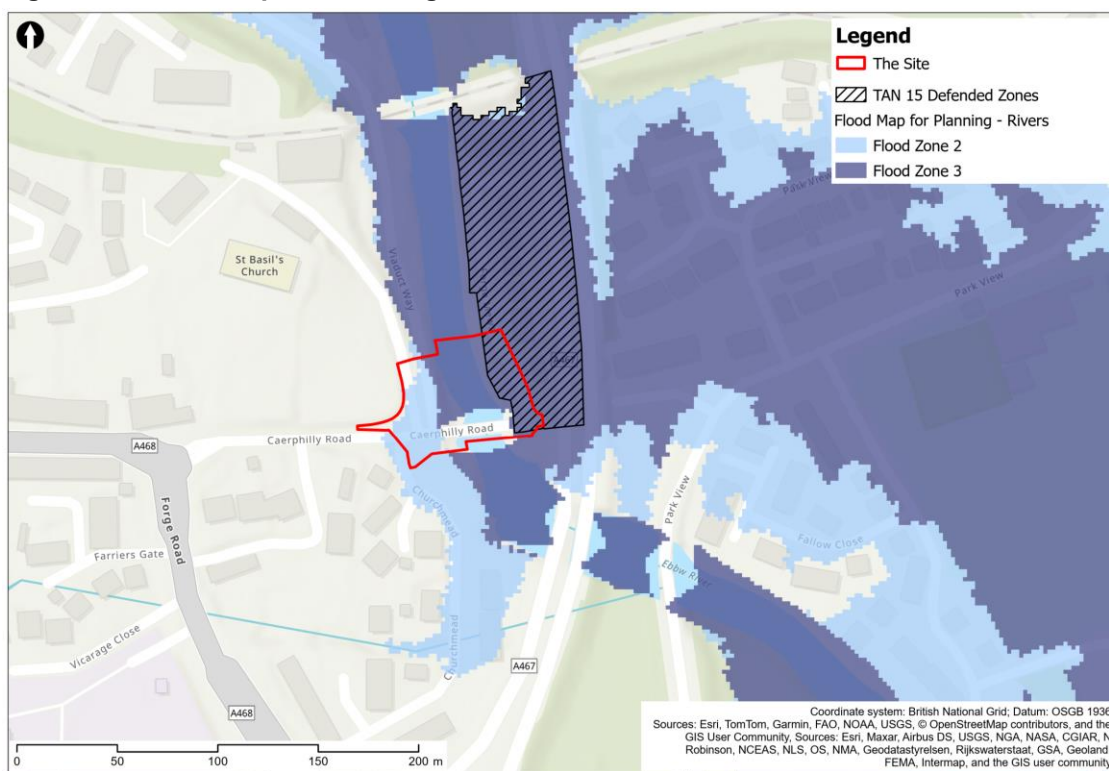
Table 3.3 presents an assessment of flood risk to the Site from tidal, fluvial, and surface water sources, based on the FMfP zones. Figure 3.1 and Figure 3.2 illustrate the flood zones applicable to the Site for fluvial and surface water flooding, respectively. Additionally, Figure 3.1 includes TAN 15 Defended Zones.

Table 3.3: Assessment of flooding on Site based on FMfP zones

Zone	Flooding from rivers	Flooding from the sea	Flooding from surface water and small watercourses
1	✓	✓	✓
2	✓	✗	✓
3	✓	✗	✗
TAN 15 Defended Zones	✓	✗	Not applicable.

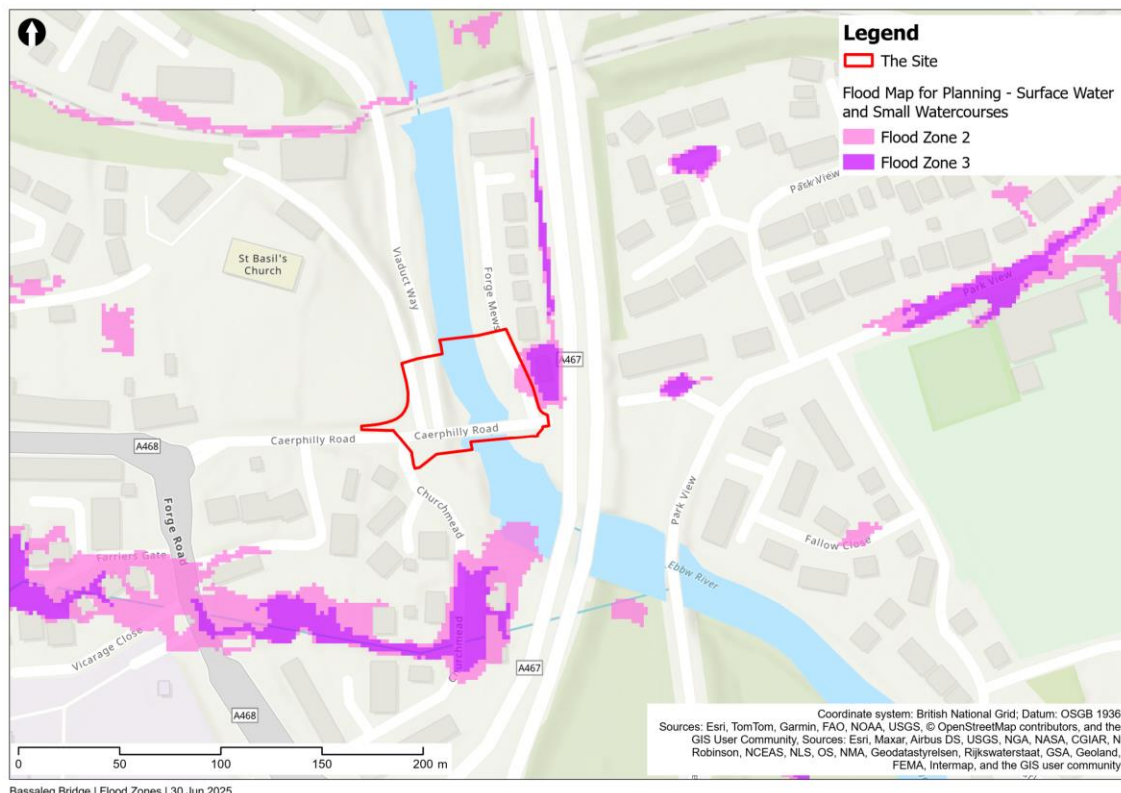
Source: NRW, 2025a. Collated by Mott MacDonald Ltd. 2025.

Figure 3.1: Flood Map for Planning – Rivers and TAN 15 Defended Zones



Source: As stated in the figure. Additionally, contains Natural Resources Wales information © Natural Resources Wales and Database Right. All rights Reserved. © Welsh Local Authorities. Some features of this information are based on digital spatial data licensed from the UK Centre for Ecology & Hydrology © UKCEH. Defra, Met Office and DARD Rivers Agency © Crown copyright. © Cranfield University. © James Hutton Institute. Contains OS data © Crown copyright and database right. Additional labels inserted by Mott MacDonald Ltd. 2025.

Figure 3.2: Flood Map for Planning – Surface Water and Small Watercourses



Source: As stated in the figure. Additionally, contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved. Some features of this information are based on digital spatial data licensed from the UK Centre for Ecology & Hydrology © UKCEH. Defra, Met Office and DARD Rivers Agency © Crown copyright. © Cranfield University. © James Hutton Institute. Contains OS data © Crown copyright and database right. Additional labels inserted by Mott MacDonald Ltd. 2025.

3.1.6 Justifying the location of development in principle

When assessing a site for development or redevelopment, Section 10 of TAN 15 sets out the criteria for justifying development proposals in flood risk areas. As outlined in this section, the proposed development is considered to be defined as 'less vulnerable redevelopment' in terms of TAN 15. It is also considered that the proposed development will achieve key local economic objectives, and it is not located within an area at risk of coastal erosion (present-day and in the future).

Consequently, its location within Flood Zone 3 (for rivers) is considered justifiable in principle, subject to demonstrating that the flood consequences are acceptable in line with the requirements of Section 11 of TAN 15.

3.2 Newport City Council Local Development Plan

The Newport Local Development Plan 2011 – 2026 (Newport City Council, 2015a) sets a vision to make Newport "a centre of regeneration that celebrates its culture and heritage, while being a focus for varied economic growth that will strengthen its contribution to the region". To achieve this vision, the plan identifies ten detailed objectives to address key issues. Objective 2 relates to flood risk:

“Objective 2 – Climate Change

To ensure that development and land uses in Newport make a positive contribution to minimising, adapting to or mitigating against the causes and impacts of climate change, by

incorporating the principles of sustainable design, changes to travel behaviour, managing the risks and consequences of flooding, and improving efficiency in the use of energy, waste and water.”

This objective from the Newport Local Development Plan aligns with the principles of TAN 15 and the assessment carried out as part of this FCA.

3.3 South East Wales Strategic Flood Consequence Assessment Stage 1

The Stage 1 South East Wales – Strategic Flood Consequence Assessment (SFCA) (JBA, 2022) was commissioned on behalf of 11 Local Planning Authorities (LPAs) in south-east Wales, including Newport City Council.

The SFCA is based on a desk study that compiles existing information to undertake a broad assessment of potential flood risks across the study area from all sources of flooding.

The SFCA identifies areas potentially at high risk of flooding, documents historical flood events, and outlines existing flood risk management infrastructure and procedures. The SFCA also highlights opportunities for natural flood management, such as slowing and storing water, and offers guidance on applying TAN 15 and managing flood risk in a development site.

Appendix G1 of the SFCA contains a flood risk review on Newport, which has been used to inform relevant parts of Section 4 of this FCA.

4 Initial assessment of flood risk

This section assesses the risk to the proposed development from all sources of flooding, based on a desk-based analysis of primarily existing flood risk data published online, notably the Wales Flood Map (i.e. FRAW map and FMfP).

With regards to the FRAW map, Section 4 of TAN 15 states:

“For advice and information about the current risk of flooding to existing properties, the Flood Risk Assessment Wales (FRAW) map provides a comprehensive picture of the nature and scale of risks and hazards.”

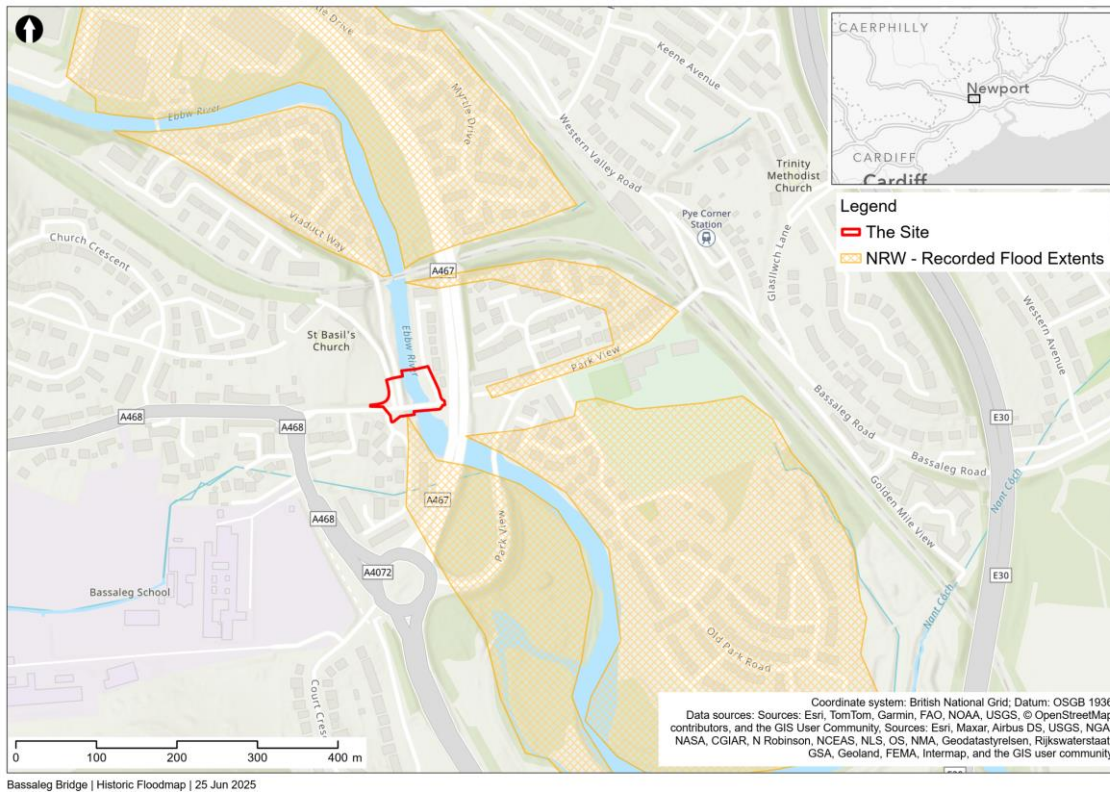
The FRAW map represents the present-day flood risk and accounts for the presence of existing defences. In contrast, as noted in Section 3, the extents shown by the FMfP include allowances for climate change but do not consider the presence of flood defences.

4.1 Historical flooding

Figure 4.1 indicates the recorded flood extents in the vicinity of the Site based on NRW's Recorded Flood Extents dataset (NRW, 2025c). This dataset shows areas that have been recorded to have flooded in the past from rivers, the sea or surface water. All the recorded flooding in the vicinity of the proposed development is from a flood event on 27 December 1979, which caused widespread flooding across south Wales.

This is also confirmed in the Stage 1 South East Wales SFCA (JBA, 2022), which identifies the cause of flooding in Bassaleg as the River Ebbw exceeding its channel capacity. Additionally, the SFCA also reports an incident of sewer flooding within the Tredegar Park electoral ward, which is located downstream of the Site.

Figure 4.1 - Recorded Flood Extents



Source: As stated in the figure. Additionally, contains Natural Resources Wales information © Natural Resources Wales and Database Right. All rights Reserved. Additional labels inserted by Mott MacDonald Ltd. 2025.

4.2 Fluvial flood risk

Fluvial flooding typically occurs when a river cannot cope with the amount of water draining into it from the surrounding land (NRW, 2025f).

Figure 4.2 provides an extract from NRW's FRAW map (NRW, 2025b), which indicates that a large proportion of the area within the Site is at 'high risk' of flooding from rivers, meaning this area has a greater than 3.3% chance of flooding in any given year. However, the area identified as 'high risk' is confined to the river channel of the River Ebbw. The area along Forge Mews and Viaduct Way within the Site are shown to be at 'medium risk' of flooding from rivers. This means these areas have between 1% to 3.3% chance of flooding in any given year, taking into account the presence of flood defences within the area.

As outlined in Section 2.4, NRW's Flood Defence Structures dataset shows a fluvial flood defence embankment located along Forge Mews, along with the indicative location of three simple culvert openings and a culvert screen situated to the south of the Site with the screen appearing to discharge into the River Ebbw (NRW, 2025d). Figure 4.2 depicts the flood defence structures in the vicinity of the Site.

According to NRW's flood alert and flood warning datasets (NRW, 2025e), parts of the Site as well as roads to its north and south benefit from NRW flood alerts for Rivers Ebbw, Sirhowy and Lwyd, and flood warnings for the River Ebbw. A Flood Alert means that flooding is possible, and site users should be prepared. NRW states that its:

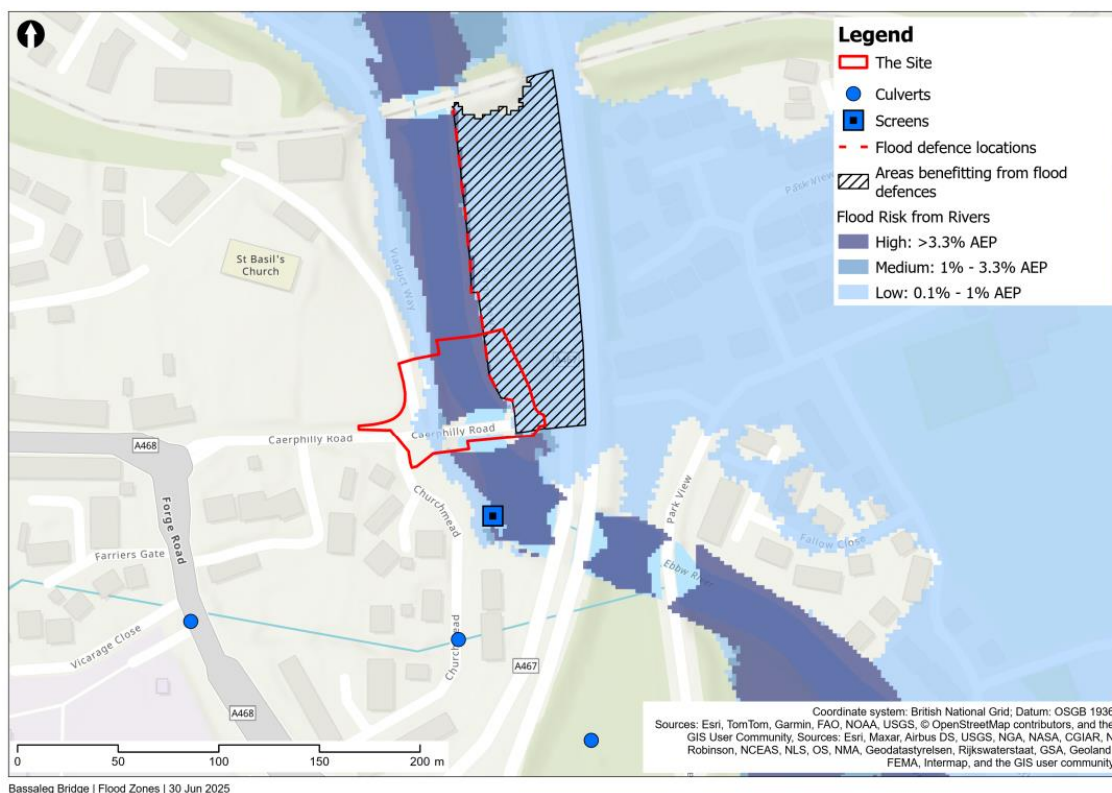
"Flood Alert Areas are geographical areas where it is possible for flooding to occur from rivers or the sea".

A Flood Warning means that flooding is expected, and immediate action would be required. NRW states that areas in its:

“Flood Warning Areas dataset are geographical areas where NRW expect flooding to occur and where NRW provide a Flood Warning Service”.

As indicated in Section 3.1.5, the majority of the Site is located within Flood Zone 3, with the rest of the Site in Flood Zones 1 and 2 with respect to fluvial (rivers) flooding. The residential area along Forge Mews is located within a TAN 15 defended zone for rivers and benefits from fluvial flood protection designed to a 1% Annual Exceedance Probability (AEP) standard, which aligns with the area benefitting from the embankment depicted in Figure 4.2.

Figure 4.2: FRAW Map – Flood risk from rivers



Source: As stated in the figure. Contains Natural Resources Wales information © Natural Resources Wales and Database Right. All rights Reserved. Additional labels inserted by Mott MacDonald Ltd. 2025.

4.3 Tidal flood risk

Tidal flooding happens typically when there are high tides and / or stormy conditions (NRW, 2025f).

The Site lies approximately 5km from the Usk Estuary with ground elevations ranging between 22 - 24mAOD within the Site, as outlined in Section 2.2 (Welsh Government, 2023).

NRW's FRAW map (NRW, 2025b) indicates that the Site is located within an area at 'very low risk' from the sea, with less than 0.1% chance of flooding in a given year.

As indicated in Section 3.1.5, the Site is located wholly within Flood Zone 1 with respect to tidal (sea) flooding.

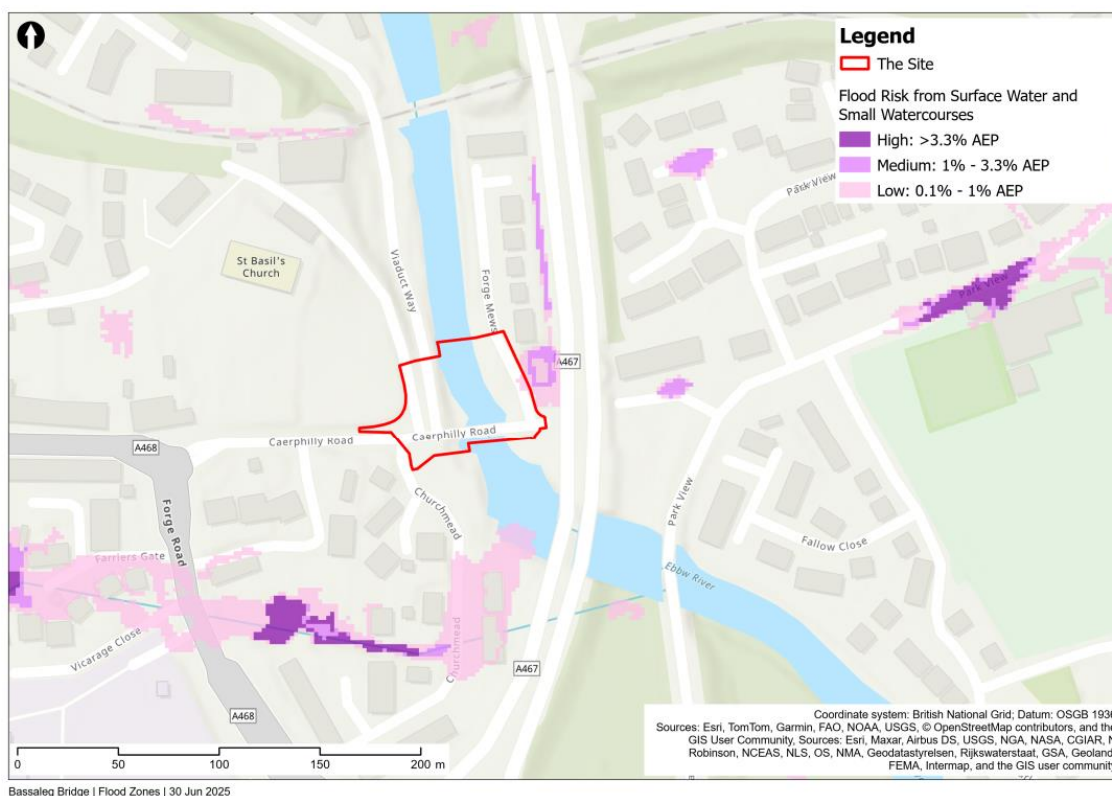
4.4 Flood risk from surface water and small watercourses

Surface water flooding typically occurs when rainwater does not drain away through local drainage systems or soak into the ground (NRW, 2025f). Conversely, flooding from small watercourses typically occurs when they cannot cope with the amount of water draining into it from the surrounding land. A small watercourse is a channel which drains an area less than 3km², which includes small rivers, streams, brooks, ditches, and drains (NRW, 2025f).

Figure 4.3 presents an extract from NRW's FRAW map (NRW, 2025b) and indicates that a small area within the Site along Forge Mews is shown to be at 'low risk' of flooding, meaning this area has between 0.1% to 1% chance of flooding in any given year. The rest of the Site is shown to be at 'very low' risk of flooding from surface water and small watercourses. Meaning the vast majority of the Site has less than 0.1% chance of flooding in any given year from surface water and small watercourses according to NRW's FRAW map.

As indicated in Section 3.1.5, majority of the Site is located within Flood Zone 1, with a small area to the east of the Site along Forge Mews in Flood Zone 2 with respect to flooding from surface water and small watercourses.

Figure 4.3: FRAW Map – Flood risk from surface water and small watercourses



Source: As stated in the figure. Contains Natural Resources Wales information © Natural Resources Wales and Database Right. All rights Reserved. Additional labels inserted by Mott MacDonald Ltd. 2025.

4.5 Groundwater flood risk

Groundwater flooding is typically caused by high groundwater levels, when excess water emerges at the ground surface. The risk of groundwater flooding is largely dependent on the nature of the geological strata that underlays the Site and the local topography.

As stated in Section 2.3, the BGS Online GeoIndex Mapping (BGS, 2020) describes the hydrogeology in the area of the Site as having a low productivity aquifer and limited groundwater.

According to the Bassaleg Bridge Ground Investigation Report (GIR) (Mott MacDonald, 2025a), groundwater was identified at a minimum of approximately 3m below ground level (bgl) within the Site.

Newport City Council's Local Flood Risk Management Plan (Newport City Council, 2015b) states that groundwater flooding is not considered to be a significant flood risk in Newport and that there are no recorded groundwater flood incidents in the 'Graig Ward' where the Site lies.

It is therefore considered that the Site is at low risk of groundwater flooding.

4.6 Flood risk from water mains and sewers

Appendix A.5 shows the existing utilities within and around the Site, with alignments detailed in Section 2.5.

Newport City Council's Local Flood Risk Management Plan (Newport City Council, 2015b) states that there are 5 reported flood incidents from sewers in the 'Graig Ward' where the Site lies, however, the exact locations are unknown.

Flooding from sewers and water mains may occur due to operational issues such as blockages or due to an overload of the hydraulic capacity of the conveyance. Therefore, a residual risk of potential flooding from water mains and sewers remains.

4.7 Flood risk from reservoirs and canals

NRW's FRAW map (NRW, 2025b) indicates that the Site is at risk of reservoir flooding from the Blaen-y-cwm Reservoir should it fail.

Natural Resources Wales (NRW, 2023) states that:

"The shading on the map shows the worst-case scenario for the area that could be flooded if a large reservoir were to fail and release the water it holds. A large reservoir is one that holds over 10,000 cubic metres of water, equivalent to approximately 4 Olympic sized swimming pools.

Reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in Wales, we ensure that reservoirs are inspected regularly and essential safety work is carried out.

The reservoir flood maps do not indicate any likelihood of a flood occurring."

As such, the risk of reservoir flooding is considered to be low.

There are no canals present in the vicinity of the Site (Canal & River Trust, 2025), with the nearest canal being Monmouthshire & Brecon Canal approximately 11km to the north of the Site. Therefore, it is reasonable to assume that the risk of flooding from canals at the Site is low.

4.8 Summary

The initial assessment presented within this section indicates that there are multiple sources of flooding that have the potential to pose a risk to the Site and proposed development. These could occur independently but also in combination. A summary of the flood risk to the Site and proposed development is presented below in Table 4.1.

Table 4.1: Summary of Flood Risk

Flood Risk Mechanism	Source	Flooding Risk	Description
Tidal	N/A	Very Low	Very low flood risk to the Site, with less than 0.1% chance of flooding in a given year (both now and in the future)
Fluvial	River Ebbw	High	According to the NRW's FRAW map, a large area within the Site is shown to be at high risk; however, the high-risk area is confined to the river channel of the River Ebbw. Much of the land adjacent to the river is classified as medium risk, meaning these areas have a 1% to 3.3% chance of flooding in any given year. Whereas, the FMfP shows parts of the Site (including areas beyond the river channel) to be in Flood Zone 3 (i.e. high risk)
Surface Water and Small Watercourses	Surface water flows and accumulation	Very Low or Low	Majority of the Site at very low risk. A small area to the east of the Site is at low risk of flooding, with a 0.1% to 1% chance of flooding in a given year (both now and in the future).
Groundwater	Groundwater within bedrock and superficial layers.	Low	Groundwater was identified at a minimum of approx. 3mbgl. Aquifer in the area of the Site has low productivity. Limited groundwater. No recorded incidents.
Sewer Exceedance	Water mains, foul and combined systems.	Deemed to be at risk	Residual risk relating to existing sewers, which have the potential to incur operational issues such as blockages or due to an overload of the hydraulic capacity of the conveyance.
Reservoirs and Large Waterbodies	Blaen-y-cwm Reservoir	Low	The Site is at risk of reservoir flooding and may be at risk from several other reservoirs due to being present along River Ebbw. However, due to the enforcement of the Reservoirs Act 1975 in Wales, reservoir flooding is extremely unlikely to happen.
Canals and Manmade Waterways	N/A	-	There are no canals present in the vicinity of the Site with the nearest canal being Monmouthshire & Brecon Canal approximately 11km to the north of the Site.

Source: Collated by Mott MacDonald Ltd. 2025.

5 Detailed assessment of flood risk and consequences

As outlined in Section 4, the Site is shown to be at high risk of flooding from rivers. To this end, fluvial flood risk and consequences posed to and by the proposed development have been assessed in greater detail through a hydraulic modelling study. This section presents an overview and summary of the results from the modelling study, with full technical details included in the Hydraulic Modelling Technical Report (Appendix C). The acceptability of the flood risk and associated consequences, assessed using information from this hydraulic modelling, is discussed in Section 6 of this FCA.

5.1 Hydraulic modelling overview

The 1D-2D hydraulic model used to inform this FCA is an adaptation of an existing NRW integrated catchment model (ICM) for the River Ebbw named 'EbbwLowerICM_5_V1.0_2018', undertaken by Wallingford HydroSolutions (WHS) in 2019 (NRW, 2025g). For the purpose of this assessment, the NRW model has been truncated, with updates made to the hydrological assessment, land digitisation using the latest Ordnance Survey (OS) MasterMap and topography using data from surveys conducted in 2024 and 2025.

The hydraulic model has been used to assess flood risk for three development phases (or cases):

- **Baseline** – Existing Site with the 'Old Bassaleg Bridge' in place.
- **Permanent** – 'New Bassaleg Bridge' and a flood bund in place with the old bridge removed.
- **Temporary** – Both the Old and New Bassaleg Bridges in place, with no flood bund, representing a precautionary short-term transitional phase of approximately one year before the old bridge is removed (due to seasonal constraints during construction).

All three cases run for a range of flood return periods up to and including the 0.1% Annual Exceedance Probability (AEP) plus climate change, as indicated in Table 5.1. Section 3.1.3 provided justification for the selected climate change allowances.

As discussed in Section 2.5.2, the twin arched Old Bassaleg Bridge structure is currently understood to trap and accumulate debris, which can lead to blockages and restrict the natural flow of water within the River Ebbw. In discussion with NRW, the bridge has been assessed as having a medium risk of blockage, and therefore a 25% blockage of the existing bridge was adopted for the baseline and temporary cases (NRW, 2021). The new bridge will have a clear span that will greatly reduce the risk of blockage occurring at the structure. Therefore, no blockage of the new structure is assumed in both the permanent and temporary cases.

Table 5.1: Cases assessed against fluvial return periods using the modelling

Case	Present day (2025)						Future (2080s)			
	50% AEP	10% AEP	3.33% AEP	1% AEP	0.5% AEP	0.1% AEP	1% AEP + 25% CC	0.1% AEP + 25% CC	0.5% AEP + 70% CC	0.1% AEP + 70% CC
Baseline	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Permanent	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Temporary	✓	✓	✓	✓	✓	✓	X	X	X	X
Note: 'CC' stands for 'Climate Change' allowance.										

Source: Produced by Mott MacDonald Ltd. 2025.

5.2 Detailed hydraulic modelling results

This section presents an overview of the hydraulic modelling undertaken to inform this FCA.

5.2.1 Baseline – present-day

Flood extents for the Baseline case from the 50% AEP up to the 0.1% AEP present-day fluvial flood events are shown in Figure 5.1.

The Baseline case results indicate that within the Site, the river remains in bank for the 50% AEP present-day event and the Site is not predicted to be at risk of flooding during the 10% AEP present-day event. Flooding during the 3.3% AEP to the 0.1% AEP present-day events are shown to primarily affect the eastern part of the Site, with some flooding also depicted to the north of the Site along Viaduct Way.

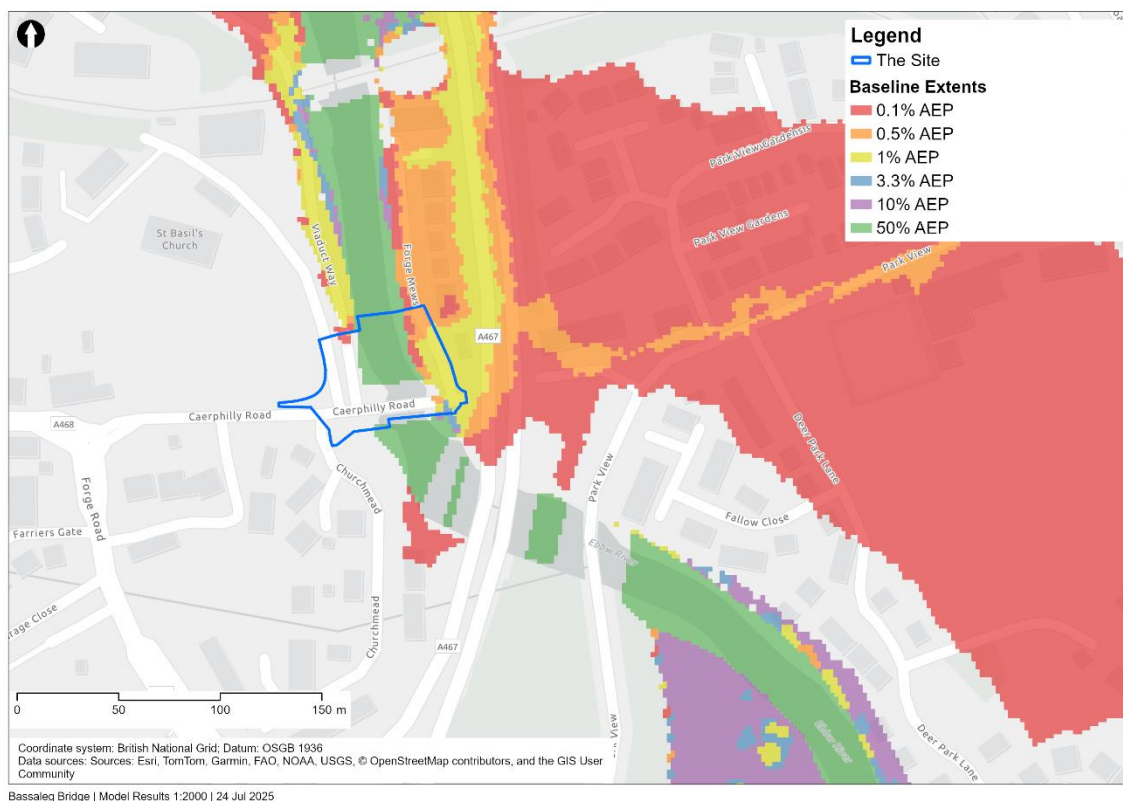
From a review of the model results, it can be seen that the Old Bassaleg Bridge constricts flows on the River Ebbw. The results suggest that the bridge becomes surcharged for an event with an AEP between 3.33% and 1%. Upstream and downstream of the Old Bassaleg Bridge, the nearest structures are much larger and are not surcharged for any of the events assessed (up to the 0.1% AEP flood event), although the Ebbw Weir, a short distance downstream of Old Bassaleg Bridge, does influence flow past the Site.

The results indicate, more widely to the Site, that there is no flooding predicted near Old Bassaleg Bridge for events up to the 3.33% AEP flood event; while bank exceedance and overtopping is predicted to begin in the Tredegar Park area between 50% to 10% AEP flood events.

Upstream of the Bassaleg Viaduct, the left bank is predicted to breach with an overland flow route passing south adjacent to the highway A467 during an event with an AEP between 3.33% and 1%. This flow path outflanks the left bank defences and is predicted to combine with the flow breaching the defence upstream of the Old Bassaleg Bridge (approximately 1% AEP). When this occurs, residential areas along Forge Mews are predicted to be at risk of flooding.

For larger events (approximately 0.5% AEP event), the A467 is predicted to become inundated (as per the 1% AEP event) in addition a flow path towards residential areas east of the Bassaleg bridge begins to establish. A large residential area is predicted to be at risk during this extreme event (as indicated by the 0.1% AEP flood extent presented in Figure 5.1). The residential area east of Churchmead are also predicted to be at risk during 0.1% AEP flood event.

Figure 5.1: Baseline case flood extents from the 50% AEP up to the 0.1% AEP present-day events



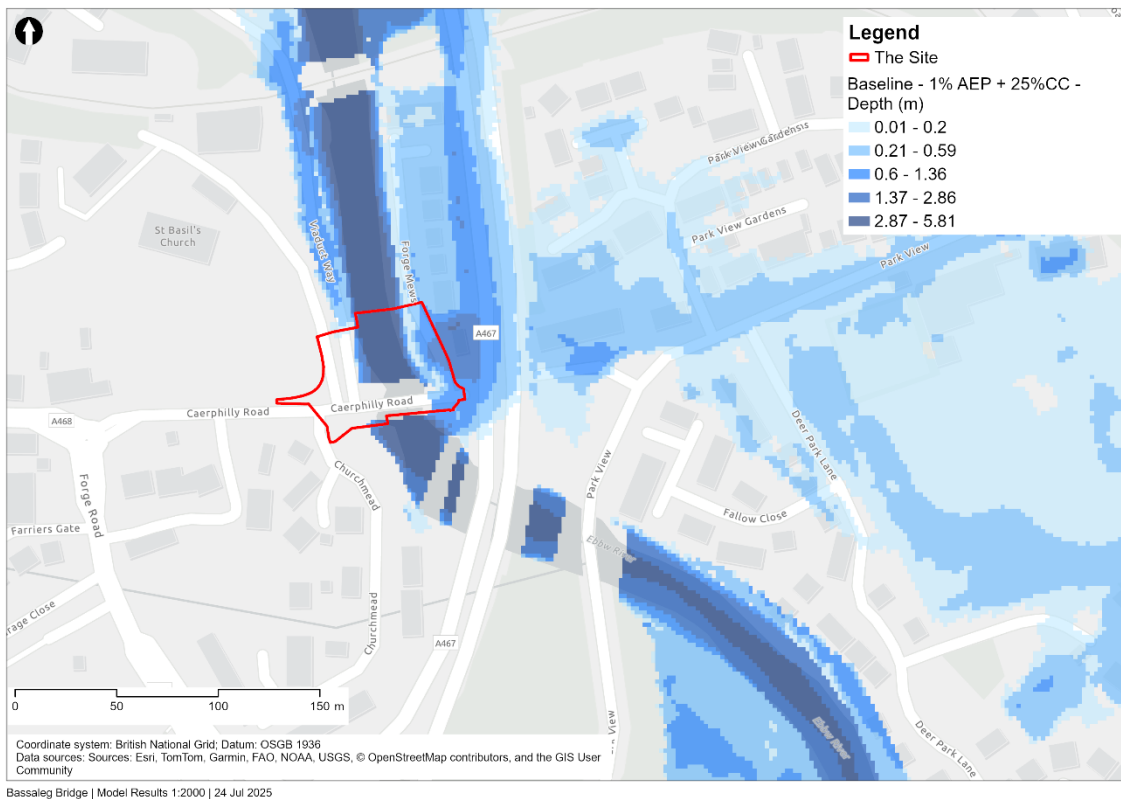
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

5.2.2 Baseline case – 1% AEP plus 25% allowance for climate change

For the Baseline case during the 1% AEP plus 25% allowance for climate change event, flooding is predicted within and adjacent to the Site, along Viaduct Way and Forge Mews, with a flood depth in the order 0.1m and up to 2m shown within these areas of the Site, respectively (See Figure 5.2).

Flood velocities of up to 1m/s and 3m/s are predicted in the flooded areas adjacent to Viaduct Way and Forge Mew (on the river side), respectively (See Appendix B.5).

Figure 5.2: Baseline case during the 1% AEP plus 25% allowance for climate change event – Depths (in m)



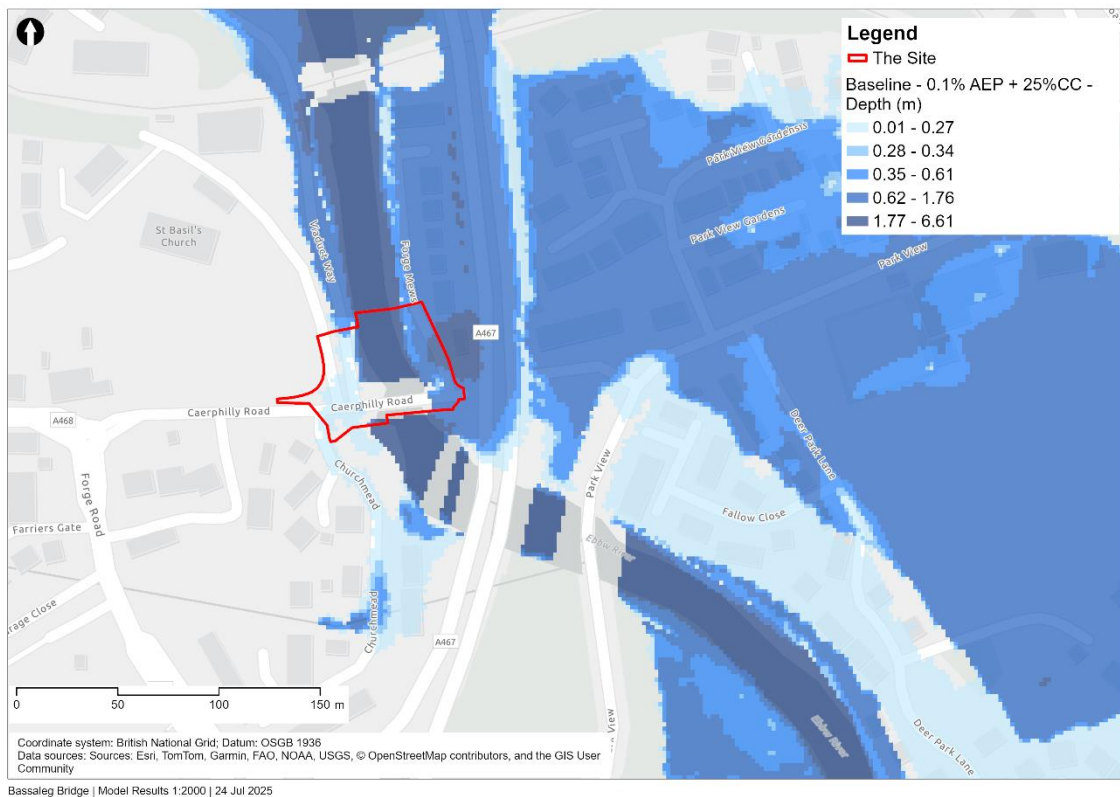
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019.
Produced by Mott MacDonald Ltd. 2025.

5.2.3 Baseline case – 0.1% AEP plus 25% allowance for climate change

For the Baseline case, during the 0.1% AEP plus 25% allowance for climate change event, flooding along Viaduct Way, Caerphilly Road and Forge Mews is predicted within the Site, with flood depths of up to 0.6m to the west, and up to 2.3m to the east of the Site (See Figure 5.3).

Flood velocities of up to 1.3m/s and up to 4.6m/s are predicted in the flood areas to the west and east of the Site (and adjacent to the river), respectively (See Appendix B.5).

Figure 5.3: Baseline case during the 0.1% AEP plus 25% allowance for climate change event – Depths (in m)



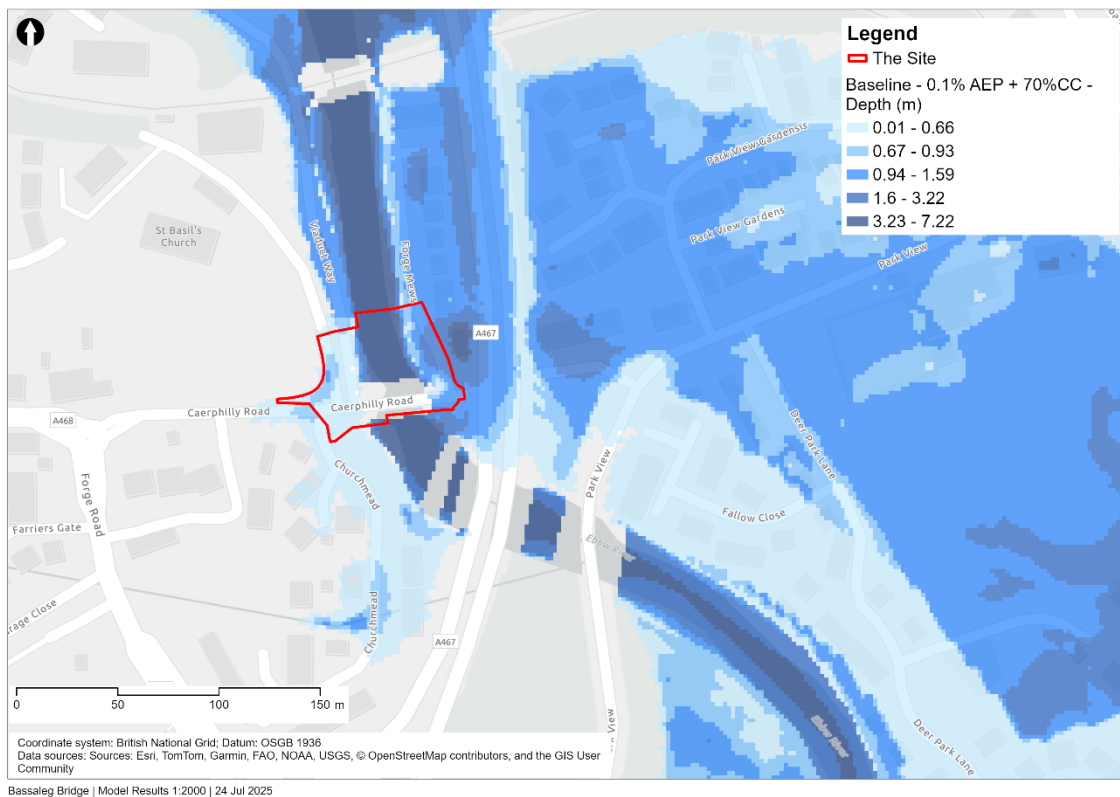
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

5.2.4 Baseline case – 0.1% AEP plus 70% allowance for climate change

During the 0.1% AEP plus 70% allowance for climate change event for the Baseline case, flooding along Viaduct Way, Caerphilly Road and Forge Mews is predicted within the Site, with flood depths of up to 1.0m to the west, and up to 2.7m to the east of the Site (See Figure 5.4).

Flood velocities of up to 9m/s are predicted in the flood areas within the Site (See Appendix B.9).

Figure 5.4: Baseline case during the 0.1% AEP plus 70% allowance for climate change event – Depths (in m)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

5.2.5 Permanent case – present-day

Flood extents for the Permanent case from the 50% AEP up to the 0.1% AEP present-day fluvial flood events are shown in Figure 5.5.

A comparison of water levels between Baseline case and Permanent case (i.e. before and after development) indicates that in general there is little to no increase in flooding predicted up to the 0.5% AEP present-day event (with the exception to this is the 1% AEP present-day event). Flood levels and extents are generally shown to decrease during the Permanent case compared to the Baseline case (i.e. post development) up to the 0.5% AEP present-day event, with areas that were shown to flood in the Baseline case development shown to be flood free during the P Permanent case (See Appendix B.11 to B.15). A general reduction in flood level is predicted upstream of the new bridge, a localised increase in flood level of approximately 0.008m is predicted in the Tredegar Park Bowl area (open space) during the 1% AEP present-day event (see Appendix B.14). This area of open space is considered “water compatible development” in terms of TAN15.

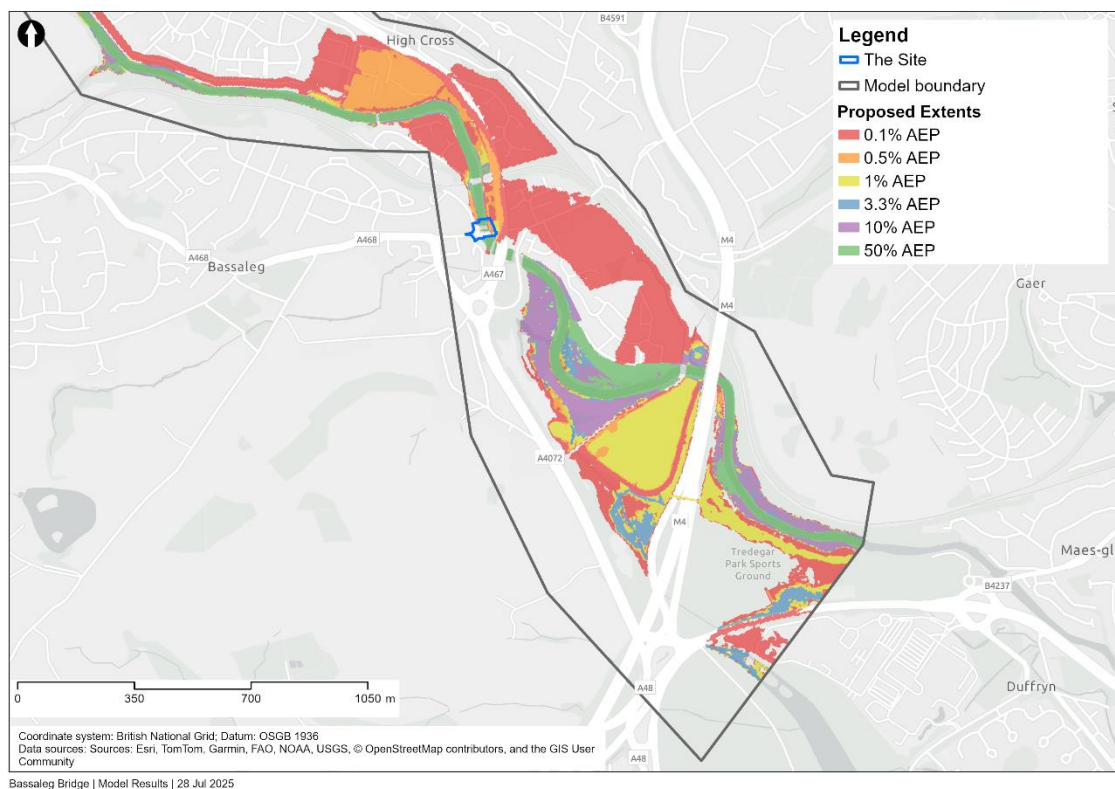
During the 0.1% AEP event, flood levels and extents are generally shown to decrease around the residential (“highly vulnerable development” in terms of TAN15) areas along Forge Mews and to the east of River Ebbw (See Appendix B.16). Residential areas along Churchmead and to the east of River Ebbw that are predicted to be flooded during the Baseline case are predicted to be flood free during the Permanent case. However, an increase in flood levels is shown within and downstream of the Site along River Ebbw. Notably, the increase in flood levels within and immediately downstream of the Site are largely contained within the River

Ebbw channel, with only minor exceedances observed adjacent to (on the river side) Viaduct Way, Forge Mews and Churchmead.

Further downstream, the increases in flood levels shown are largely limited to areas of open spaces along the River Ebbw, with the exception of an area adjacent to Fallow Close and Deer Park Lane (on the river side) where increased flooding of approximately 0.05m is predicted. The residential areas at Fallow Close and Deer Park Lane were constructed on a development plateau, with ground levels in this area ranging from approximately 19.1mAOD to 19.8mAOD (Fairhurst Group LLP, 2016; Welsh Government, 2023). As such, land levels are greater than the 0.1% AEP flood level at this location, by 0.2m to 0.5m. Meaning this residential area is not predicted to flood during the 0.1% AEP event.

The vast majority of areas depicting an increase in flood levels during the 0.1% AEP event are shown to flood during the Baseline case (i.e. pre-development).

Figure 5.5: Permanent (proposed) case flood extents from the 50% AEP up to the 0.1% AEP present-day events

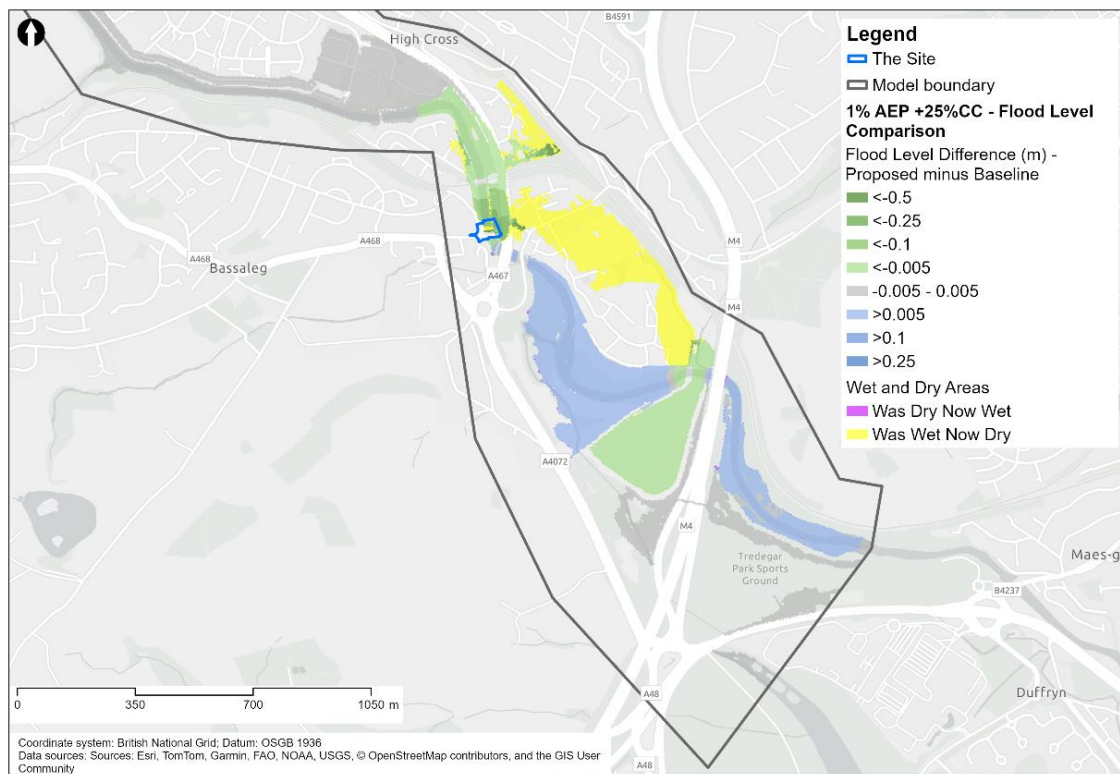


Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

5.2.6 Permanent case – 1% AEP plus 25% allowance for climate change

As per the Baseline case, in the Permanent case flooding has also been observed during the 1% AEP plus 25% allowance for climate change event (See Section 5.2.2). However, from a comparison of flood levels between the baseline and permanent cases (See Figure 5.6), flood levels during this event are depicted to decrease in residential (highly vulnerable) areas along Forge Mews in the order of approximately up to 0.42m. In this event, residential areas to the east of River Ebbw, which are shown to flood during the Baseline case are now shown to be outside the extent of flooding during the Permanent case.

Figure 5.6: Comparison of Permanent and Baseline water levels for the 1% AEP plus 25% allowance for climate change event (in m)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

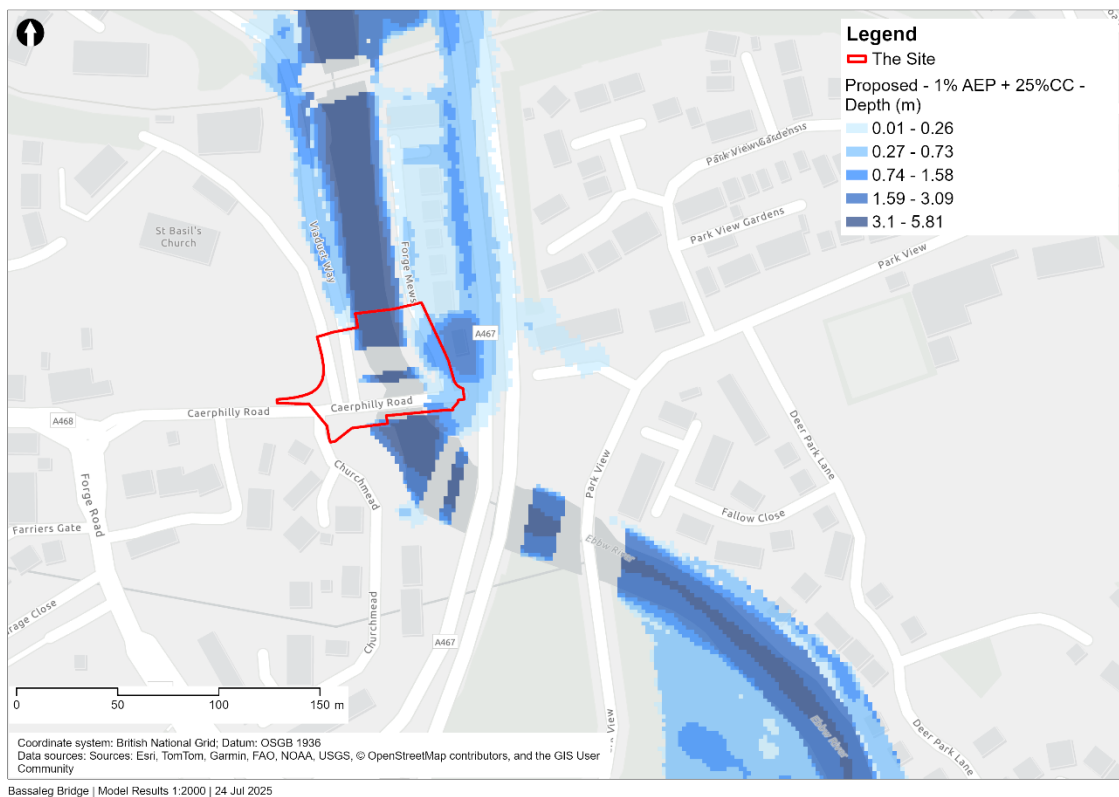
Generally, little to no increase in flooding (levels and extent) is predicted within, upstream and immediately downstream of the Site. Further downstream there is an increase in flood levels shown but this is largely limited to areas of open spaces (water compatible areas) along the River Ebbw, with the exception of an area adjacent to Fallow Close and Deer Park Lane (on the river side) where an increase in flood level of up to 0.03m is predicted. However as discussed in Section 5.2.5, the development in this area was constructed on a raised plateau, which is higher than the predicted flood level during the 1% AEP flood event plus 25% allowance for climate change (by approximately 0.3m to 0.6m), and therefore there is no change in flood risk at this location predicted.

The vast majority of areas depicting an increase in flood levels are shown to flood during the Baseline case (Figure 5.7).

A comparison of the flood hazard maps for the baseline and permanent cases during the 1% AEP plus 25% allowance for climate change event (See Appendix B and B.2) shows a decrease in flood hazard rating in areas upstream of the proposed bridge and the eastern section of the Site, particularly along Forge Mews and Viaduct Way. A decrease in flood hazard rating is also shown in residential areas to the east of River Ebbw. In areas where an increase in flood level is indicated in the Permanent case, it is noted that the overall flood hazard in these areas remains unchanged from the Baseline case.

The flood depths of up to 1.4m and flow velocities of up to 2.7m/s are predicted at the Site during the 1% AEP + 25% allowance for climate change event (See Figure 5.7 and Appendix B.6).

Figure 5.7: Permanent (proposed) case during the 1% AEP plus 25% allowance for climate change event – Depths (in m)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

5.2.7 Permanent case – 0.1% AEP plus 25% allowance for climate change

As per the Baseline case, flooding is observed during the 0.1% AEP plus 25% allowance for climate change event (See Section 5.2.3). However, from a comparison of flood levels during the Baseline case and Permanent case (see Figure 5.8), flood levels during this event are depicted to decrease in residential (highly vulnerable) areas to the east of River Ebbw in the order of 0.15m approximately. Some residential areas along Churchmead and to the east of River Ebbw shown to flood during the Baseline case are to be flood free during the Permanent case.

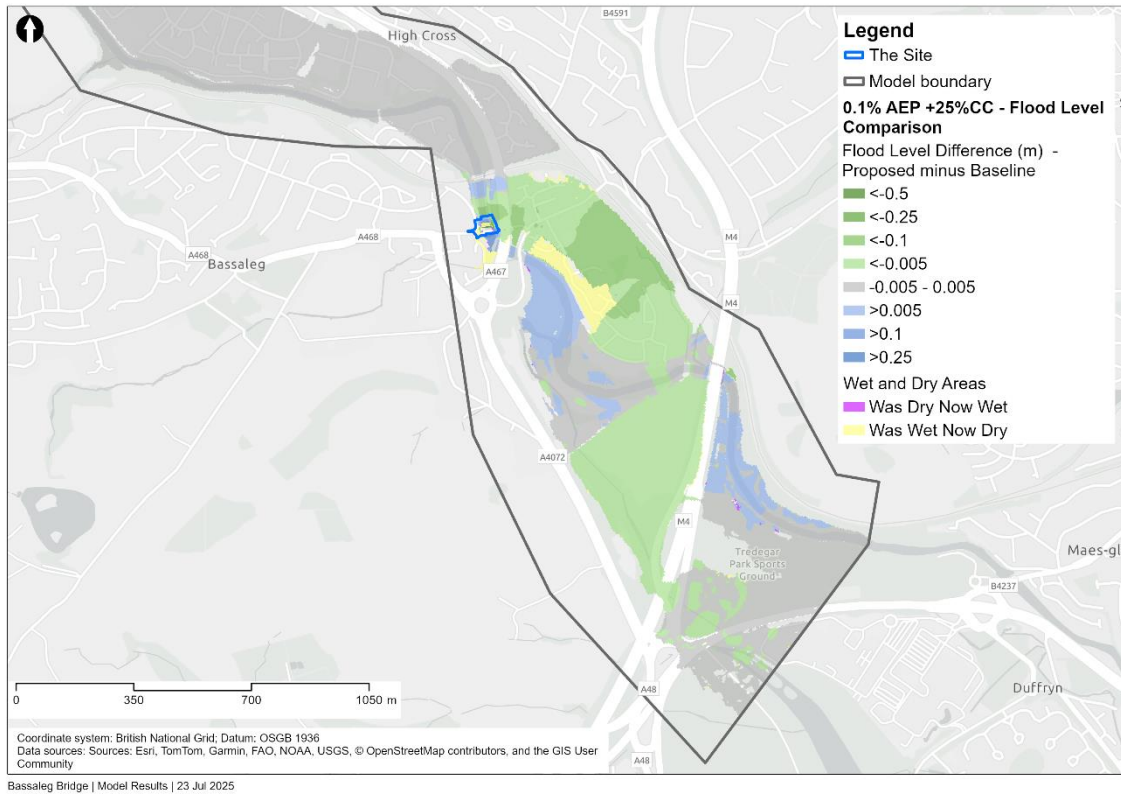
Increased flooding is predicted in some areas within, upstream and immediately downstream of the Site. An increase in flood level is shown along Viaduct Way and Forge Mews, with increased flood levels in residential areas on Forge Mews predicted in the order of approximately 0.09m. This area is shown to flood during the Baseline case to a depth of up to 1.2m during the 0.1% AEP plus 25% allowance for climate change event. This increase is limited to the 0.1% plus 25% allowance for climate change flood event.

Small areas adjacent (on the river side) to the old bridge shown to be flood free during the Baseline case are shown to flood during the Permanent case.

Further downstream from the Site, an increase in flood levels is shown, however this is largely limited to areas of open spaces (water compatible areas) along the River Ebbw, with the exception of an area adjacent to Fallow Close and Deer Park Lane (on the river side) where an increase in flood level of approximately 0.024m is predicted. Generally, all areas depicting an increase in flood levels are shown to flood during the Baseline case. The residential areas at

Fallow Close and Deer Park Lane were constructed on a development plateau. The plateau is higher than the predicted flood level for 0.1% AEP flood event plus 25% allowance of climate change of by approximately 0.2m to 0.4m at this location. As such, the residential areas are not predicted to flood during the 0.1% AEP flood event plus 25% allowance of climate change.

Figure 5.8: Comparison of Permanent and Baseline water levels for the 0.1% AEP plus 25% allowance for climate change event (levels in m)

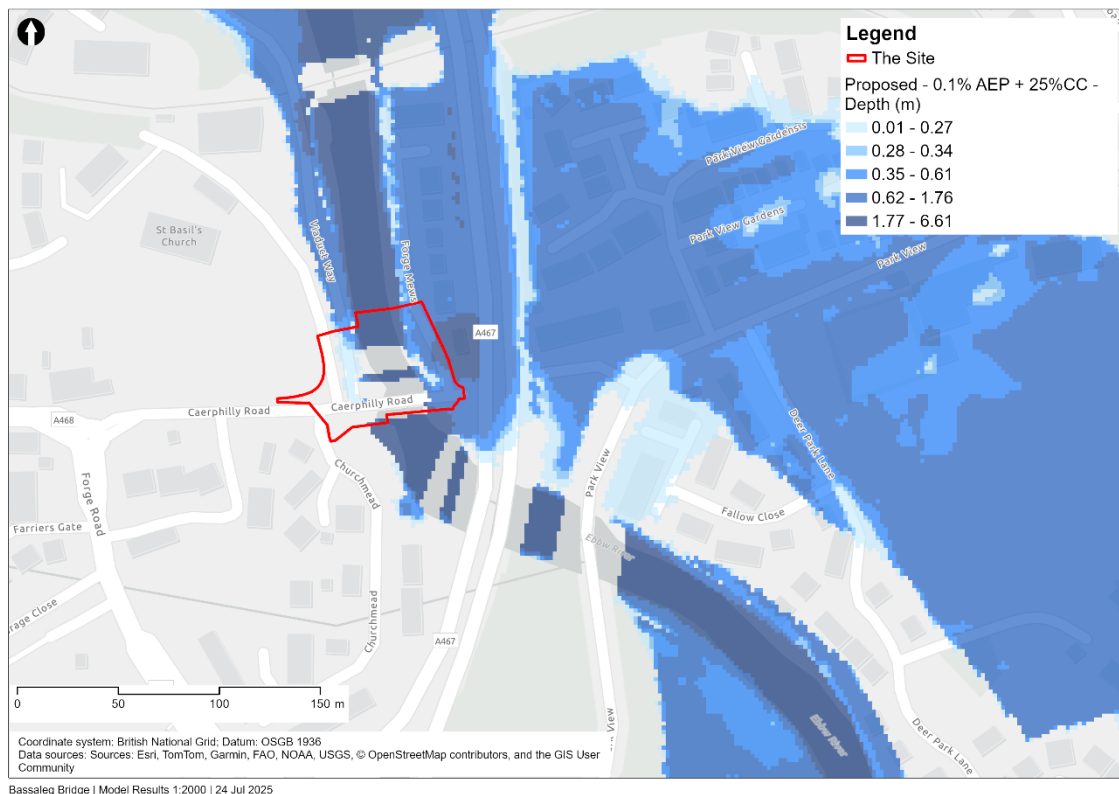


Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

A comparison of the flood hazard maps for the baseline and permanent case during the 0.1% AEP plus 25% allowance for climate change event (see Appendix B.3 and B.4) shows a general decrease in flood hazard rating in residential areas to the east of River Ebbw, the Churchmead area and the immediate right bank adjacent to the proposed development. With the exception of the residential area on Forge Mews where an increase in hazard rating is predicted.

The flood depths and flow velocities within the Site are up to 2.2m and 5.8m/s respectively during the 0.1% AEP plus 25% allowance for climate change event (See Figure 5.9 and Appendix B.8).

Figure 5.9: Permanent (proposed) case during the 0.1% AEP plus 25% allowance for climate change event – Depths (in m)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

5.2.8 Permanent case – 0.1% AEP plus 70% allowance for climate change

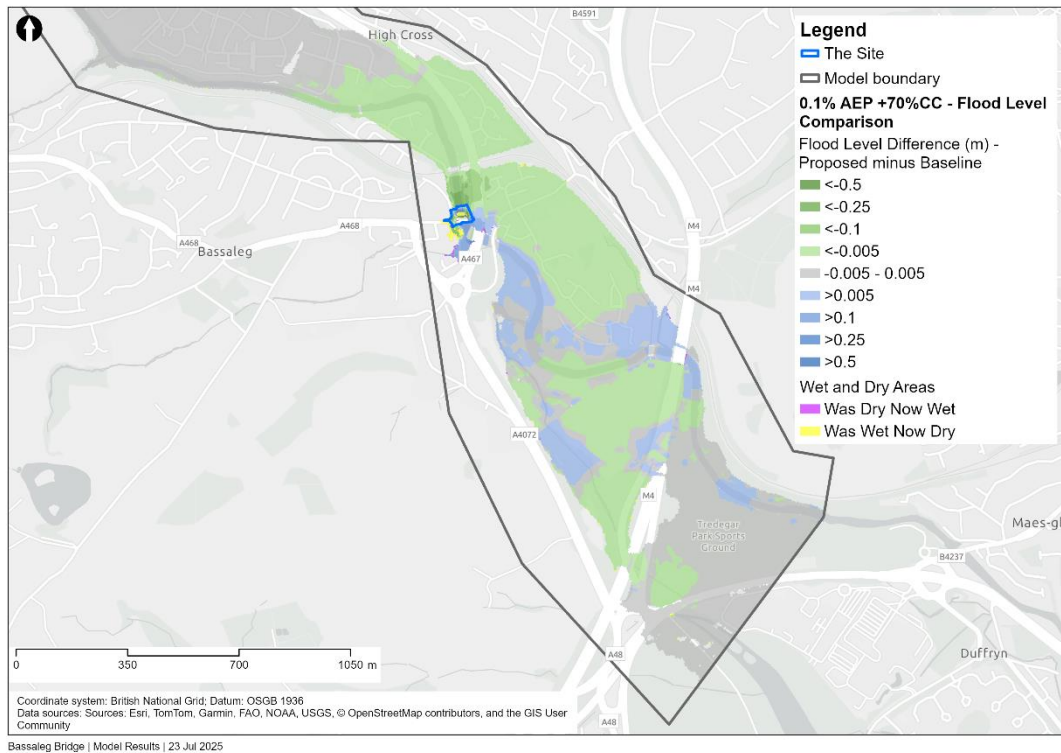
As per the Baseline case, flooding is observed during the 0.1% AEP plus 70% allowance for climate change flood event (see Section 5.2.4). However, from a comparison of flood levels between the baseline and permanent cases (see Figure 5.10), flood levels during this event are depicted to decrease in residential areas upstream of the Site and to the east of River Ebbw in the order of up to 0.4m approximately.

An increase in flood level is predicted within and immediately downstream of the Site, with the A467 and some residential areas along Churchmead predicted to be at an increased risk in the order of approximately 0.15m to 0.4m. While some new areas near Churchmead are shown to flood during the Permanent case, the overall flood extent within Churchmead area is generally observed to decrease compared to the Baseline case.

An area with increased flood levels is predicted downstream of the Park View bridge, largely limited to open spaces (water compatible) along the River Ebbw, with the exception of an area adjacent to Fallow Close and Deer Park Lane where an increase in flood level of approximately 0.012m is predicted. The residential areas of Fallow Close and Deer Park Lane were constructed on a raised development plateau. The plateau is higher than the predicted flood level for 0.1% AEP flood event plus 70% allowance of climate change by approximately 0.1m to 0.3m at this location. As such, these residential areas are not predicted to flood during the 0.1% AEP flood event plus 70% allowance of climate change.

The flood depths and flow velocities within the Site are up to 2.3m and 8.6m/s respectively during the 0.1% AEP plus 70% allowance for climate change event (See Figure 5.11 and Appendix B.10).

Figure 5.10: Comparison of Permanent and Baseline water levels for the 0.1% AEP plus 70% allowance for climate change event (levels in m)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025

Legend

- The Site
- Proposed - 0.1% AEP + 70%CC - Depth (m)
 - 0.01 - 0.66
 - 0.67 - 0.93
 - 0.94 - 1.59
 - 1.6 - 3.22
 - 3.23 - 7.23

Coordinate system: British National Grid; Datum: OSGB 1936
 Data sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Bassaleg Bridge | Model Results 1:2000 | 24 Jul 2025

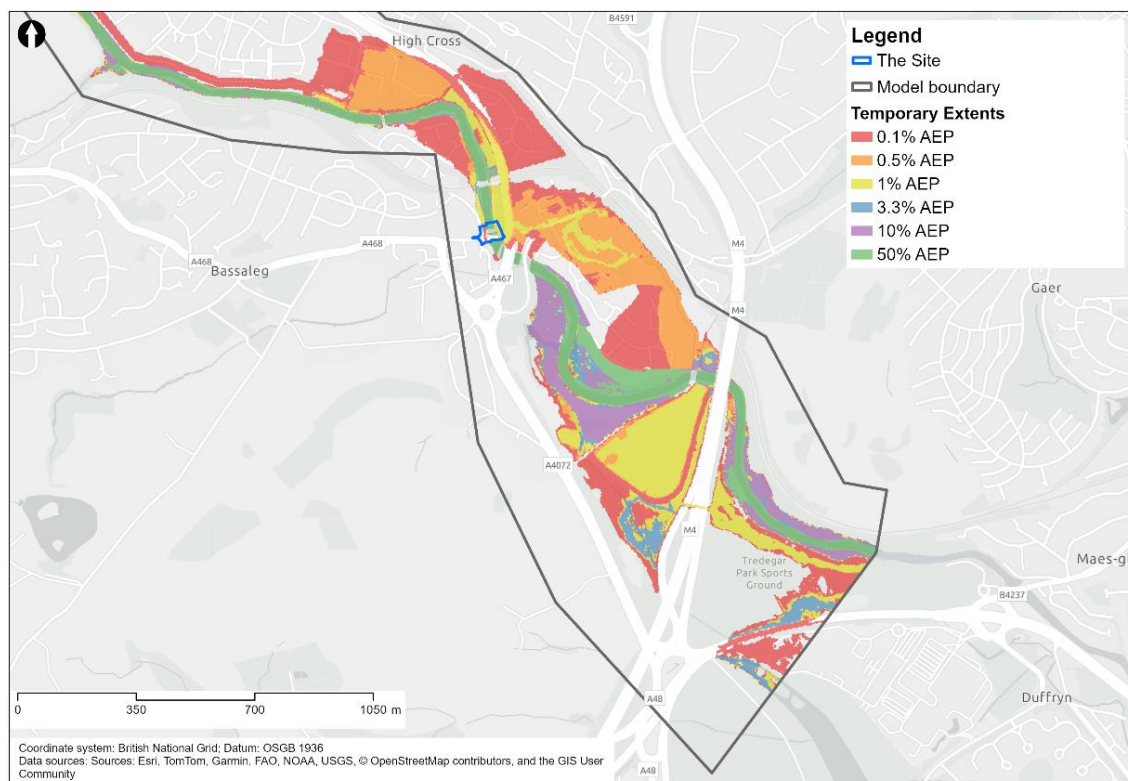
5.2.9 Temporary case – present-day

A comparison of water levels between the baseline and temporary cases indicates that in generally there is little to no increase in flood levels from the 50% AEP to the 3.3% AEP present-day events (See Appendix B.17 to B.19).

While an reduction in flood level is predicted in the open spaces downstream of the Site during the 1% AEP present-day event, flood levels are shown to increase within, upstream and immediately downstream of the Site, as well as within the wider area (See Appendix B.20). The residential area to the east of the Site is particularly shown to be affected, with the flood extent increasing post construction of new bridge and when the old bridge is still in place (i.e. during the temporary case).

An increase in flood levels is shown within, upstream and downstream of the Site during the 0.5% AEP event (See Appendix B.21). Residential, industrial uses and transport infrastructure are predicted to be affected by the increase in flood levels. Similar is the case for the 0.1% AEP event, with the exception of further increase in flood extents downstream and to the east of River Ebbw affecting a greater number of areas (See Appendix B.22).

Figure 5.12: Temporary case flood extents from the 50% AEP up to the 0.1% AEP present-day events



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

5.2.10 Results summary

Table 5.2 presents a summary of the detailed flood modelling undertaken.

As evident from Table 5.2, the Site and surrounding areas are shown to be at risk of fluvial flooding. The Permanent case results in a change to flood risk impact (when compared to the Baseline case). Up to the 0.1% AEP plus 25% climate change allowance event, a general reduction in flood risk (i.e. betterment) is predicted – particularly in highly vulnerable residential areas. Where increases in flooding are observed, they are largely confined to water-compatible areas adjacent to the river. An exception occurs during the 0.1% AEP plus 25% climate change flood event, where a localised flood depth increase of 0.09m (i.e. 8% increase compared to the Baseline case) is predicted to affect a residential area on Forge Mews. This area is shown to flood during the Baseline case, and this change is limited to the 0.1% plus 25% allowance for climate change flood event.

There is a residual risk of flooding to some residential areas along Churchmead predicted during the 0.1% AEP plus 70% climate change flood event.

More significant changes are expected in the Temporary case, particularly during the period when both the old and new bridges are in place, which is only anticipated to be for around 1 year. However, these impacts are generally limited to higher magnitude flood events, such as the 1% AEP event and beyond.

Table 5.2: Summary of detailed flood modelling results

Scenario		Baseline case	Permanent case	Temporary case
Present day (2025)	50% AEP	No flooding shown; river remains in bank area of the Site	Little to no change increase in flood levels and extents is predicted. Flood levels generally shown to decrease, with previously flooded areas now shown to be flood-free during the Permanent case.	Minimal change in flood levels compared to the baseline are shown, except for a slight increase in flood levels upstream of the old bridge during the 50% AEP event, but mostly contained within the River Ebbw channel.
	10% AEP	Site not at risk		
	3.3% AEP	Flooding shown in eastern side of the Site and Viaduct Way.		
	1% AEP	Flooding shown at Viaduct Way and Forge Mews; flood depths ~0.1–2m; flood velocities up to 3 m/s.	Little to no change increase in flood levels and extents is predicted, except for a localised increase in flood levels (~0.008m) in Tredegar Park Bowl predicted during the 1% AEP event.	An improvement in flood levels in Tredegar Park Bowl is shown, however, increased flooding within, upstream, and downstream of the Site is also predicted. Forge Mews residential area affected due to increased flood extent.
	0.1% AEP	Flooding shown to expand to Viaduct Way, Caerphilly Road, Forge Mews; depths up to 2.3m	~0.15m decrease flood levels in residential areas (Forge Mews, Churchmead and the area to the east of the River Ebbw). The increase in flood levels predicted within and downstream of the Site is generally confined to water compatible areas adjacent to the river.	Greater flood extents downstream and east of River Ebbw shown. Affects a larger number of residential and public areas.
Future (2080s)	1% AEP plus 25% + CC	Flooding shown at Viaduct Way & Forge Mews in the Site; depths ~0.1–2m; flood velocities up to 3 m/s (Forge Mews).	A general decrease in flood levels is predicted in highly vulnerable (residential) areas (up to 0.42m). As per above the increase in flood levels predicted within and downstream of the Site.	N /A
	0.1% AEP plus 25% + CC	Flooding shown at Viaduct Way, Caerphilly Road, Forge Mews in the Site; depths up to 2.3m; velocities up to 4.6 m/s	As per above in terms of betterment. A small increase in flood levels (up to 0.09m) is shown in parts of the Site, which is limited to this event. As per above in terms of increases shown downstream of the Site	
	0.1% AEP plus 70% + CC	Intensified flooding shown in the Site; depths up to 2.7m; velocities up to 9m/s.	Up to 0.4m decrease upstream; 0.15–0.4m increase at Churchmead	

Note: 'CC' stands for 'Climate Change' allowance.

5.3 Access and Egress

As illustrated in Figure 5.9, the 0.1% AEP plus 25% allowance for climate change event results in flooding of roads located to the north and east of the Site. As mentioned in Section 4.2, parts of the Site as well as roads to its north and south lie within NRW's flood alert and flood warning

areas for the River Ebbw (NRW, 2025e). The preferred access, egress and flood evacuation route would be away from the source of the risk, in this case River Ebbw. Therefore, it is recommended that the proposed route should be directed westward of the Site via Caerphilly Road (A468), away from the area of predicted flood risk.

6 Acceptability of flood consequences

As mentioned in Section 3.8, TAN 15 states that whether a development should proceed depends on whether the consequences of flooding can be safely managed, including its effects on flood risk elsewhere. TAN 15 sets out the key requirements that must be met to demonstrate that development is appropriate for its location, which are detailed within this section.

In order to meet these conditions, where applicable this section also identifies potential mitigation measures necessary to reduce the predicted flooding consequences to an acceptable level in line with current TAN 15 guidance.

6.1 Frequency thresholds

Table 6.1 outlines the flood events that proposed developments (both new and redevelopment projects) must be designed to withstand without flooding (i.e. the events up to and including which the developments must be ‘flood-free’). These requirements apply across all vulnerability categories, as specified in Table 3.3. For redevelopment TAN15 states the thresholds may be applied with “more flexibility”.

Table 6.1: Flood events in which development must be flood-free

Vulnerability categories		Flood event types	
		Rivers	Sea
Highly vulnerable development	Emergency services (command centres and hubs)	0.1% plus climate change	0.1% plus climate change
	All other types	1% plus climate change	0.5% plus climate change
Less vulnerable development		1% plus climate change	0.5% plus climate change
Water compatible development that may be occupied by people			
Note: ‘Plus climate change’ refers to the % allowance adopted for this FCA, i.e. 25% (See Section 3.1.3).			

Source: Adapted from Figure 5 of TAN 15 (2025).

As the proposed development is classed as ‘less vulnerable redevelopment’ (see Section 3.1.2), and is at risk of fluvial flooding (see Section 5), the required design standard for the Site is to be flood-free during the 1% AEP fluvial event, plus an allowance for climate change over the lifetime of development.

As discussed in Section 5.2.6, the proposed development (i.e. the new bridge) is generally shown to remain flood-free during the 1% AEP event with 25% allowance for climate change. The exception to this is the connecting roads, where it is not practicable to raise levels above existing. Noting also that these roads are also shown to be flooded during the Baseline case for the 1% AEP event with 25% allowance for climate change.

As per the above reasonings, the proposals meet the ‘1% AEP fluvial event plus climate change allowance’ frequency threshold.

6.2 Tolerable conditions

The flood-free thresholds outlined in Table 6.1 relate to very serious but not the most extreme flood events (except for the thresholds for developments for emergency services). During

extreme flood events, it is recognised that it may not be possible to keep all development flood-free. Section 11.9 of TAN 15 states that in these circumstances, it is imperative that flooding does not endanger life. Therefore, it must be demonstrated that conditions within the development during extreme events will be tolerable.

Table 6.2 indicates the tolerable flood depth and velocity conditions for different types of development, when assessed against the 0.1% AEP flood event plus 25% allowance for climate change.

Table 6.2: Tolerable conditions in an extreme flood event

Types of new development	Maximum depth of flooding (mm)	Maximum velocity of flood waters (metres/sec)
Highly vulnerable development	600	0.15
Less vulnerable development	600	0.3
Infrastructure associated with highly vulnerable development e.g. car parks, access, paths and roads		
Water compatible development (limited to those built elements of development that may be occupied by people)		

Source: Adapted from Figure 6 of TAN 15 (2025).

Section 11.11 of TAN 15 states that mitigation and flood resilience measures are not sufficient justification to permit a development if the tolerable conditions are exceeded during the 0.1% AEP flood event with an allowance for climate change. The guidance further states that high velocities and/or depths of floodwater pose a potential risk to life, may cause structural damage to buildings, and could impact on human health and wellbeing. However, Section 11.12 of TAN 15 states that each site must be considered individually, and a judgement taken in the context of the circumstances which could prevail at that site.

Following a review of the modelling data (see Section 5.2.7) and proposed design drawings (see Appendix A), majority of the proposed development falls within tolerable conditions set out by TAN 15 in Table 6.2. However, on the eastern side of the River Ebbw, where the bridge connects into the existing infrastructure, the predicted flood depths and velocities in parts of this area are shown to exceed the tolerable conditions. As this location serves as the tie-in point between the development and the existing road infrastructure, it is not considered practicable to raise levels here to meet the TAN 15 recommendations.

A comparison of the flood hazard maps for the baseline and permanent (proposed) case during the 0.1% AEP plus 25% allowance for climate change event (see Appendix B.3 and B.4) shows a generally either no change or a decrease in flood hazard rating within the Site.

As per the above reasonings, the proposals generally meet tolerable conditions in an extreme flood with a few exceptions that are due to circumstances which prevail at that Site.

6.3 Acceptability Criteria

The development has been assessed against the Acceptability Criteria as outlined in Section 11 of TAN 15, and summary is presented in Table 6.3.

Table 6.3: Assessment of Acceptability Criteria

TAN-15 Acceptability Criteria	Comments	Consistent with / met criteria
No increase in flooding elsewhere	As discussed in Section 5, the development results in a change to flood risk impacts. It is expected to generally result in a reduction in flood risk, especially in vulnerable residential areas, up to the 0.1% Annual Exceedance Probability (AEP) event with a 25% climate change allowance. Any increases in flooding are mostly limited to water-compatible areas near the river. An exception to this is a localised increase in flood depth of 0.09m (8% increase on the Baseline case), affecting the residential area on Forge Mews during the 0.1% AEP event with a 25% climate change allowance. However, this change is limited to the 0.1% plus 25% allowance for climate change flood event. In the short term (up to 1 year), more noticeable changes may occur while both old and new bridges are present, however, this is mainly limited to the higher magnitude flood events like the 1% AEP and above. The assessment indicates that in the long term, in most cases, the proposed development is not expected to increase flooding elsewhere, except in water-compatible areas. General reductions in flood levels are anticipated in residential areas. Therefore, the impacts are considered to be broadly consistent with the acceptability criteria outlined in TAN15.	Consistent
Occupiers aware of flood risk	Given the public use of the Site, it will be difficult to ensure users are aware of the flood risk or take appropriate action during an actual flood event or in response to a flood warning or alert. To mitigate this, the site operator could: • Erect prominent notices to make site users aware of the risks and potential consequences of flooding, and the appropriate actions to be taken in response to a flood warning or alert. • Close the bridge, such that it is not in use when a flood alert or warning is in operation. NRW's flood alert and flood warning datasets indicate that parts of the Site benefit from NRW flood alerts for Rivers Ebbw, Sirhowy and Lwyd, and flood warnings for the River Ebbw.	Met
Escape / evacuation routes present	As detailed in Section 5.2.10, the preferred flood evacuation route would be away from the source of the risk, in this case River Ebbw. Therefore, it is recommended that the proposed escape and evacuation route should be to the west of the Site via Caerphilly Road (A468), away from the area of flood risk.	Met
Flood emergency plans and procedures are agreed and in place	Details of residual flood risk posed to the Site (existing and proposed) and the actions to be taken by operatives in the event of a forecast or actual flood, should be clearly set out in a Flood Management Plan. During proposed construction works, the appointed contractor will need to prepare and implement a Construction Environmental Management Plan (CEMP), which should include a list of recommended flood risk and response actions.	Met
Flood-resistant and resilient design	As discussed in Section 2.5, a flood bund / wall will be constructed as a flood mitigation measure to protect developments downstream of the Site during the 0.1% AEP plus 25% allowance for climate change event. The flood bund is to be maintained by the council.	Met
Acceptable consequences for the type of use	Detailed in Sections 6.1 and 6.2.	Consistent

Source: Collated by Mott MacDonald Ltd. 2025.

6.4 Surface water management

Existing surface water drainage arrangements around the Site comprise of surface water channels and gullies. These channels and gullies either drain into the watercourse (i.e. River Ebbw), the combined sewer network or the surface water network.

Details of proposed approach to manage surface water within the Site (and associated with the proposed development) without causing an increase in surface water flood risk are presented within Drainage Strategy Report (Mott MacDonald, 2025b). This will be submitted to the SuDS Approving Body (SAB) for approval.

7 Conclusions and recommendations

7.1 Conclusions

Mott MacDonald Limited has been commissioned by Newport City Council to undertake the detailed design of a new bridge structure to replace the existing 'Old Bassaleg Bridge', which crosses the River Ebbw in Newport, Wales. The 'New Bassaleg Bridge' is to be located immediately upstream of the Old Bassaleg Bridge structure, which will be removed following the construction of the proposed bridge. This FCA has been prepared for the purpose of satisfying the planning requirements for the proposed development in relation to flood risk; namely Planning Policy Wales and Technical Advice Note 15: Development, flooding and coastal erosion (TAN 15).

Reviewed against TAN 15 acceptability criteria, the assessment of flood risk and consequences may be summarised as follows –

- The Site is at high risk of flooding from the River Ebbw, which is considered to be the primary source of flooding to the proposed development.
- The Site is at low risk of flooding from groundwater, surface water and small watercourses.
- The Site is at very low risk of flooding from the sea.
- The Site could be at risk of flooding from water mains, sewers, reservoirs and canals.
- The hydraulic modelling results for the permanent case conclude the following:

Present-day:

- **Up to 0.5% AEP:** Little to no increase in flood levels or extents is predicted. Flood levels generally shown to decrease, with previously flooded areas shown to be flood-free post-development. An exception being a localised increase in flood levels (0.08m) in Tredegar Park Bowl predicted during the 1% AEP event.
- **0.1% AEP:** A general reduction flood levels is predicted in residential areas (e.g. Forge Mews, Churchmead and the area to the east of the River Ebbw) and open spaces downstream in Tredegar Park Bowl. The increase in flood levels is predicted within and downstream of the Site along the River Ebbw, generally confined to open spaces adjacent to the river.

Future:

- **1% AEP + 25% Climate Change Allowance:** A general decrease in flood levels is predicted in residential areas (up to 0.4m). An increase in flood levels is predicted downstream of the Site along River Ebbw, but this is limited to open spaces.
A reduction in hazard rating is predicted within and upstream of the Site particularly along Forge Mews and Viaduct Way. Reduction is also shown in residential areas to the east of River Ebbw.
- **0.1% AEP + 25% Climate Change Allowance:** Similar decrease in flood levels is predicted in residential areas during this event to the east of the Site. A small increase in flood levels (up to 0.09m) is shown on Forge Mews, which is limited to this event. This area is shown to flood during the Baseline case. A increase in flood levels is also predicted downstream of the Site along River Ebbw but this is limited to open spaces.
- Since flood levels and extents are generally predicted to reduced (i.e. betterment) — particularly in residential areas—and areas of increase in flood levels and extents are largely confined to open spaces (and council-owned parkland), the overall flood consequences elsewhere post-development are considered to improve as a result of the development in general terms.

- Based on the hydraulic modelling results, the proposed development (i.e. the new bridge) is generally shown to remain flood-free during the 1% AEP event with climate change allowance. As such, the proposals meet the '1% AEP fluvial event plus climate change allowance' frequency threshold.
- Following a review of the hydraulic modelling data and proposed design drawings, majority of the proposed development falls within tolerable conditions set out by TAN 15. However, at the eastern bank of the River Ebbw – where the bridge connects to the existing infrastructure – the predicted flood depths and velocities exceeds the tolerable conditions. As such, the proposals generally meets the '0.1% AEP fluvial event plus climate change allowance' tolerable conditions with a few exceptions at existing tie-in points (where it is not considered practicable to raise levels).
- There is a residual risk of flooding to some residential areas along Churchmead predicted during the 0.1% AEP plus 70% climate change flood event.

The evidence and assessments contained within this FCA confirm that the proposed development (redevelopment) has either met or is consistent with the acceptability considerations outlined in TAN15.

7.2 Recommendations

To mitigate and manage the consequences of flooding, it is recommended that –

- Details of residual flood risk posed to the Site (existing and proposed) and the actions to be taken by operatives in the event of a forecast or actual flood, should be clearly set out in a Flood Management Plan.
- During proposed construction works, the appointed contractor will need to prepare and implement a Construction Environmental Management Plan (CEMP), which should include a list of recommended flood risk and response actions.
- It is recommended that the proposed escape and evacuation route should be to the west of the site via Caerphilly Road (A468), away from the area of flood warning.

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A. Site Plans

A.1 Existing plan and elevation drawing

A.2 Proposed structural layout

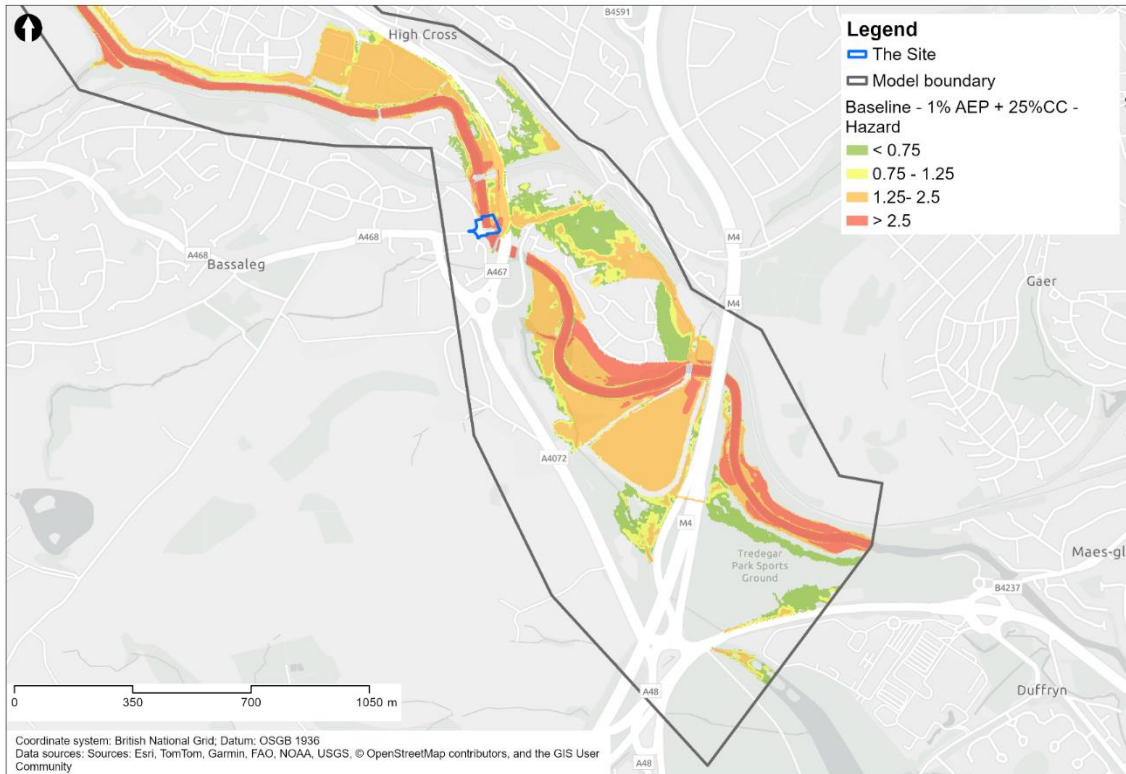
A.3 Proposed elevation drawing

A.4 Proposed section drawing

A.5 Utilities Plan

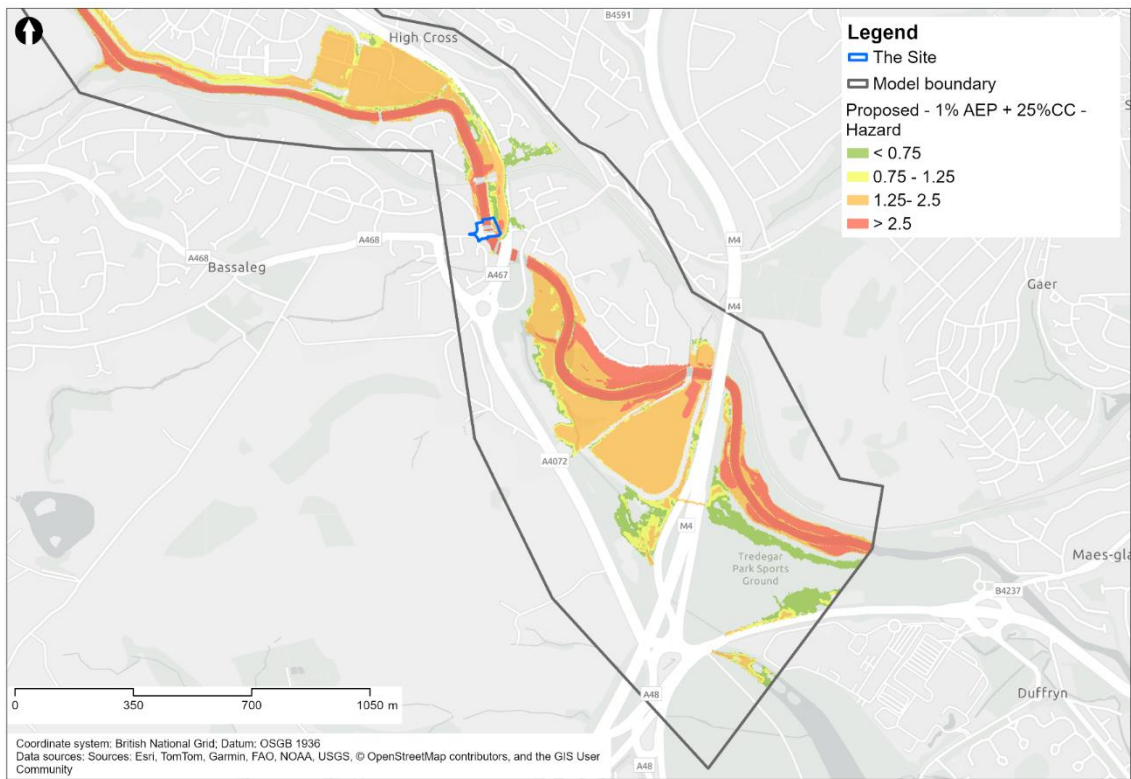
B. Hydraulic modelling results

B.1 Hazard map – Baseline case during the 1% AEP plus 25% allowance for climate change event



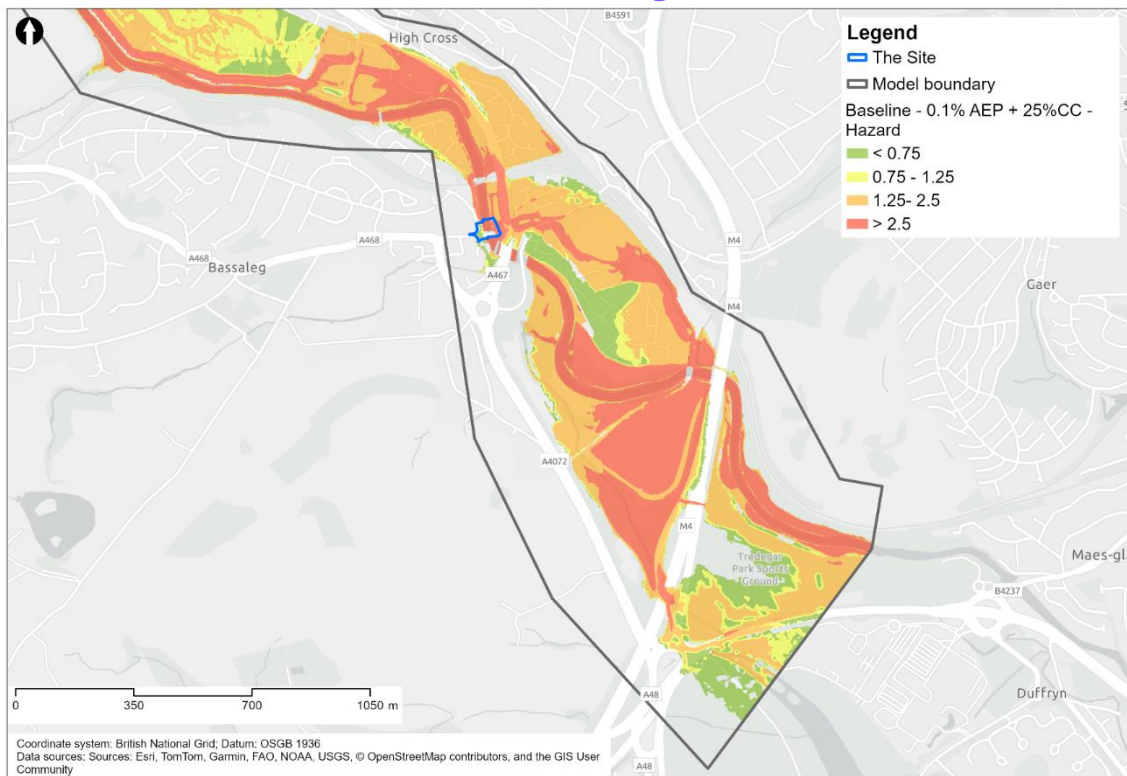
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.2 Hazard map – Permanent (proposed) case during the 1% AEP plus 25% allowance for climate change event



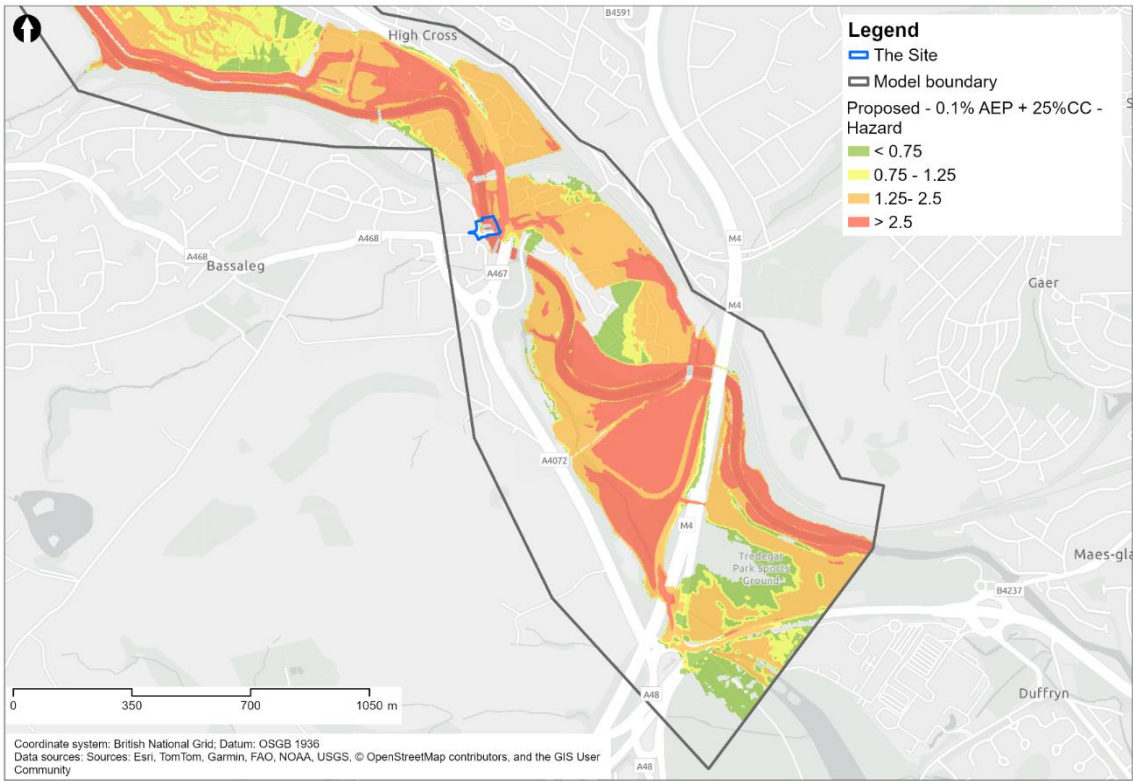
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.3 Hazard map – Baseline case during the 0.1% AEP plus 25% allowance for climate change event



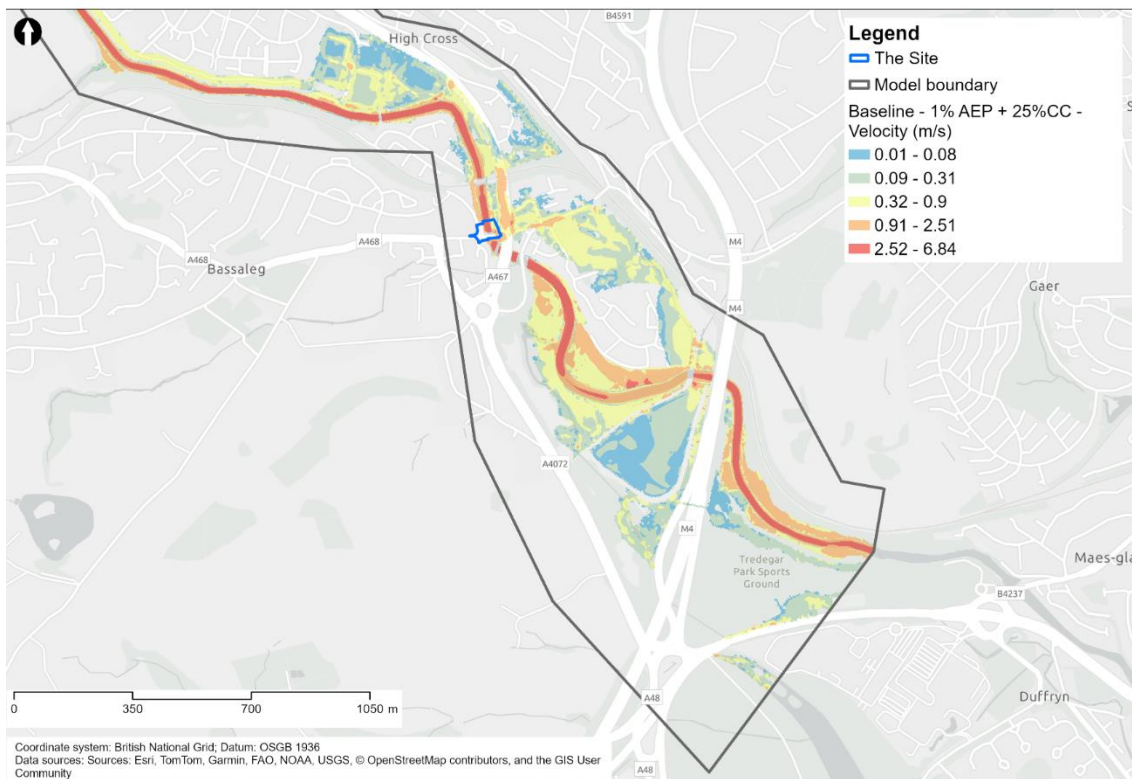
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.4 Hazard map – Permanent (proposed) case during the 0.1% AEP plus 25% allowance for climate change event



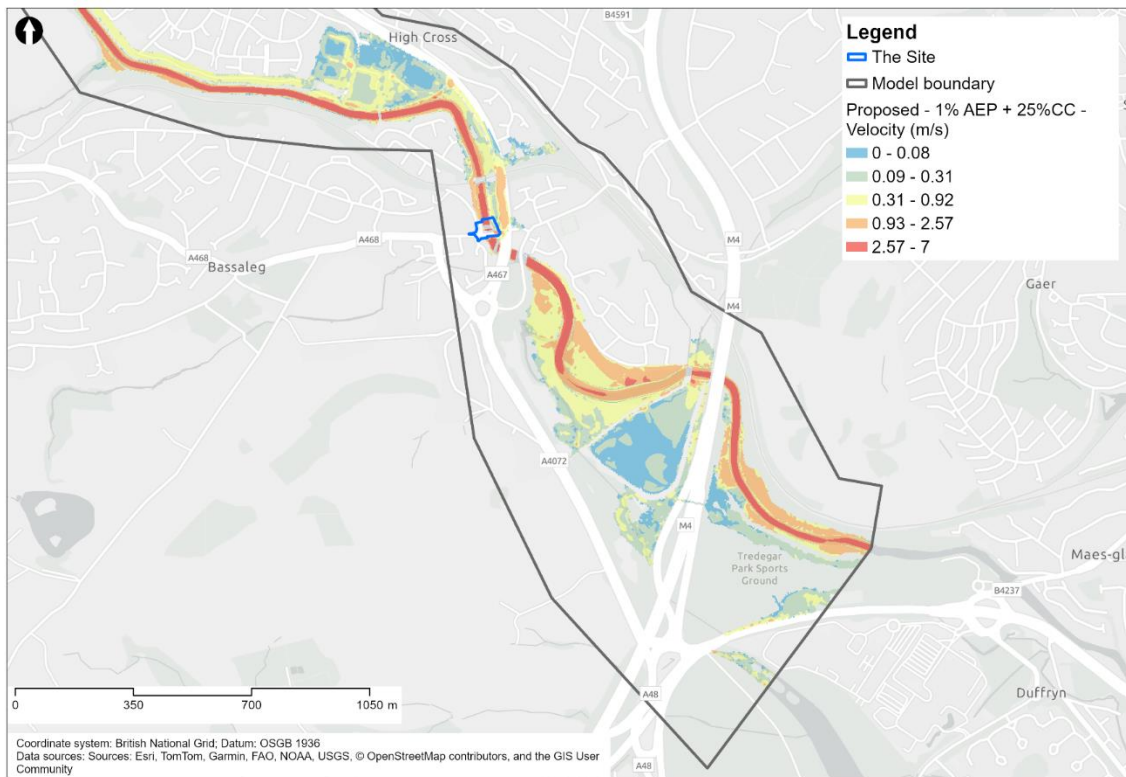
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.5 Velocity map – Baseline case during the 1% AEP plus 25% allowance for climate change event (in m/s)



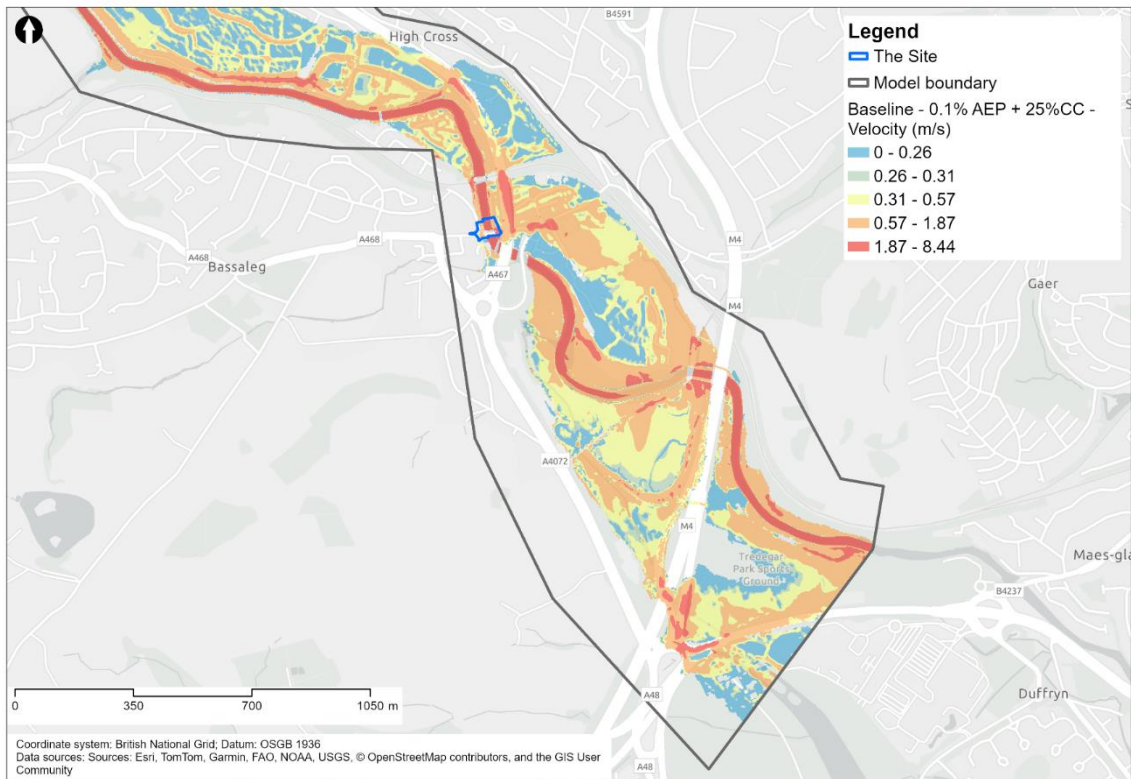
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.6 Velocity map – Permanent (proposed) case during the 1% AEP plus 25% allowance for climate change event (in m/s)



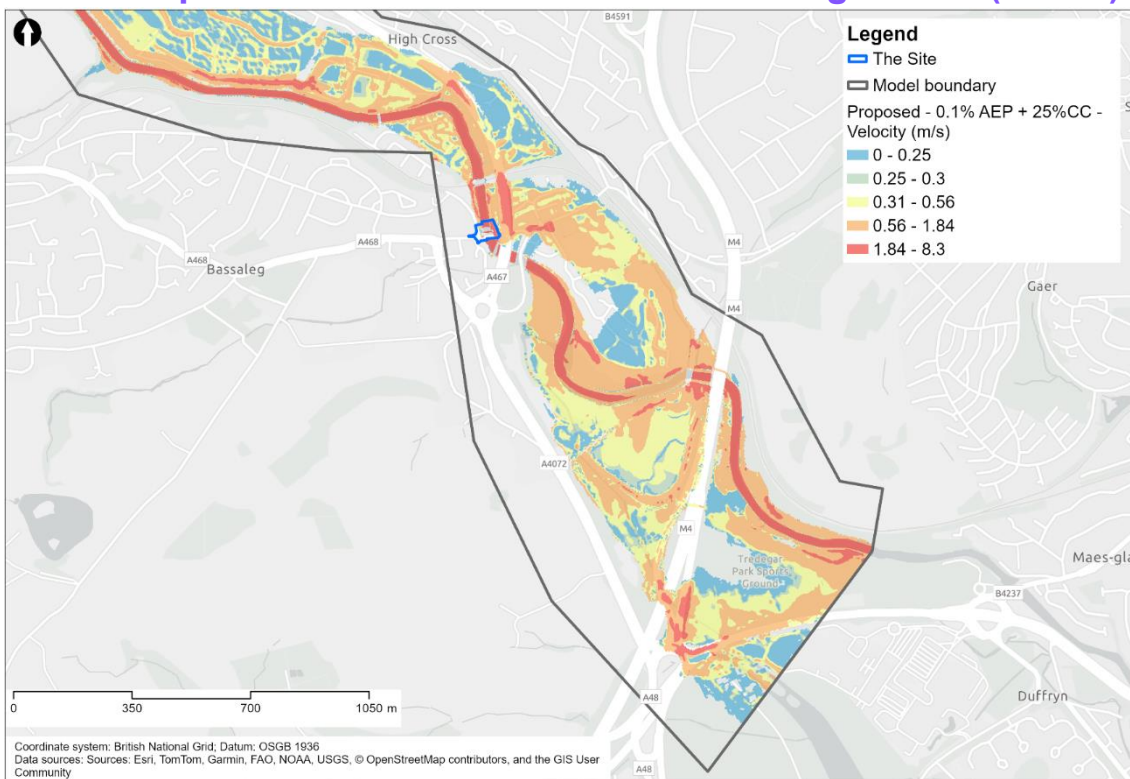
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.7 Velocity map – Baseline case during the 0.1% AEP plus 25% allowance for climate change event (in m/s)



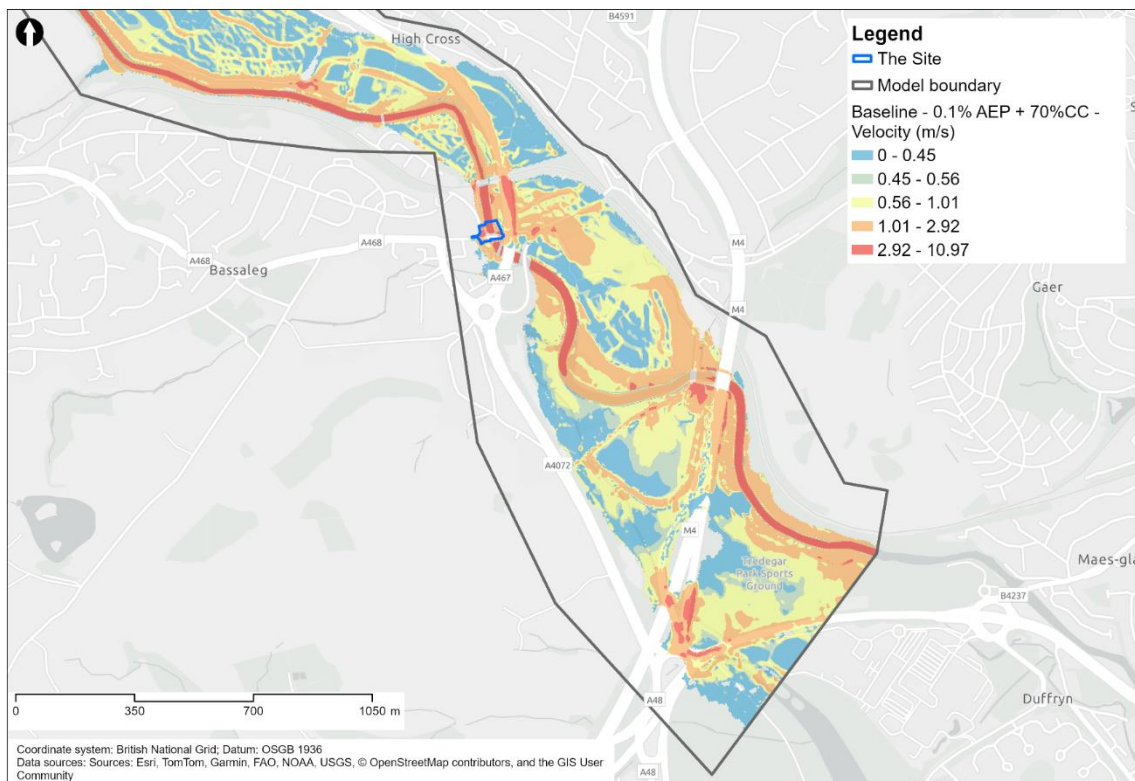
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.8 Velocity map – Permanent (proposed) during the 0.1% AEP plus 25% allowance for climate change event (in m/s)



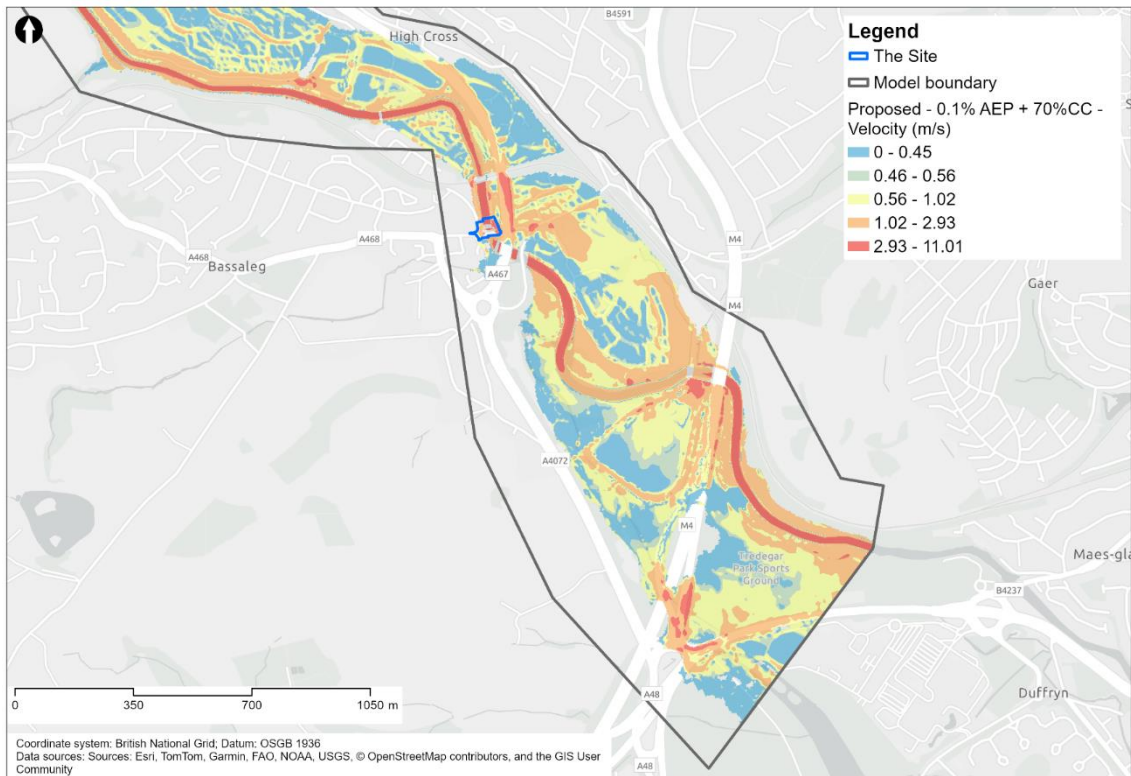
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.9 Velocity map – Baseline case during the 0.1% AEP plus 70% allowance for climate change event (in m/s)



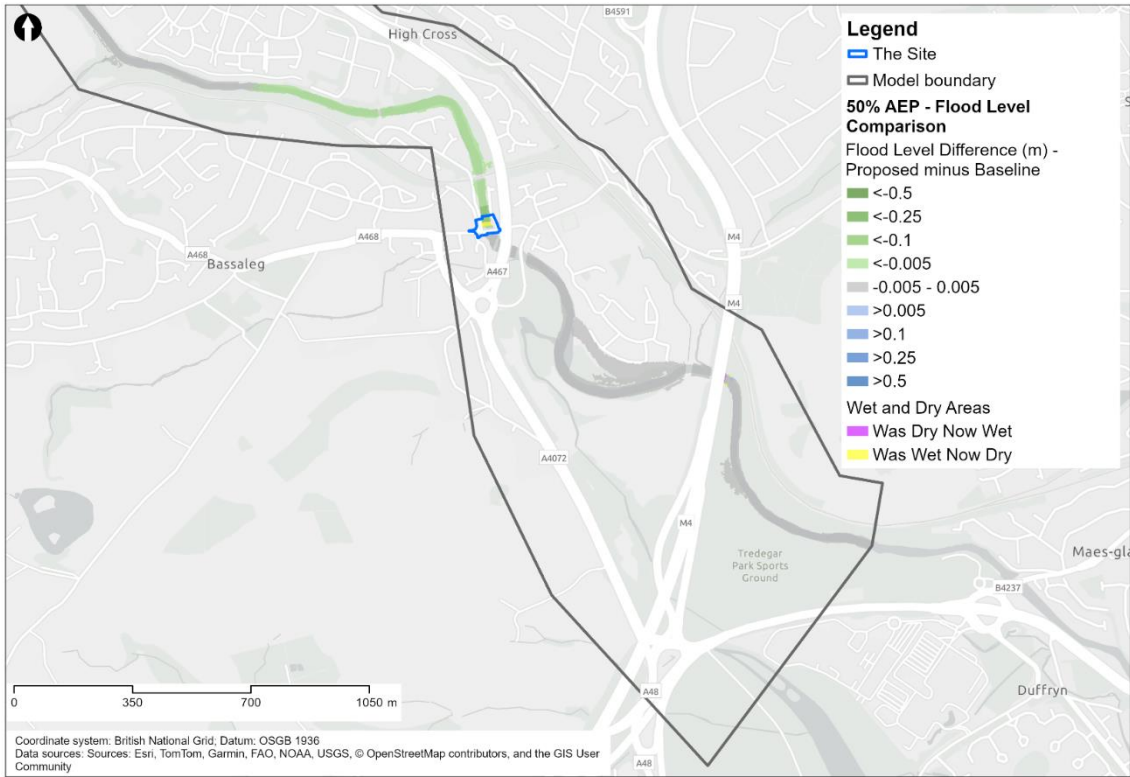
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.10 Velocity map – Permanent (proposed) case during the 0.1% AEP plus 70% allowance for climate change event (in m/s)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

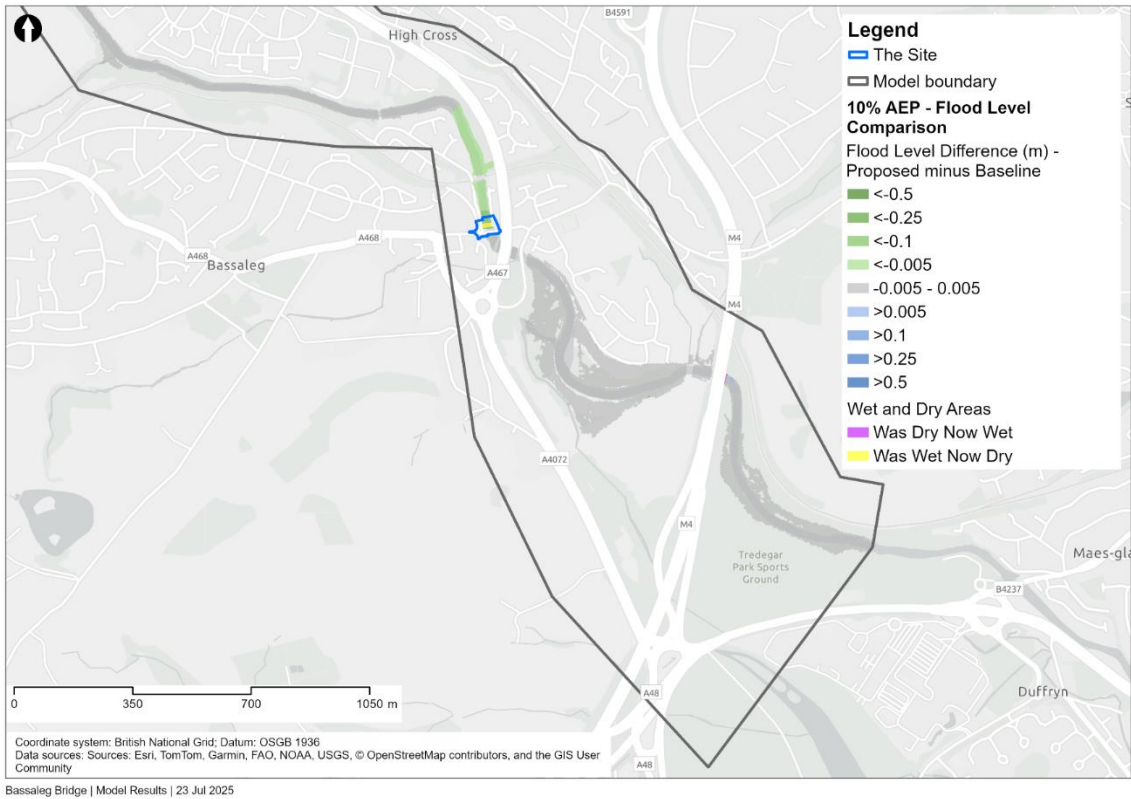
B.11 Comparison of water levels before and after development
for the 50% AEP event (levels in m)



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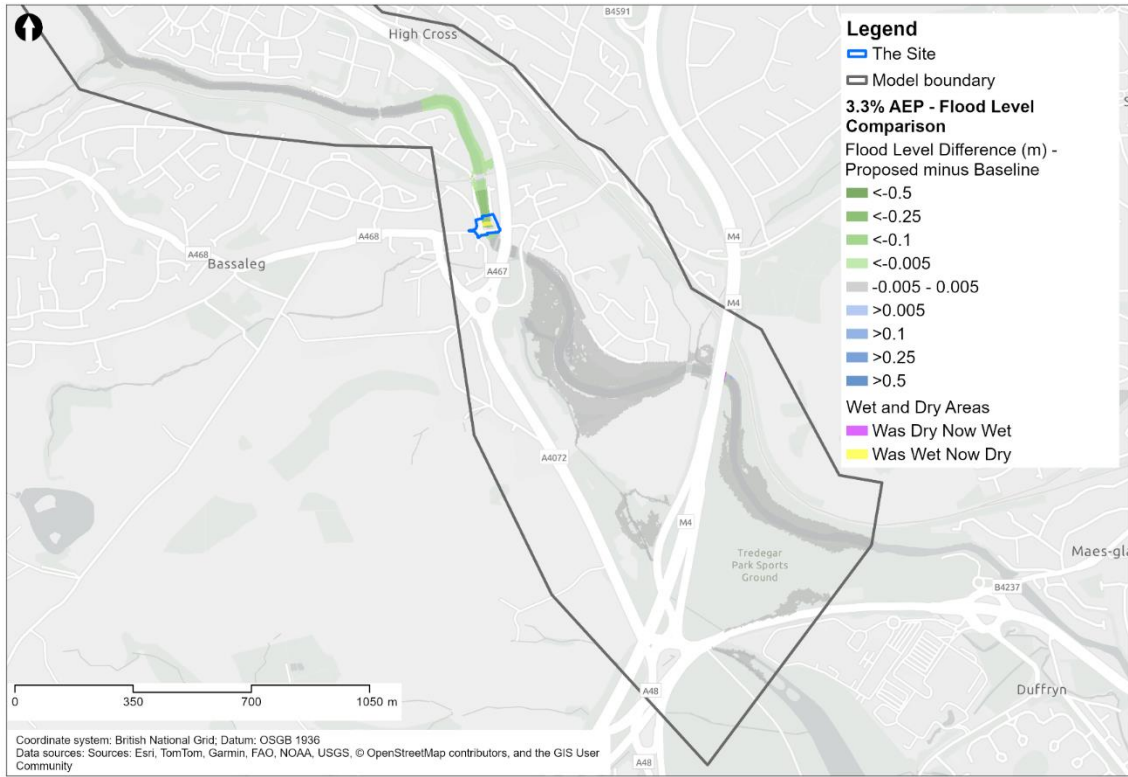
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.12 Comparison of water levels before and after development
for the 10% AEP event (levels in m)



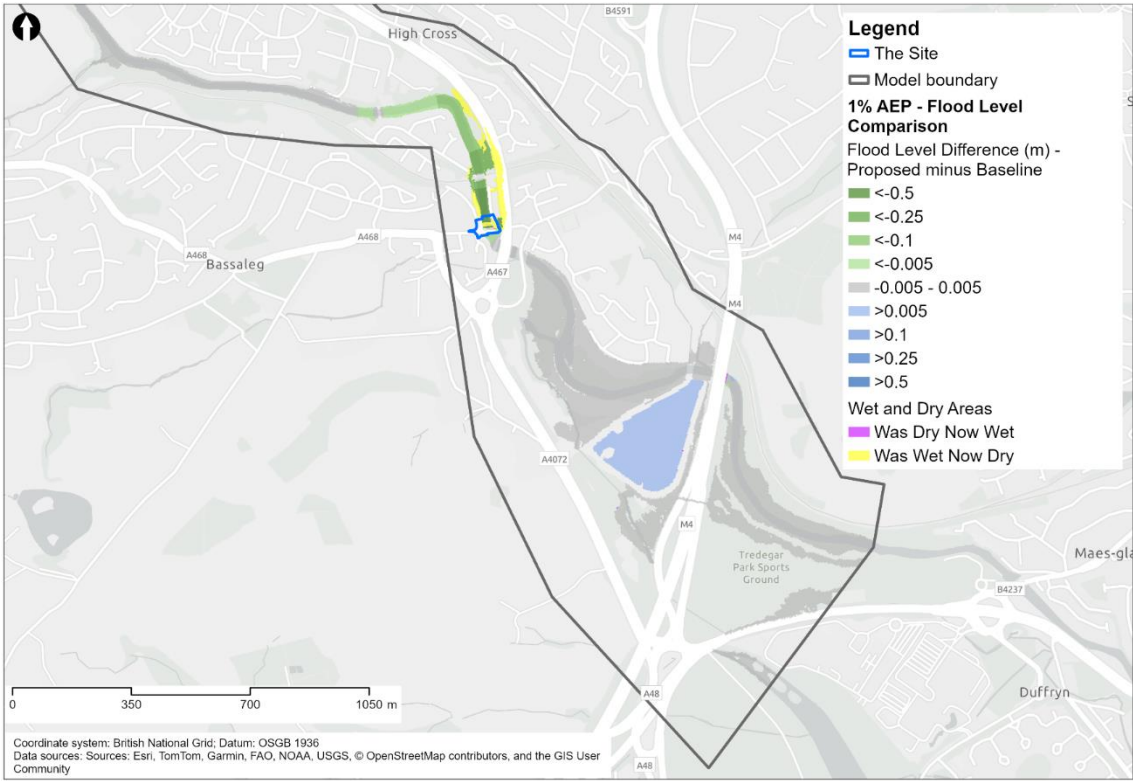
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.13 Comparison of water levels before and after development
for the 3.3% AEP event (levels in m)



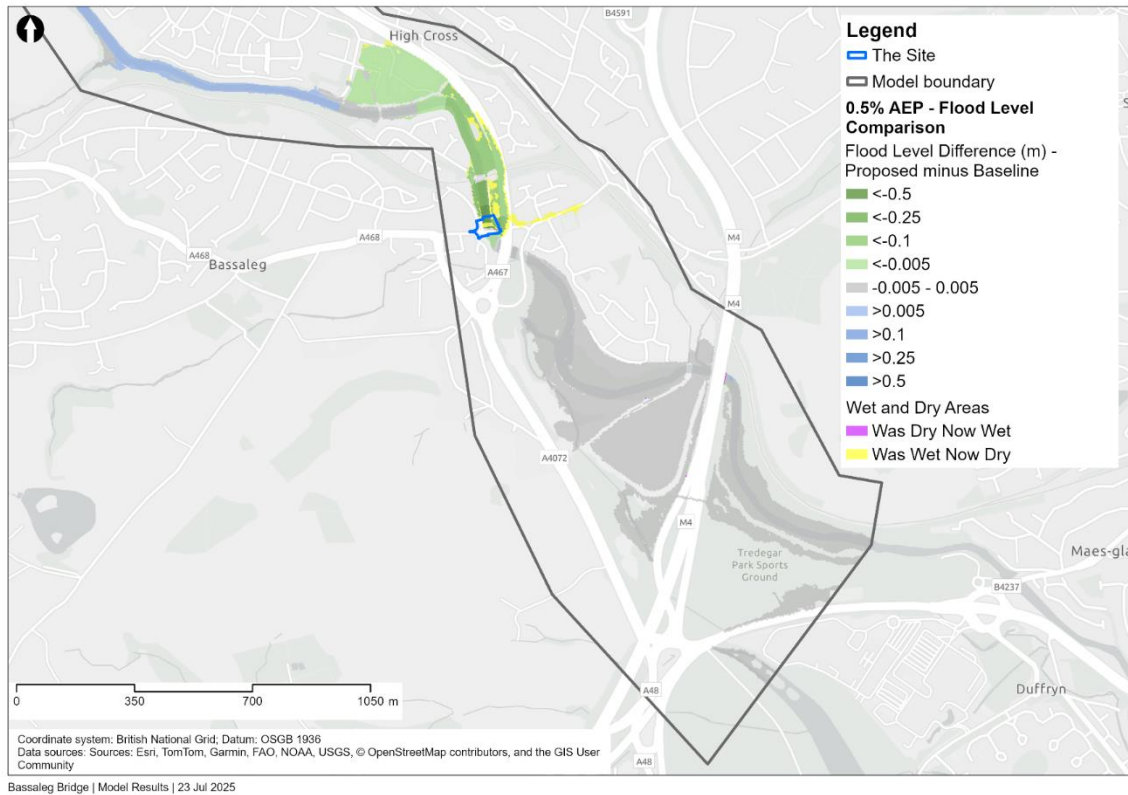
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.14 Comparison of water levels before and after development for the 1% AEP event (levels in m)



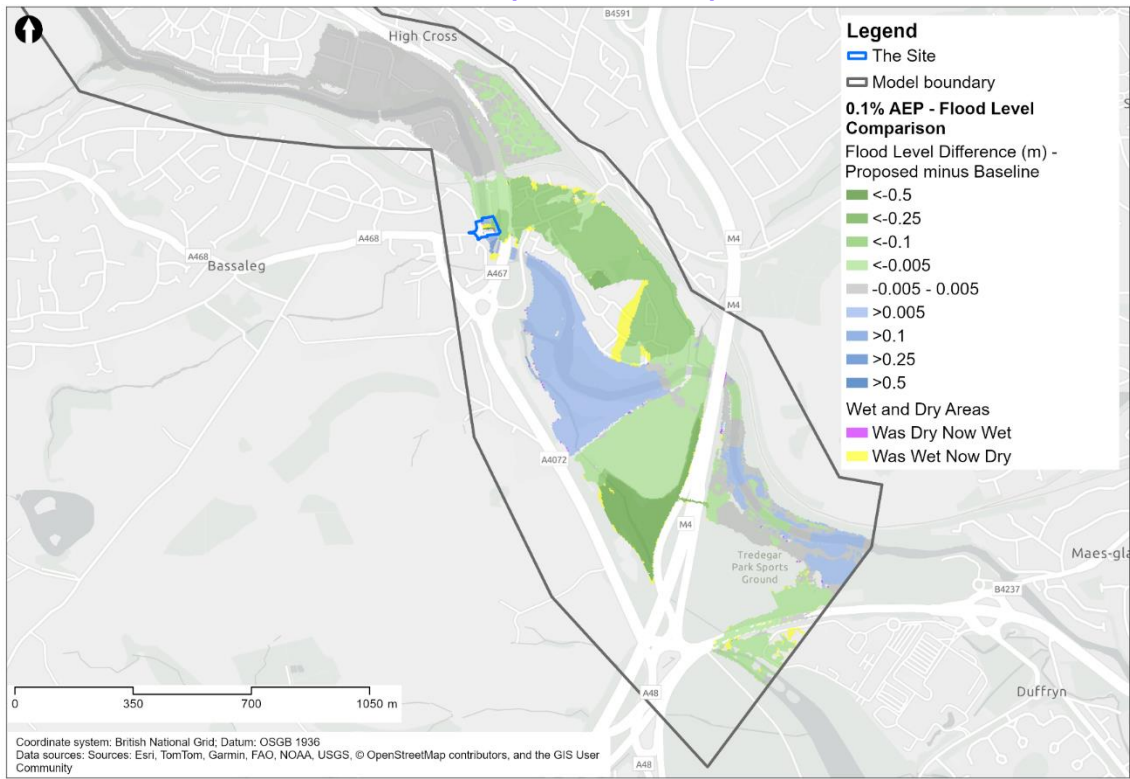
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.15 Comparison of water levels before and after development
for the 0.5% AEP event (levels in m)



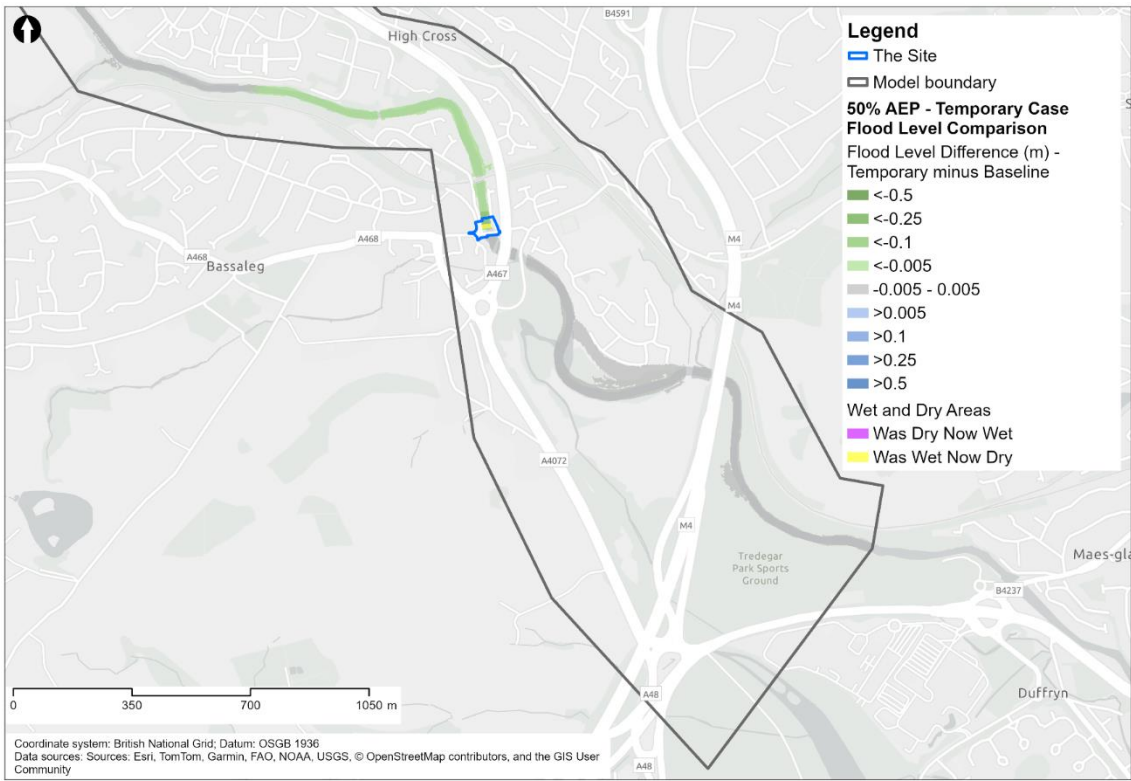
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.16 Comparison of water levels before and after development
for the 0.1% AEP event (levels in m)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

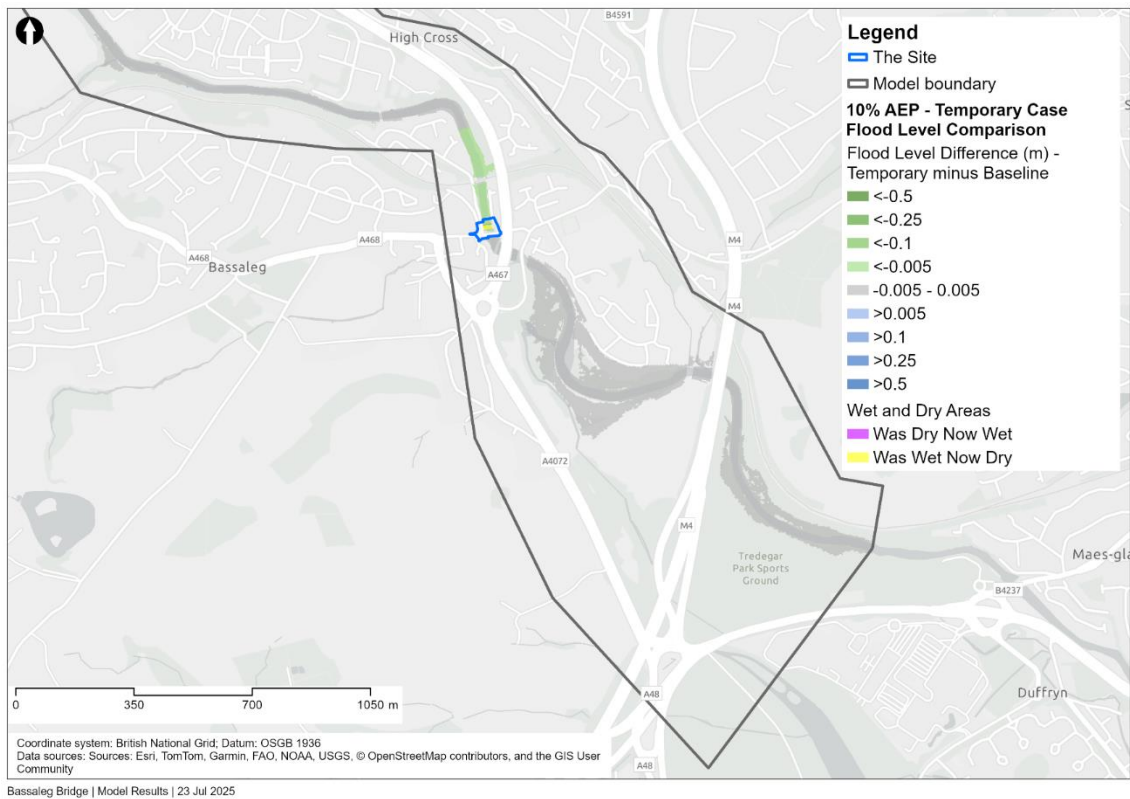
B.17 Comparison of water levels between the temporary and baseline case for the 50% AEP event (levels in m)



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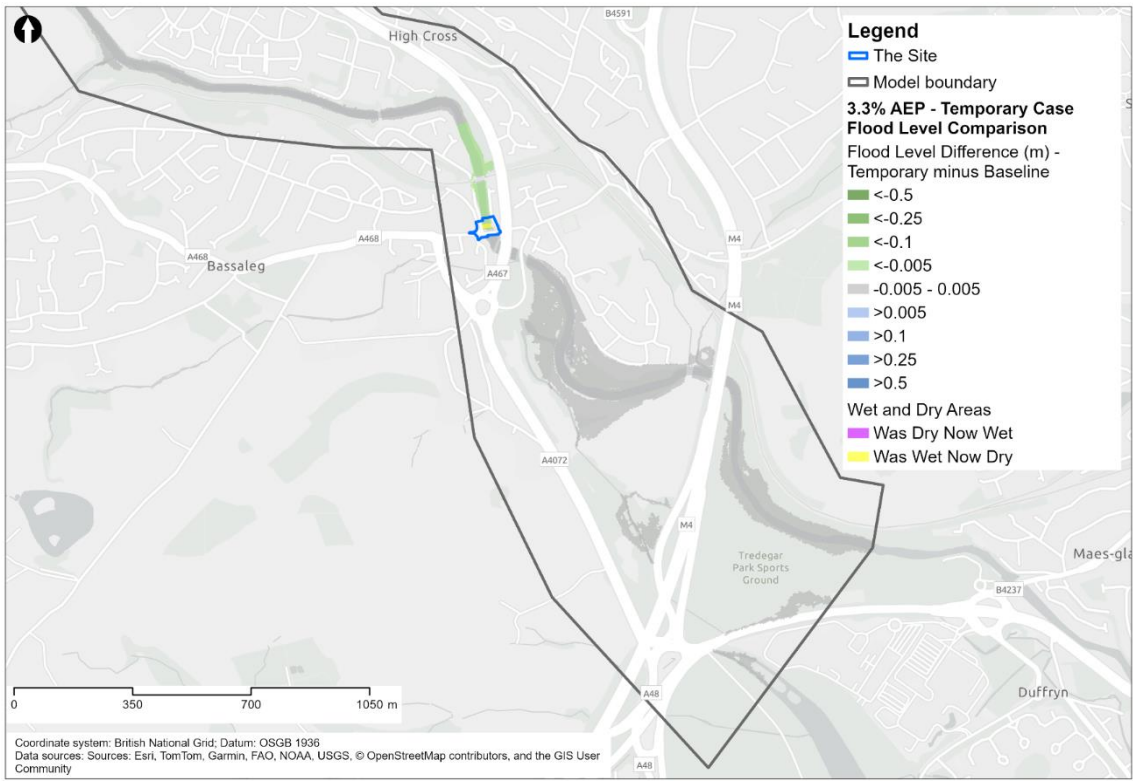
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.18 Comparison of water levels between the temporary and baseline case for the 10% AEP event (levels in m)



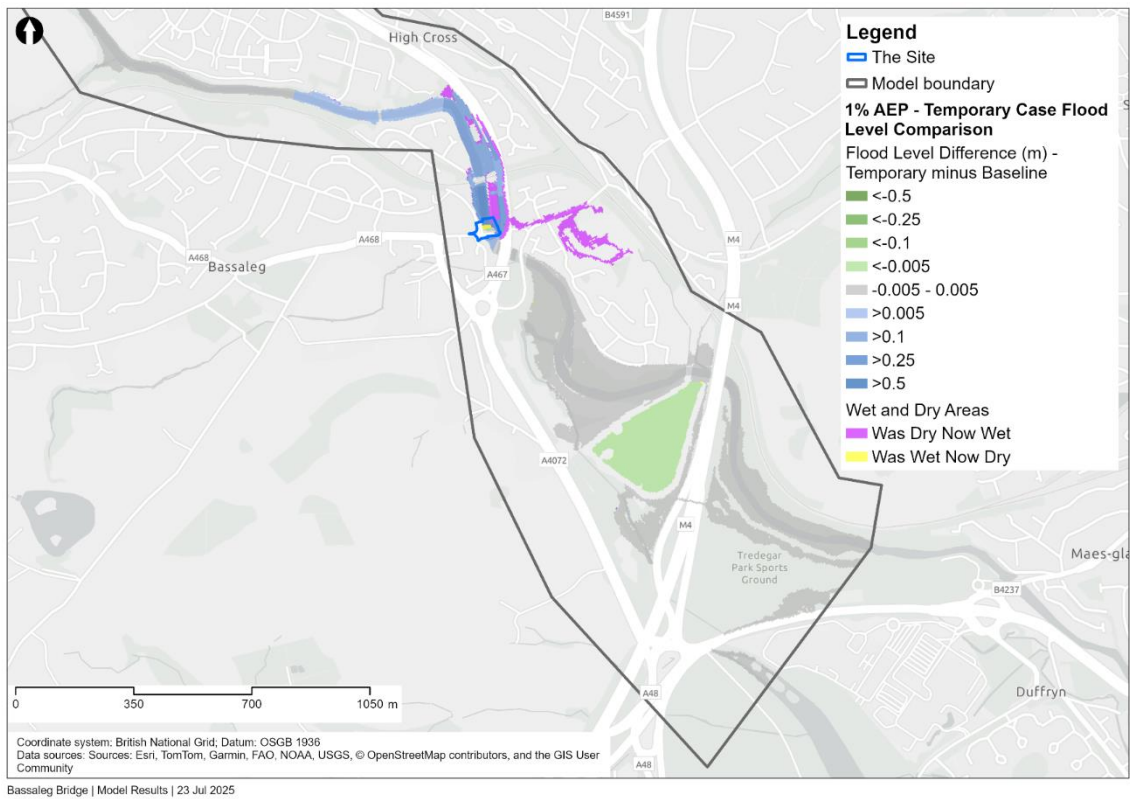
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.19 Comparison of water levels between the temporary and baseline case for the 3.3% AEP event (levels in m)



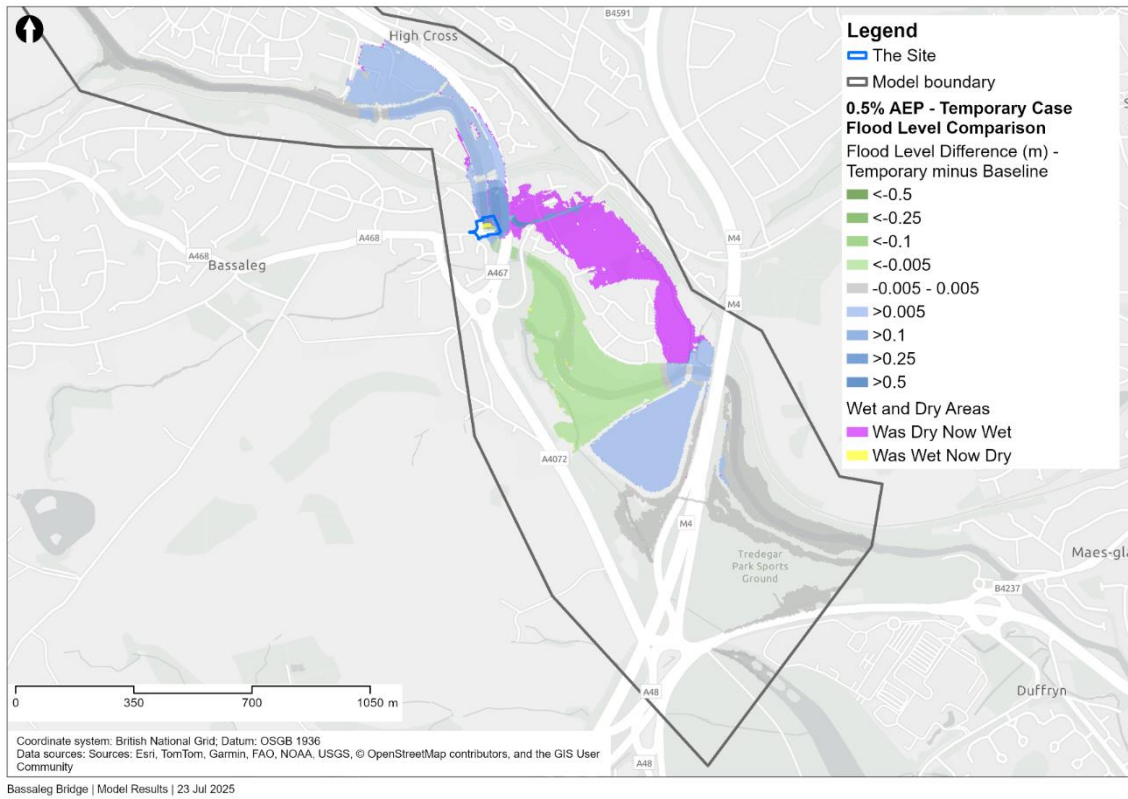
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.20 Comparison of water levels between the temporary and baseline case for the 1% AEP event (levels in m)



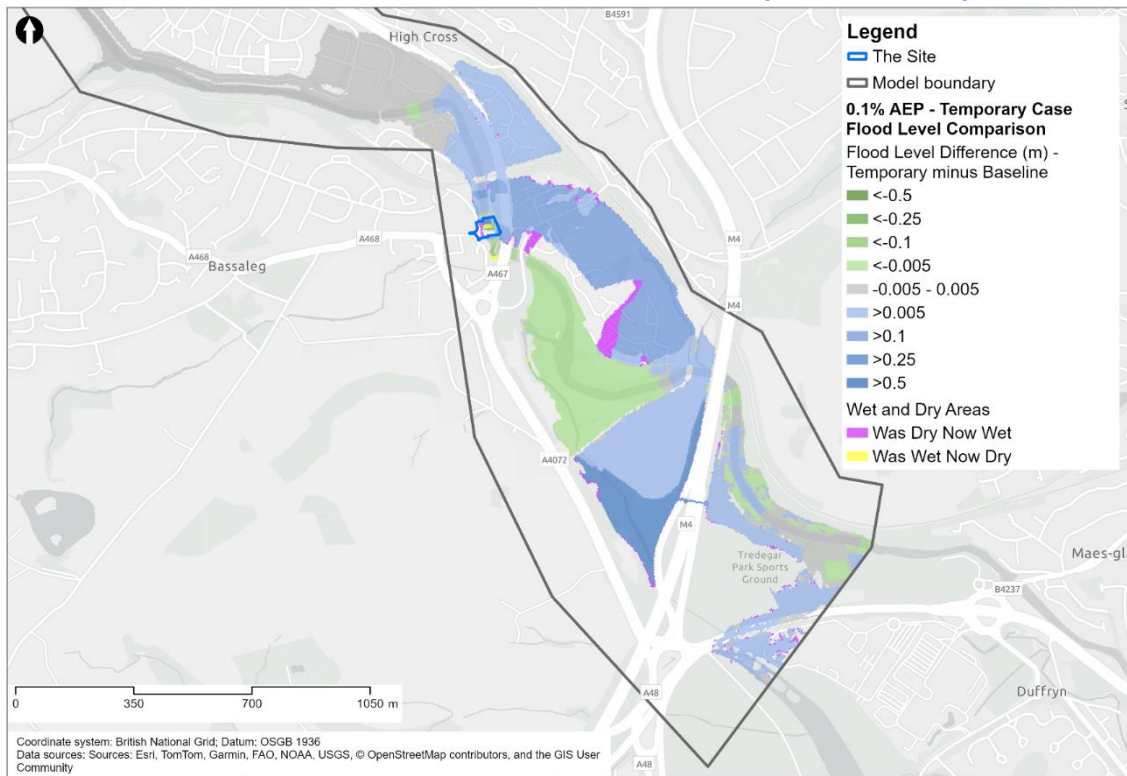
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.21 Comparison of water levels between the temporary and baseline case for the 0.5% AEP event (levels in m)



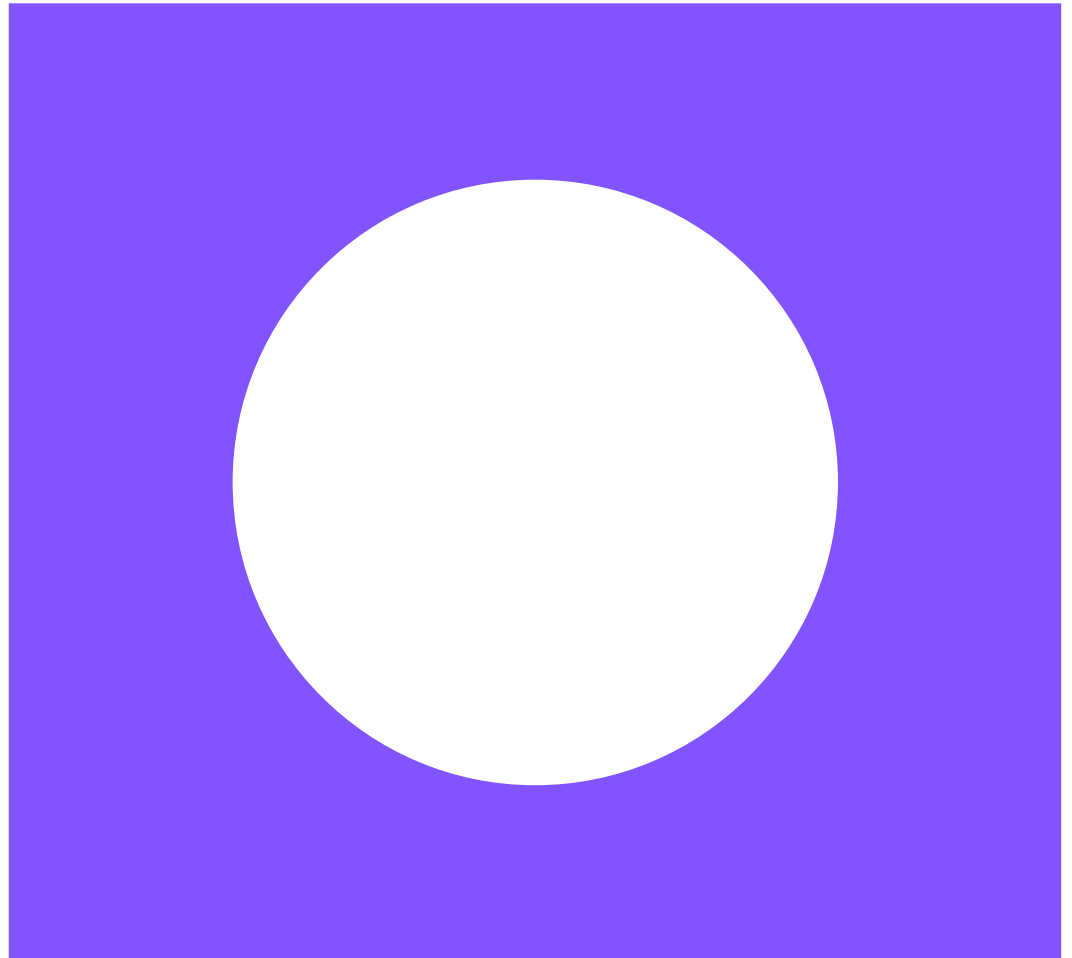
Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

B.22 Comparison of water levels between the temporary and baseline case for the 0.1% AEP event (levels in m)



Source: As stated in the figure. Adapted from the 'EbbwLowerICM_5_V1.0_2018' Model, WHS 2019. Produced by Mott MacDonald Ltd. 2025.

C. Hydraulic Modelling Report



Bassaleg Bridge Detail Design

Hydraulic Modelling Technical Report

September 2025

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Bassaleg Bridge Detail Design

Hydraulic Modelling Technical Report

September 2025

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1 Introduction

Mott MacDonald Limited (Mott MacDonald) has been commissioned by Newport City Council to undertake the detailed design of a new bridge structure to replace the “Old Bassaleg Bridge”, which crosses the River Ebbw in Newport, Wales. The Old Bassaleg Bridge has been closed to vehicles since August 2021 as a result of severe structural deficiencies arising from scour of its western pier. The proposed new bridge (“New Bassaleg Bridge”) will comprise of precast prestressed reinforced concrete and provide both pedestrian and vehicular access from Forge Mews to Viaduct Way. The New Bassaleg Bridge will be constructed immediately upstream of the Old Bassaleg Bridge, which will be removed following its construction.

Flood modelling was required to support the design process and Flood Consequence Assessment (FCA). This technical report provides a summary of the data collection, hydrological assessment, hydraulic model development and analysis of the results from the flood modelling study. The hydraulic model developed for this study is an adaptation of an existing integrated catchment model (ICM) for the River Ebbw, undertaken by Wallingford Hydro Solutions (WHS) in 2019 on behalf of Natural Resources Wales (NRW).

The hydraulic modelling study was undertaken with the following objectives:

1. Create a baseline model for scope area using “River Ebbw Integrated Catchment Model”, dated 14 June 2019.
2. Update the baseline model with OS Master Map data and surveyed cross-section details.
3. Develop a proposed scheme model based on the detailed design to assess two scenarios that represent the site during (Temporary case) and after construction (Permanent case).
4. Run the models for a range of flood events.
5. Complete sensitivity analysis to identify key uncertainties.
6. Provide mitigation measures to reduce detrimental effects, if any.

1.1 Development Proposal

The New Bassaleg Bridge will provide access across the River Ebbw, between Forge Mews and Viaduct Way and will replace the Old Bassaleg Bridge access along Caerphilly Road. The new bridge will carry a two-way single-lane carriageway of 7.5m width. On the north side of the carriageway, there will be a 0.6m wide verge for maintenance and on the south side, there will be a 3.5m wide verge for shared cycle and pedestrian use. Watercourse regrading will be undertaken to enhance hydraulic performance and to provide scour protection measures.

Figure 1.1 and Figure 1.2 show visualisations of the plan view and upstream view of the new bridge, respectively. These figures do not include scour protection, in accordance with the latest design.

There are two design cases for the proposal. The “Temporary case” assesses the period where both the existing and the new bridges are in place simultaneously. The “Permanent” case assesses the proposed development following demolition of the existing bridge.

Further information regarding the design of the bridge can be found in the Bassaleg Bridge Detailed Design Flood Consequence Assessment (100119581-MMD-XX-XX-RP-FL-0002) (Mott MacDonald, 2025a).

Figure 1.1: Plan view of new bridge



Source: Visualisation produced on Infracore by Mott MacDonald Ltd. 2025.

Figure 1.2: Upstream view of new bridge



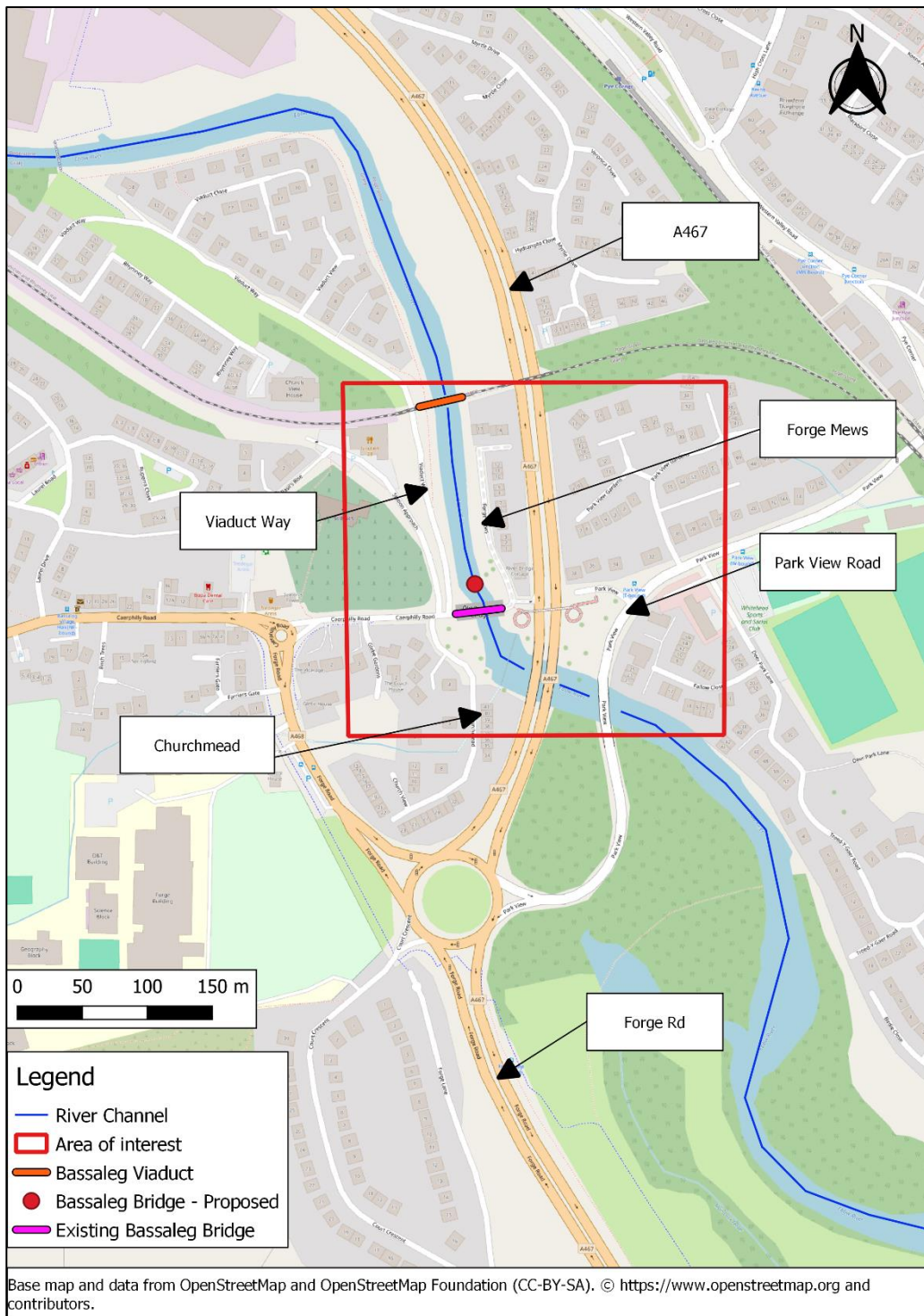
Source: Visualisation produced on Infracore by Mott MacDonald Ltd. 2025.

Note: The above visualisations do not include the update to replace sheet pile walling with block stone scour protection, in line with the latest design drawings.

1.2 Location Overview

The New Bassaleg Bridge is located between Forge Mews and Viaduct Way, Bassaleg, Newport, crossing the River Ebbw at Grid Reference ST 27840 87060. The New Bassaleg Bridge will be located to the north (upstream) of the Old Bassaleg Bridge. Figure 1.3 shows the area of interest around Old Bassaleg Bridge.

Figure 1.3: Model location overview



Source: Includes data from River Ebbw Integrated Catchment Model, Natural Resource Wales, June 2019

1.3 Notations

- The report refers to the left and right bank of the river from the perspective of looking downstream.
- The frequency of a flood can be quoted in two ways. The first is as a return period, defined as the expected time in years between two floods of equal or greater severity. The second is annual exceedance probability (AEP), which is the inverse of the return period and describes the percentage chance of a given flood being exceeded given year. The table below is provided to enable quick conversion between return periods and annual exceedance probabilities.

Table 1.1: Annual exceedance probability (AEP) and related return period reference table

AEP (%)	50	10	3.33	1	0.5	0.1
Return period (1 in X yrs)	2	10	30	100	200	1000

1.4 Disclaimers

Information presented within this report is dependent upon the accuracy and reliability of the information, correspondence, and data available to Mott MacDonald at the time of the assessment. Any party developing detailed design should not rely on assumptions made in this report but should satisfy themselves in that regard. A list of modelling assumptions and limitations are provided in Section 8 of this report.

Mott MacDonald has followed accepted procedure in providing the services, but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, Mott MacDonald takes no liability for and gives no warranty against actual flooding of any property (client’s or third party) or the consequences of flooding in relation to the performance of the service. This modelling report has been prepared for the purposes of supporting a planning application for the proposed development to replace the Old Bassaleg Bridge only.

Any assessment of the effects of climate change included in this report is based on guidance provided by Welsh Government at the date of this report (Welsh Government, 2021). These recommendations may change in the future, increasing the extent of predicted effects, and Mott MacDonald recommends that climate change guidance and the potential impact of climate change on the management of flood risk at the site of interest is reviewed throughout the project.

2 Model Method Statement

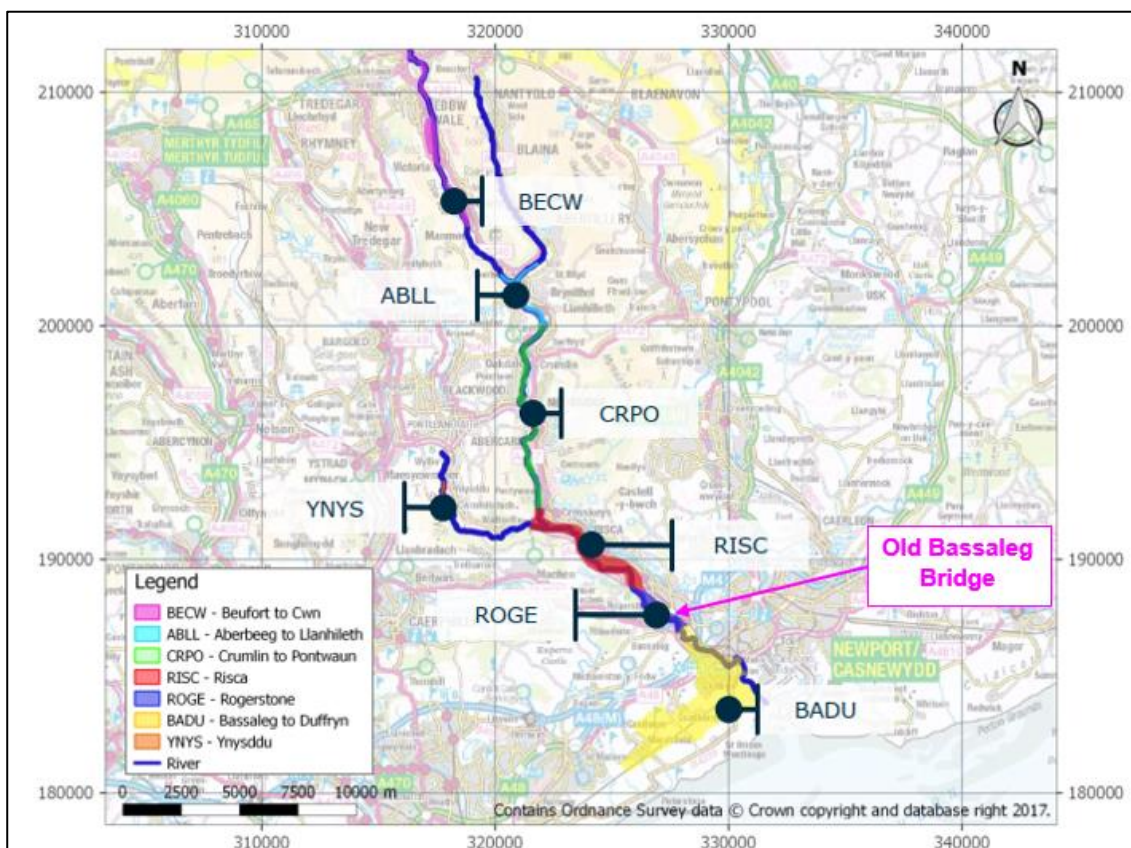
The site-specific model for the project builds on an existing hydraulic model developed by Wallingford Hydro Solutions (WHS) in 2019 using Flood Modeller-TUFLOW (Wallingford HydroSolutions Ltd, 2019). This model which represents the River Ebbw catchment was assessed and updated for the purpose of inform this assessment. This section summaries the review completed of the original model data.

2.1 Existing Flood Model

WHS developed an ICM for the River Ebbw, bringing together data from a number of prior studies carried out within the River Ebbw catchment. This provided a consistent and up to date approach to assessing flood risk within the catchment. The project sought to create a set of hydraulic river models and detailed 1D/2D modelling to improve flood risk information in the River Ebbw catchment to allow identification of the flood levels, extent, mechanism and threshold of river flooding for a range of design events.

The model extends from the Heads of the Valley Road (A465) at Beaufort (NGR 316400, 212100) down to the River Ebbw's outfall into the River Usk, close to the Severn estuary in Duffryn, Newport (NGR 331600,183700), refer Figure 2.1. The model predicts flood extents in the vicinity of the Old Bassaleg Bridge and it is observed that the structure is predicted to constrict flows.

Figure 2.1: ICM model extent and location of 2d domains



Source: WHS, River Ebbw Integrated Catchment Model, Hydraulic Modelling Report, 2019

The ICM covers a larger area than is needed to inform this modelling study. It was therefore decided to produce a truncated version of the model by extracting the Rogerstone (ROGE) domain. Changes to the model extent are discussed in further detail in Section 5.1.

There are 20 inflows included in the entire 1D model, with three lateral flows (AE10, AE11, and AE12) within the ROGE domain. The downstream extent of the model is the River Usk close to the Severn estuary in Duffryn, Newport. Therefore, the downstream boundary is depth-limited and based on a tidal curve with peak water level of 8.8mAOD. The predicted water level at the downstream extent of the ROGE domain is approximately 35mAOD and extreme tidal level is 7.64m AOD, consequently, the tidal influence does not impact the reach of the model where the existing and new bridges are located.

The existing hydraulic model is based on channel survey data from 13 separate surveys dating between 1997 to 2014. The ROGE domain is based on a 2006 flood model which utilised channel topographical data collected in 2005. Due to the age of the data, check surveys were completed in 2016 to ascertain the accuracy of the original data and whether the river channel had changed in the intervening period. From these check surveys it was concluded that the existing survey was fit for the purpose.

The 2D model domains (floodplains) are based on a 4m cell size with elevations defined predominately based on 1m and 2m resolution LiDAR data downloaded from Welsh Government GIS portal (lle.gov.wales – decommissioned in 2023) in September 2016. The exception to this is Risca (RISC) and Rogerstone (ROGE) domains which were based on 1m and 2m resolution LiDAR data taken from the preceding flood modelling study produced in 2015. Further discussion regarding the LiDAR data is provided in Section 3.2.

There are a number of flood defences located within the River Ebbw catchment, including embankments and walls in the immediate vicinity of the Old Bassaleg Bridge. The representation of the existing NRW defences in the current model was based on data provided in the form of a defence and flood alleviation scheme survey. Local authority and private defences were defined using a record log of all local authority and private defences provided by NRW in conjunction with surveyed data. The report associated with the existing model (Wallingford HydroSolutions Ltd, 2019) notes that details for a private defence at Tredegar Park (located a short distance downstream of Old Bassaleg bridge) were based on proposed data as the defence was under construction during the completion of the study.

Because the existing model was created from a series of previous models and new sections, the channel roughness coefficients for the 1D FM model were reviewed and standardised where appropriate. The floodplain roughness values were digitised in the existing model using the OS MasterMap data.

2.2 Software

The WHS 1D-2D hydraulic model of the River Ebbw that has been adapted for this modelling study was created using the Flood Modeller (FM) and TUFLOW software packages. The study has utilised FM version 4.4 and TUFLOW 2018-03-AD. For this modelling study FM version 4.5 and TUFLOW 2018-03-AE have been used.

2.3 Required Model Updates

For the existing hydraulic model to be suitable for this modelling study, a number of updates were required. These are predominantly to bring the model in line with the latest data available and increase the level of detail of the modelling in areas adjacent to the site. The updates to the model are summarised as follows:

- Truncated the existing model extent to the reach near Old Bassaleg Bridge to improve model run efficiency.
- Updated boundary conditions to reflect latest hydrological data and changes in model extent.
- Collect additional channel survey through area of interest and use data to update model to improve representation in the area adjacent to the site.
- Updated 2D model domain, where appropriate, using new topographical surveys.
- Updated surface roughness to reflect changes in land usage.
- Updated linkage between 1D FM and 2D TUFLOW domains due to topographical changes.

Subsequent sections will discuss the reasoning and methodology behind these updates in further detail.

3 Input Data

3.1 Available Information

All relevant input data used in the model setup is summarised in Table 3.1.

Table 3.1: Sources of information

File Name	Citation	Description
NRW Ebbw ICM Model	(Wallingford HydroSolutions Ltd, 2019)	ICM was developed in 2019, to bring together data from a number of prior studies carried out within the River Ebbw catchment to provide a consistent and up to date approach to assessing flood risk within the catchment. Model includes cross section, structure along the rivers, existing Bassaleg bridge data etc.
OS MasterMap Data	(Ordnance Survey, 2024)	Latest land use type to use in the current model from Ordnance Survey
Flood Estimation Report: Bassaleg Bridge - Rhiwderin	(Mott MacDonald Ltd, 2025b)	Updated hydrology assessment report updates the hydrology to 2024.
Old Bassaleg Bridge Watercourse Survey	(Infomap Surveys Ltd, 2024)	Provides channel cross-sectional survey data for 9 cross sections.
Old Bassaleg Bridge Topographic Survey	(Infomap Surveys Ltd, 2025)	Additional topographic survey data for Churchmead, Fallow Close and Deer Park Lane area.
Planning Policy Wales Technical Advice Note 15 (TAN 15): Development, flooding and coastal erosion	(Welsh Government, 2004)	-
Planning Policy Wales Technical Advice Note 15 (TAN 15): Development, flooding and coastal erosion	(Welsh Government, 2025)	-
Guidance: Climate change allowances and flood consequence assessments	(Welsh Government, 2021)	-
DataMapWales LiDAR viewer	(Welsh Government, 2023)	-
Welsh Government LiDAR tile catalogue 2020-2023	(Welsh Government, 2024)	-
NRW Modelling Blockage and Breach Scenarios	(NRW, 2021)	-

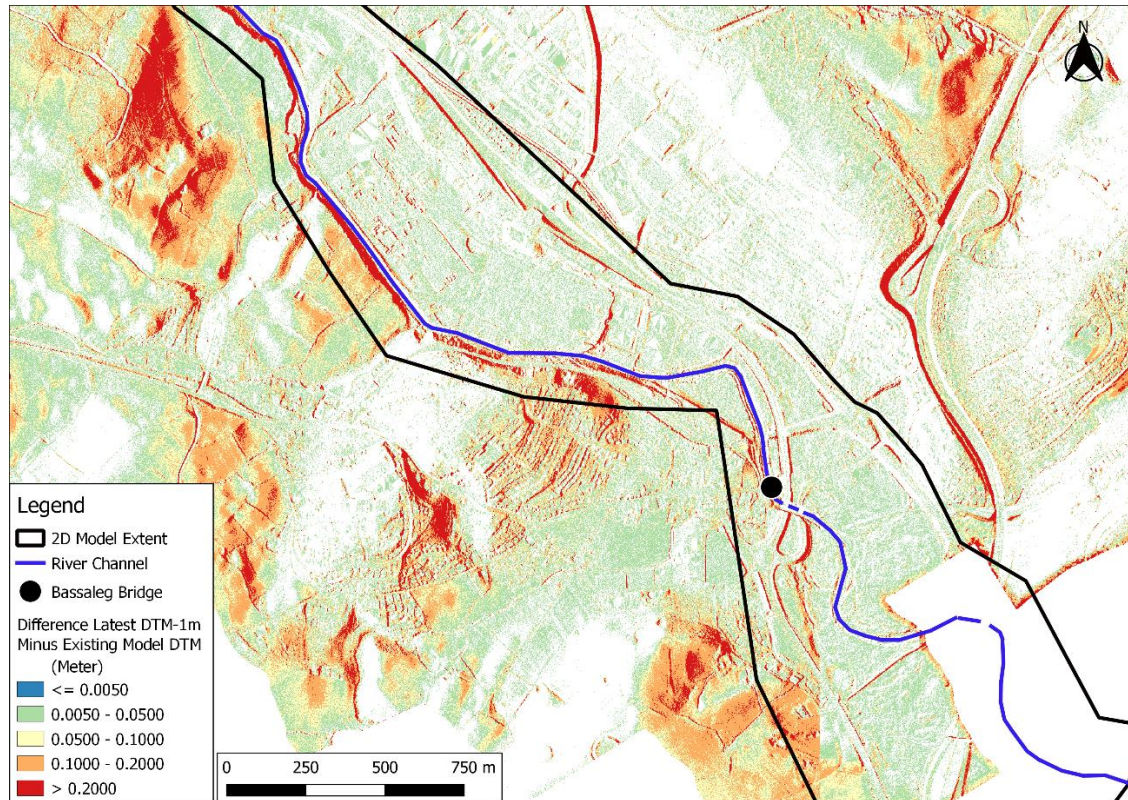
3.2 Digital Terrain Model

At the commencement of this modelling study, the latest available DTM data from DataMapWales within the study area (resolution of 1m and 2m, published 2023) was obtained and compared with the DTM used in the existing model (ICM project). This comparison is shown in Figure 3.1 and Figure 3.2. The coverage of both DTM datasets within the model domain is limited, the 1-metre DTM extends up to Park View Lane, while 2-metre DTM reaches as far as Tredegar Park.

Overall, both datasets were in good agreement over flood plain with elevation differences ranging from 0.005m to 0.05m. However, there were some differences shown, predominately

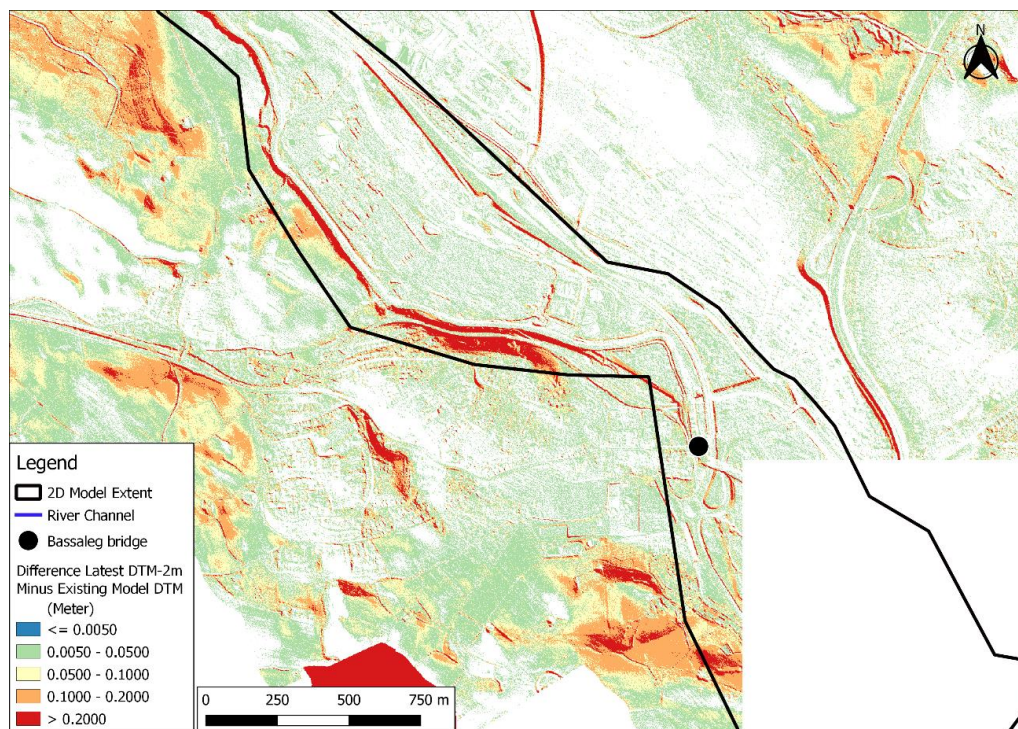
along the River Ebbw banks and right floodplain where the latest DTM shows elevation changes between 0.2m and 1.5m. After reviewing these differences and considering the limited spatial coverage, it was concluded that the existing DTM from the existing model remained the most suitable dataset for further model updates (i.e. this modelling study).

Figure 3.1: Comparison of LiDAR (2023 DataMapWales 1-metre LiDAR data minus ICM LiDAR data)



Source: Includes data from River Ebbw Integrated Catchment Model, Natural Resource Wales, June 2019, and LiDAR from New map | DataMapWales (gov.wales)

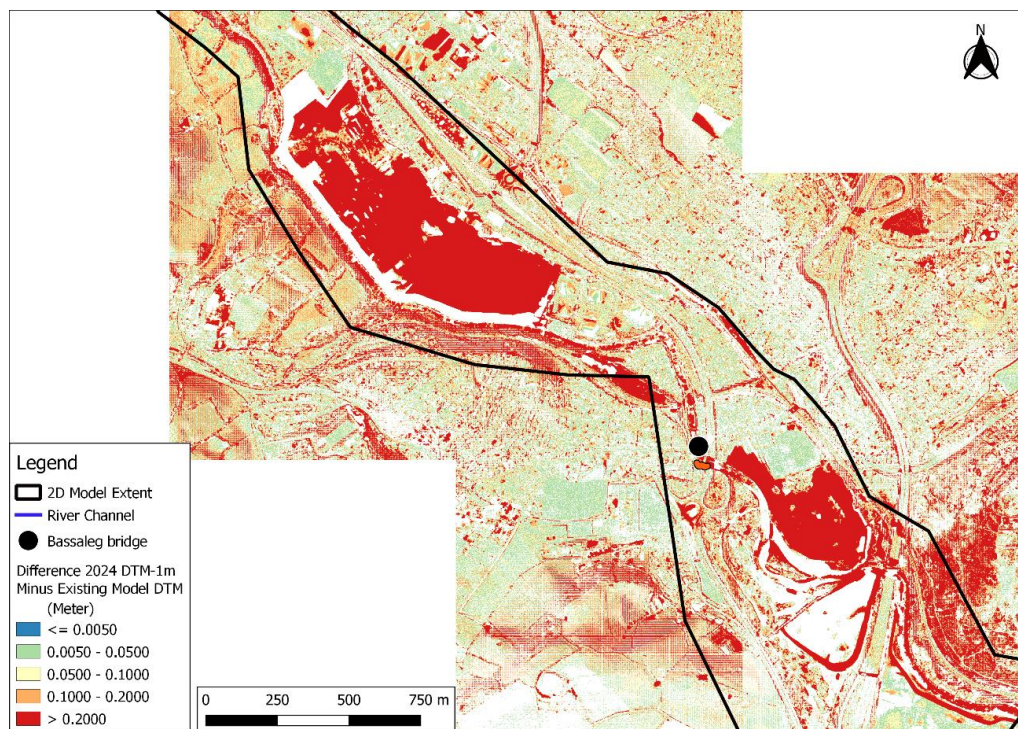
Figure 3.2: Comparison of LiDAR (2023 DataMapWales 2-metre LiDAR data minus ICM LiDAR data)



Source: Includes data from River Ebbw Integrated Catchment Model, Natural Resource Wales, June 2019, and LiDAR from New map | DataMapWales (gov.wales)

Subsequently, a new LiDAR dataset released in 2024 and has also reviewed. Figure 3.3 presents the comparison between the 2024 LiDAR and the existing model LiDAR, showing that the new dataset captured several recent updates within the model domain. These updates were already represented using Zshape layers in the existing model. While the 2024 dataset provided useful confirmation of these updates, it was not used in the modelling process because it became available after the modelling study was already well advanced at this stage.

Figure 3.3: Comparison of LiDAR (2024 DataMapWales 1-metre LiDAR data minus ICM LiDAR data)

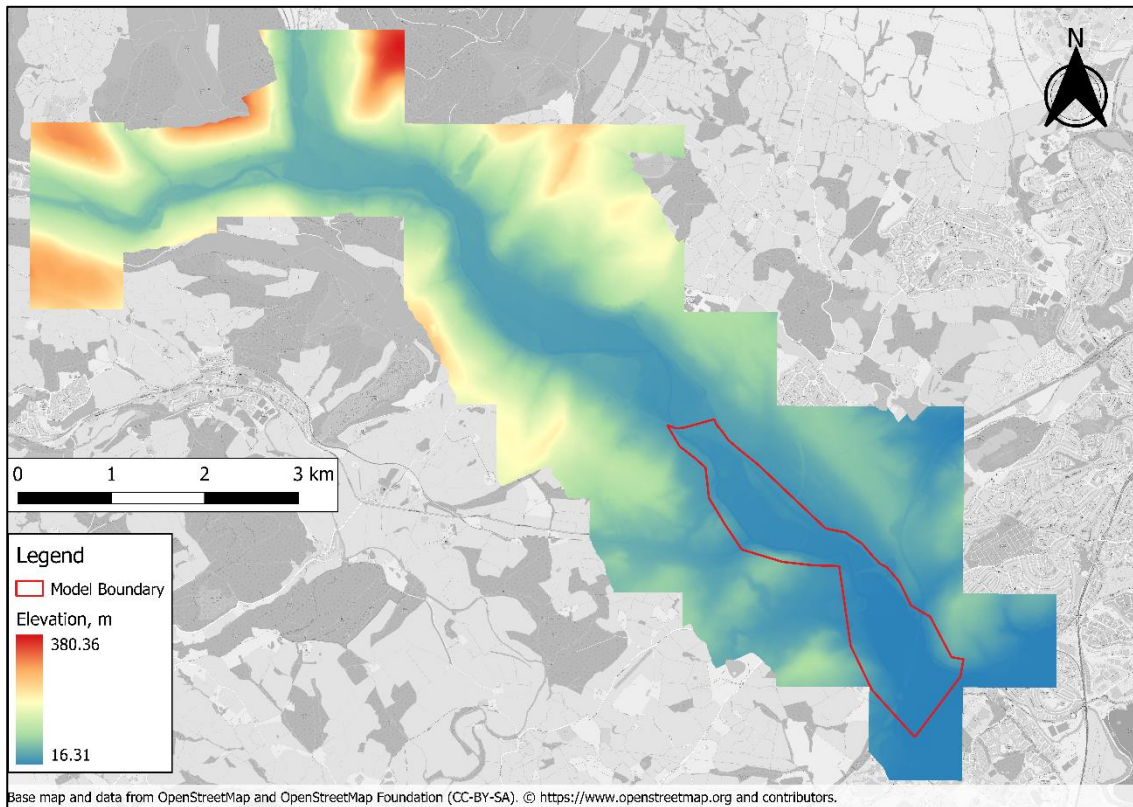


Source: Includes data from River Ebbw Integrated Catchment Model, Natural Resource Wales, June 2019, and LiDAR from New map | DataMapWales (gov.wales)

Figure 3.4 displays the existing Digital Terrain Model (DTM) used in the existing model. This was used as the foundation for setting up this modelling study. This DTM is primarily derived from filtered LiDAR data with 1-metre and 2-metre resolution.

LiDAR data used in the existing model was downloaded from Lle GeoPortal¹ with the exception of RISC and ROGE where the LiDAR data were obtained from the original v7.0 Risca model.

¹ <http://lle.gov.wales> Accessed: Sep 2016.

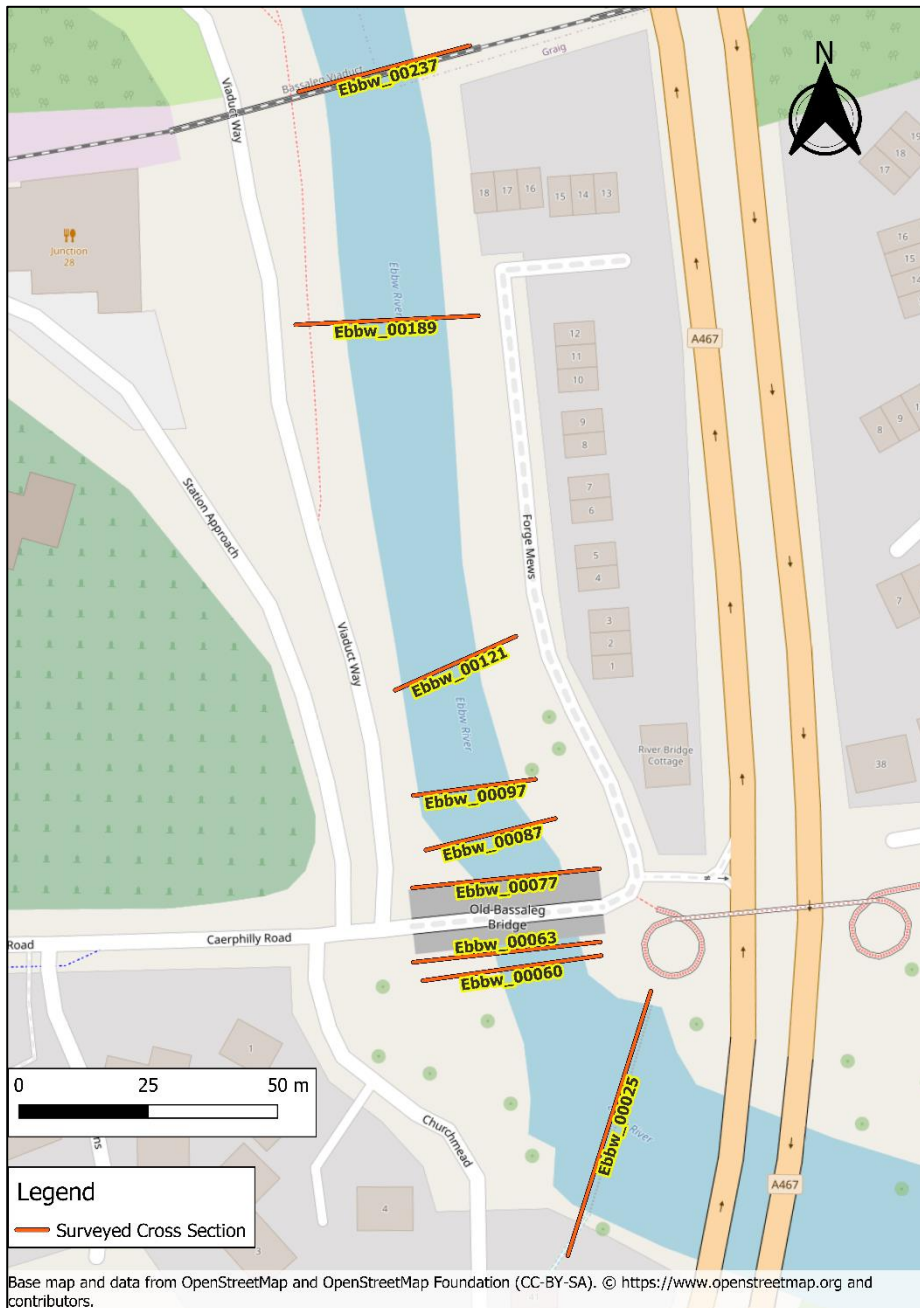
Figure 3.4: Existing model digital terrain model

Source: Includes data from River Ebbw Integrated Catchment Model, Natural Resource Wales, June 2019, and model boundary added by Mott MacDonald 2025, which relates to this modelling study.

3.3 Channel Topographic Survey

The channel survey of the River Ebbw and topographic survey of the floodplain in the area of interest was undertaken in November 2024 and April 2025 to inform this modelling study (Infomap Surveys Ltd, 2024; 2025). This includes a total of 9 channel cross sections, as shown in Figure 3.5.

Checks were undertaken comparing the new cross section survey data with the LiDAR to verify whether the LiDAR data were representative. The comparison showed that the bank levels matched well with the LiDAR data.

Figure 3.5: Channel cross sections

Source: Mott MacDonald 2025 and as stated in figure.

3.4 Floodplain Topographic Survey

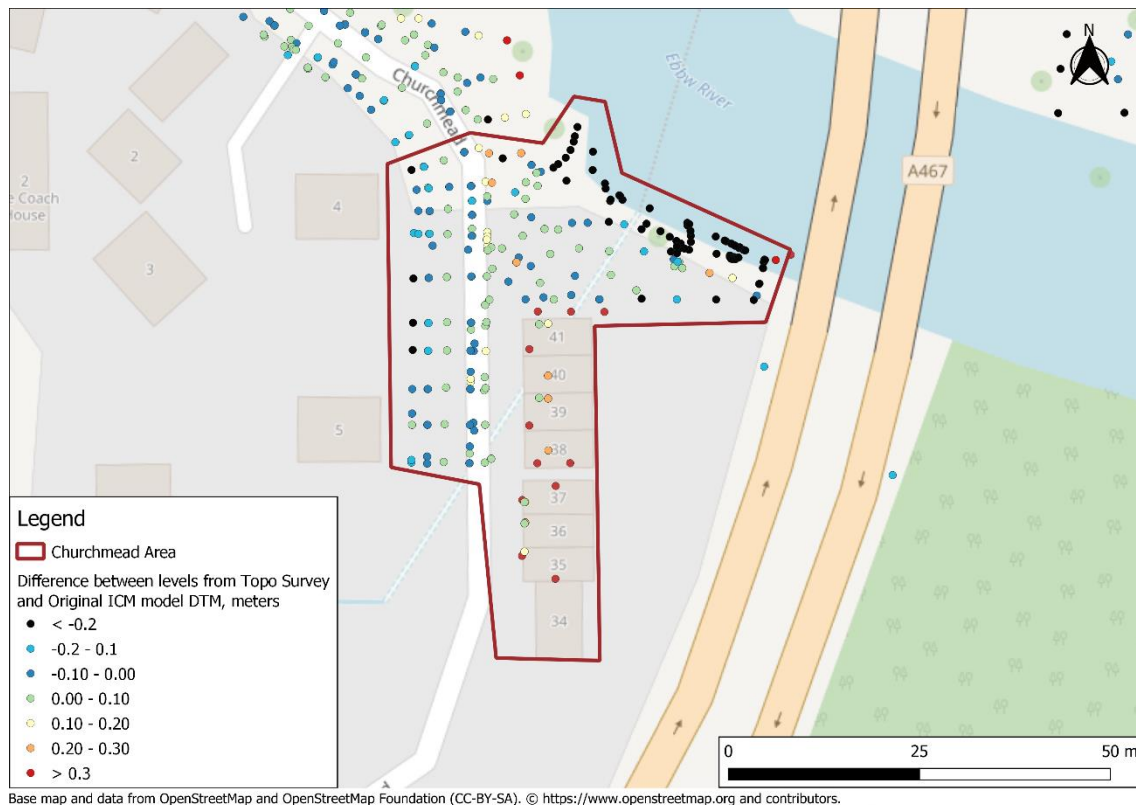
A topographic survey within the floodplain (Infomap Surveys Ltd, 2025) was carried out in addition to the channel survey covering the Old Bassaleg Bridge area and Churchmead Road along with check surveys at Fallow Close and Deer Park Lane. Figure 3.6 and Figure 3.7 presents the difference in ground level between new survey and existing model DTM at the surveyed locations.

Along Churchmead, the level differences between the topographic survey and model DTM are generally within +/- 0.1m. However significant discrepancies are observed along the riverbank

near the A467 road. To improve model accuracy, the model topography in this area was updated using the new survey data.

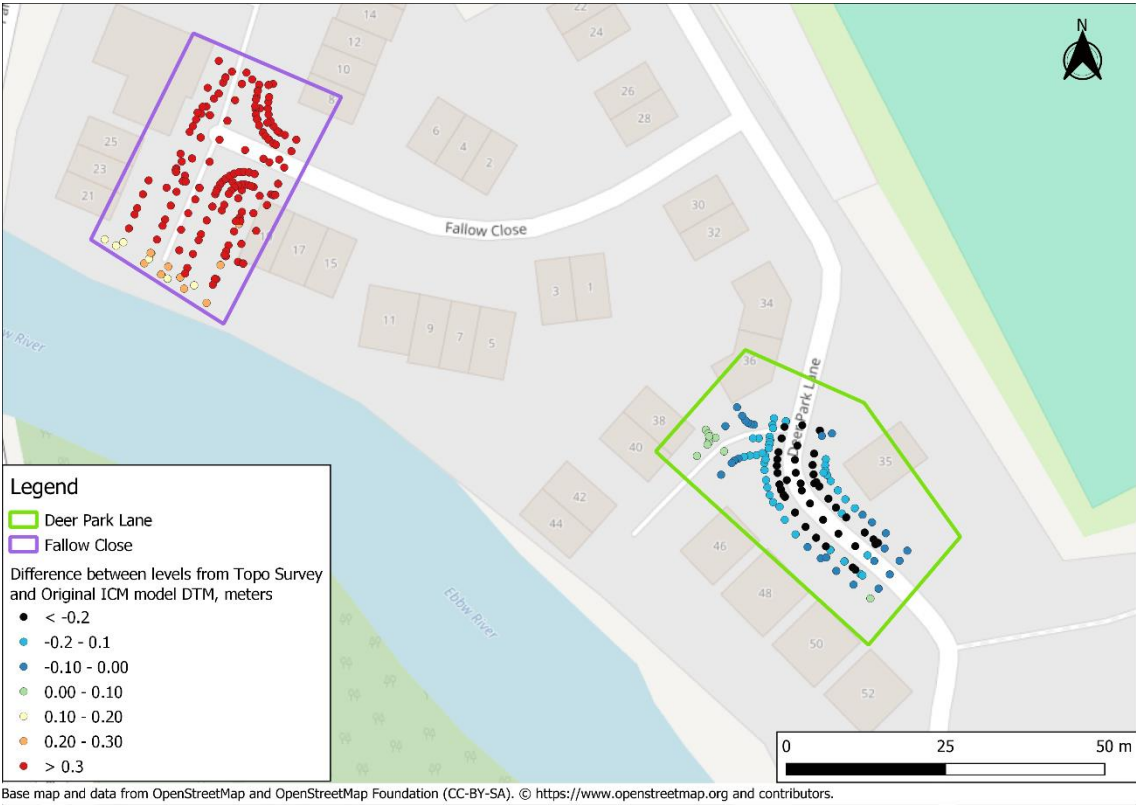
At Fallow Close the ground level differences exceeded 0.3m (refer Figure 3.7). These differences are due to recent developments that were not captured or presented in the existing model, and the development platform used to raise ground levels in this area did not extend sufficiently in the existing model. The survey data was used improve the model representation in this area as part of this modelling study.

Figure 3.6: Survey of Churchmead area compared to existing model DTM



Source: Mott MacDonald 2025 and as stated in figure.

Figure 3.7: Survey of Fallow close and Deer Park Lane compared to existing model DTM



Source: Mott MacDonald 2025 and as stated in figure.

4 Hydrology

The hydrological assessment of the River Ebbw catchment at Rhiwderin (Mott MacDonald Ltd, 2025b), provided in Appendix A, updates peak flow estimates using the latest NRFA v12 dataset. This is to provide the most up to date flow inputs into the upstream boundary of the hydraulic model.

4.1 Overview

The catchment has an area of 212km² with sandstone geology and BFIHOST value of 0.538. The catchment is considered moderately urbanised, with developments along the valley floor and in upper and lower reaches. This gives a URBEXT value of 0.0743.

The peak flow estimation method previously detailed by WHS in the hydrology assessment for the existing River Ebbw hydraulic model was followed. The FEH statistical method has been used to calculate peak flows for events with greater than 1% AEP. To calculate the 0.5% AEP and 0.1% AEP events, corresponding ReFH2 peak flow ratios were applied to the 1% AEP peak flow.

The peak flows for the climate change event were calculated by applying a 25% increase for the central allowance and a 70% increase for the upper end allowance to the 1% and 0.1% AEP event.

Figure 4.1 shows the FEH River Ebbw at Rhiwderin catchment area assessed as part of this study, compared against the NFRA Rhiwderin catchment.

Figure 4.1: River Ebbw catchment at Rhiwderin



Source: Flood estimation report: Bassaleg Bridge – Rhiwderin, Mott MacDonald 2025

4.2 Summary of Peak Flows

Table 4.1 shows estimated flood peaks at upstream boundary location and Table 4.2 shows the corresponding flows at downstream extent. For the current assessment, the flow hydrographs calculated for the downstream extent of the model were applied at the upstream boundary at EBBW_US node.

Table 4.1: Estimated flood peak (m³ /s) for various return periods (in years) at upstream.

AEP (%)	50	10	3.33	1	0.5	0.1	1%+ 25%CC	0.1% + 25%CC	0.5%+ 70%CC	0.1%+ 70%CC
Peak flow (m3/sec)	105.8	154.2	189.2	235.2	268.5	375	294	468.7	456.4	637.4

Source: Flood Estimation Report Bassaleg Bridge – Rhiwderin, Mott MacDonald 2024

Table 4.2: Estimated flood peak (m³ /s) for various return periods (in years) at downstream.

AEP (%)	50	10	3.33	1	0.5	0.1	1%+ 25%CC	0.1%+ 25%CC	0.5%+ 70%CC	0.1%+ 70%CC
Peak flow (m3/sec)	110.9	161.7	198.4	246.6	281.6	393.2	308.3	491.6	478.7	668.6

Source: Flood Estimation Report Bassaleg Bridge – Rhiwderin, Mott MacDonald 2024

In the existing model, lateral inflows AE10 and AE11 were included to represent additional contribution from the catchment area between the upstream gauge and the downstream boundary. However, for this modelling study, the decision was made to simplify the boundary condition setup and apply the downstream flow estimate to the upstream extent of the model domain. Therefore, lateral inflow AE10 has been omitted.

The existing model, applied a fixed inflow of 0.1m³/s to AE11, which has been kept unchanged. Since this flow is added downstream of the Ebbw weir, it is not expected to affect conditions at existing or new bridge.

Table 4.3 provides a comparison of the modelled flows at the upstream extent, past Old Bassaleg Bridge and at the downstream extent of the model. It can be seen that in general the peak flows through the model remain consistent and therefore no adjustments to the flows were made.

Table 4.3: Modelled flood peak (m³/s) for various AEPs at upstream, Old Bassaleg bridge and downstream end.

AEP (%)	50	10	3.33	1	0.5	0.1	1%+ 25%CC	0.1%+ 25%CC	0.5%+ 70%CC	0.1%+ 70%CC
Upstream End	110.9	161.7	198.4	246.7	281.6	393.3	308.4	491.6	478.7	668.6
Old Bassaleg Bridge	111.0	161.8	198.5	245.9	272.1	392.9	301.6	491.5	477.8	675.0
Downstream End	111.1	162.2	199.7	244.0	276.4	402.2	307.9	510.1	498.2	685.9

Source: Hydraulic Model Bassaleg Bridge, Mott MacDonald 2025

5 Hydraulic Model Development

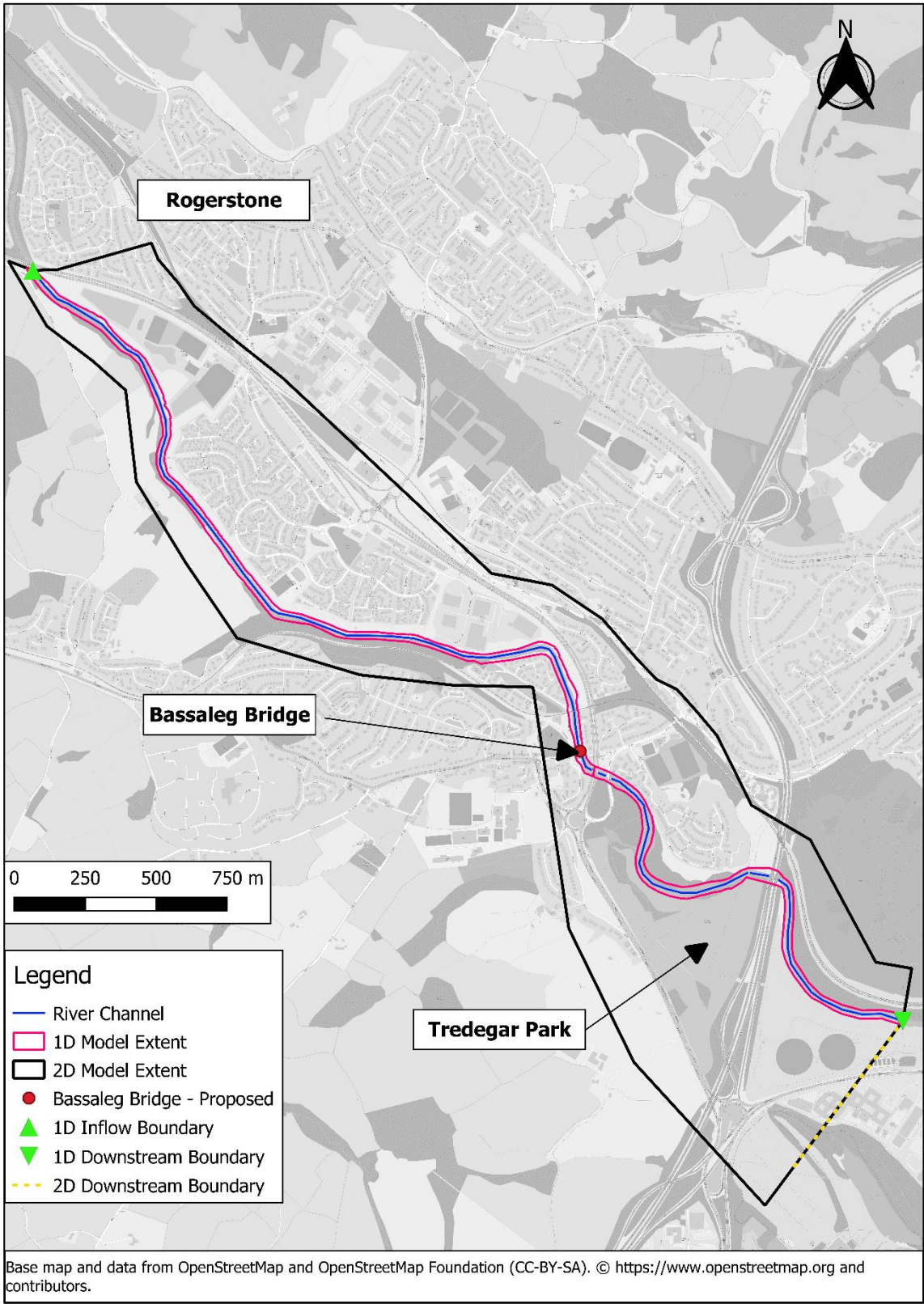
The existing model along with the associated topographic, inflow and land use files have been trimmed to align with the finalised model boundary. The topography and land use data have further updated using recent survey data and Ordnance Survey (OS) MasterMap data.

The updated model is simulated using TUFLOW version 2018-03-AE and FM version 4.5. To ensure consistency and validate the baseline, the existing model was also re-run using the updated software versions (TUFLOW 2018-03-AE and FM 4.5). Comparison of water levels between the original and updated simulations confirms the suitability of the baseline model.

5.1 Model Extent

Figure 5.1 displays the model extent truncated from the existing hydraulic model. The upstream boundary is defined at node EBBW_6959.8, located at the A467 bridge, approximately 2.9km upstream of Old Bassaleg Bridge. The downstream boundary is set at node EBBW_2166, situated 1.7km downstream of the Old Bassaleg Bridge near Tredegar Park.

Figure 5.1: Model extent



Source: Mott MacDonald 2025

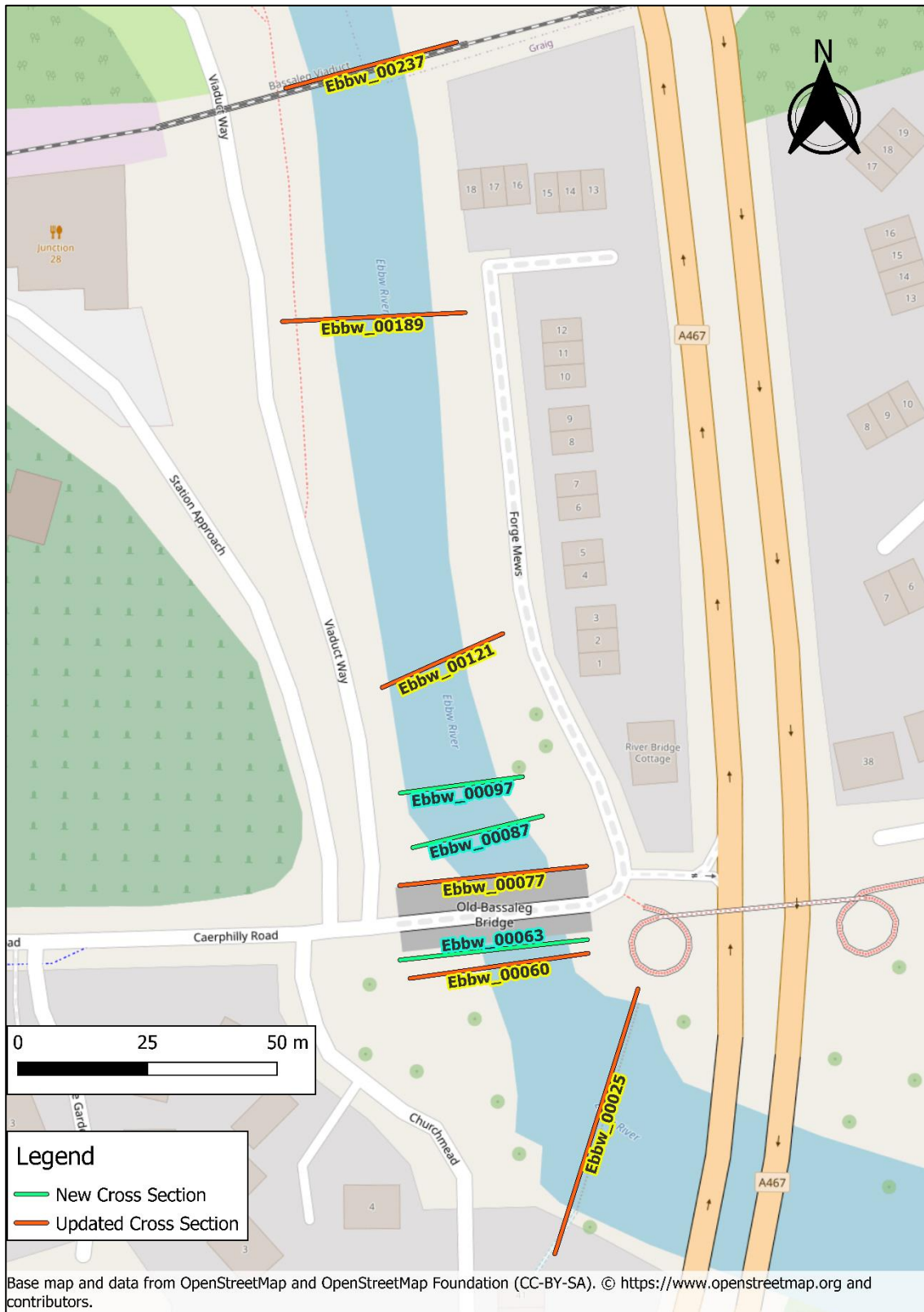
5.2 Boundary Conditions

Inflow into the model is applied using a Flow Time (QT) boundary at the upstream 1D extent which represents the flow estimated to the downstream extent of the modelled reach (see Section 4). There are two lateral inflows (AE10 and AE11) which were retained from the existing model setup. However, following further review, the flow estimate at the downstream extent of the model was conservatively applied at the upstream extent and flows at AE10 and AE11 were omitted.

The tidal boundary present in the original model has been removed, as the curtailed model domain lies beyond the influence of tidal effects. Instead, a normal depth boundary has been applied at the downstream extents of the 1D and 2D model domains based on an estimate of the downstream bed slope derived using channel data from the larger model.

5.3 Channel Cross-Sections

As part of the update to the existing model, six existing channel cross-sections were replaced using new topographic survey data (Infomap Surveys Ltd, 2024). Additionally, three cross-sections were added between the Bassaleg Viaduct and the Old Bassaleg Bridge to improve the model representation in the immediate vicinity of the new bridge. The locations of these new sections are shown in Figure 5.2.

Figure 5.2: Details of cross section data

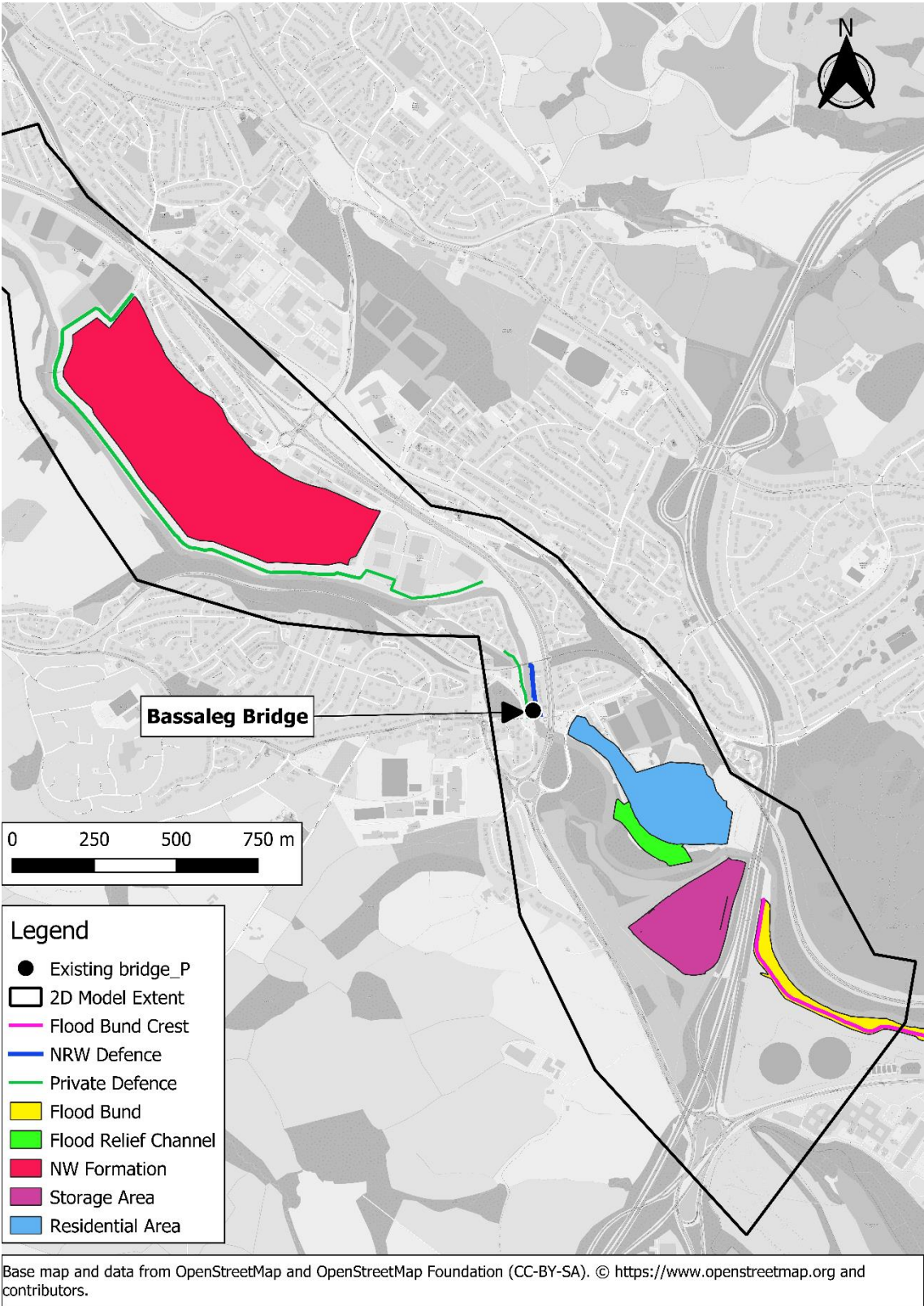
Source: Mott MacDonald 2025

5.4 Floodplain Topography

The terrain data used in the original ICM model was clipped to match the truncated model extent. Several topographic features from the existing model have been retained as shown in Figure 5.3.

During model development, it was observed that ground elevations in some areas of the floodplain adjacent to Old Bassaleg Bridge were not accurately captured in the existing topographic data. To address this, an additional survey (Infomap Surveys Ltd, 2025) was conducted to obtain accurate ground elevations for Churchmead Road, Fallow Close, and Deer Park Lane. Details of this survey are provided in Section 3.4. The updated elevations were subsequently incorporated into the model to improve representation of the floodplain in these areas.

Figure 5.3: Topographic features retained from the existing model



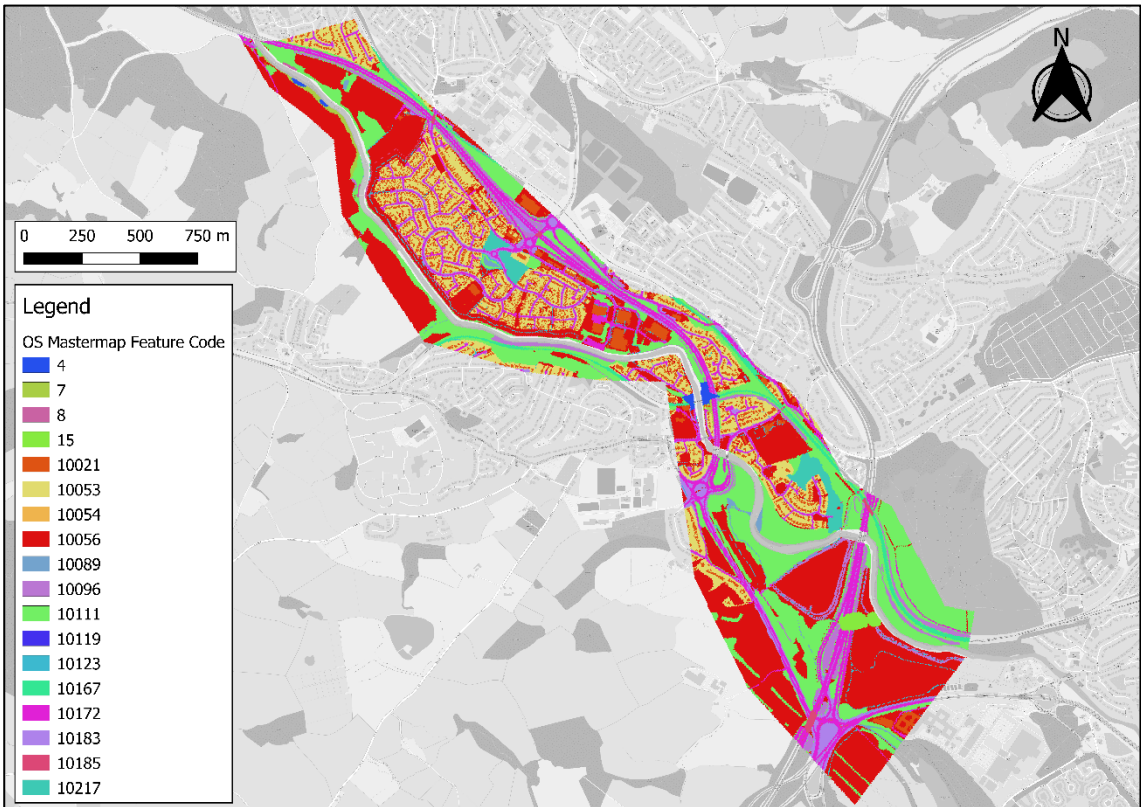
Source: Mott MacDonald 2025

5.5 Surface Roughness

Floodplain roughness coefficients were delineated in the existing model using OS MasterMap data. This data, was updated with new mapping data (Ordnance Survey, 2024) as part of the model update. Figure 5.4 shows the new data categorised by their feature codes. The associated Mannings roughness coefficients applied to the updated model are shown in Table 5.1.

Manning's roughness values applied to the river sections in the 1D model range from 0.035 to 0.05. These remain consistent with the existing model.

Figure 5.4: OS Master Map feature code



Source: Mott MacDonald 2025

Table 5.1: Application of manning's roughness coefficient values in 2d domain

OS MasterMap feature code	Description	Manning's n value applied in 2D domain
10021	Buildings	0.3
10053	General Surface	0.05
10054		
10056		
10062	Glasshouse	0.3
10089	Water	0.03
10096	Land/Rail	0.02
10111	Natural Environment	0.05
10167	Rail	0.05
10119	Roads Tracks and Paths	0.02
10123		
10172		
10183		
10185	Structure	0.3
10187		
10193		
10203	Tidal Water, Foreshore	0.03
10210	Rough Grassland	0.075
10217	Unclassified	0.05
10099	Landform	0.02
4	Gardens, Fences	0.05
7	River, Open Water	0.035
8	Applied to improve model instability	0.25
15	Applied to improve model instability in the 1000 year defended model simulation.	0.9

Source: Mott MacDonald 2025

5.6 Existing Hydraulic Structures

A total of nine existing structures are present within the curtailed model reach. These are detailed in Table 5.2. In general no modifications have been made to the structural parameters of these structures and they have been retained as defined in the existing model. The exceptions to this are Old Bassaleg Bridge and Ebbw Weir which were updated based on new channel survey data.

The twin arched Old Bassaleg Bridge structure (shown in Figure 5.5) is currently understood to trap and accumulate debris, which can lead to blockages and restrict the natural flow of water within the River Ebbw. In particular the right-hand arch (looking downstream) is shallow and affected by vegetation on the river bank. Further to discussions with NRW, the bridge has been assessed as having a medium risk of blockage, and therefore a 25% blockage (NRW, 2021) has been applied to the existing bridge in the model through a manual reduction in the flow area.

Ebbw weir has been represented in the flood model using channel survey data collected in 2024. It is understood that the condition of the weir is deteriorating and therefore the geometry / functionality of the weir may change in the future. Should the weir fail, the upstream channel may also be affected. Any changes the weir and channel will affect the predicted water levels through the area of interest.

Table 5.2: Hydraulic structures in model

Name / Location	Description
Footbridge 1	- Present at upstream of the model - The structure has been represented using a 'rectangular' bridge unit in FM - Soffit and springing level is 30.43mAOD
Footbridge 2	- Represented by node EBBW_4624B - The structure has been represented using a 'rectangular' bridge unit in FM - Soffit and springing level is 27.39mAOD
Railway Viaduct	- The structure has been represented using an 'Arch' bridge unit in FM (EBBW_4169B). - Four Arch Stone Viaduct.
Old Bassaleg Bridge	- The structure has been represented using an 'Arch' bridge unit in FM (EBBW_4008B) - The flow area of the bridge has been manually reduced by 25% to represent a medium risk of blockage.
Weir structure	Weir structure with concrete strip
Road Bridge	- Single Span Steel and Concrete Bridge - Represented by node EBBW_4624B - The structure has been represented using a 'rectangular' bridge unit in FM
Caerphilly Road Bridge	- Single Span Steel and Concrete Bridge - The structure has been represented using a 'rectangular' bridge unit in FM (EBBW_3886B)
Tredegar Park Footbridge	- Triple Span Stone and Iron Bridge - The structure has been represented using a 'rectangular' bridge unit in FM (EBBW_3059B)
Motorway Bridge	- Concrete Bridge - The structure has been represented using a 'rectangular' bridge unit in FM (EBBW_2984B)

Source: Mott MacDonald 2025

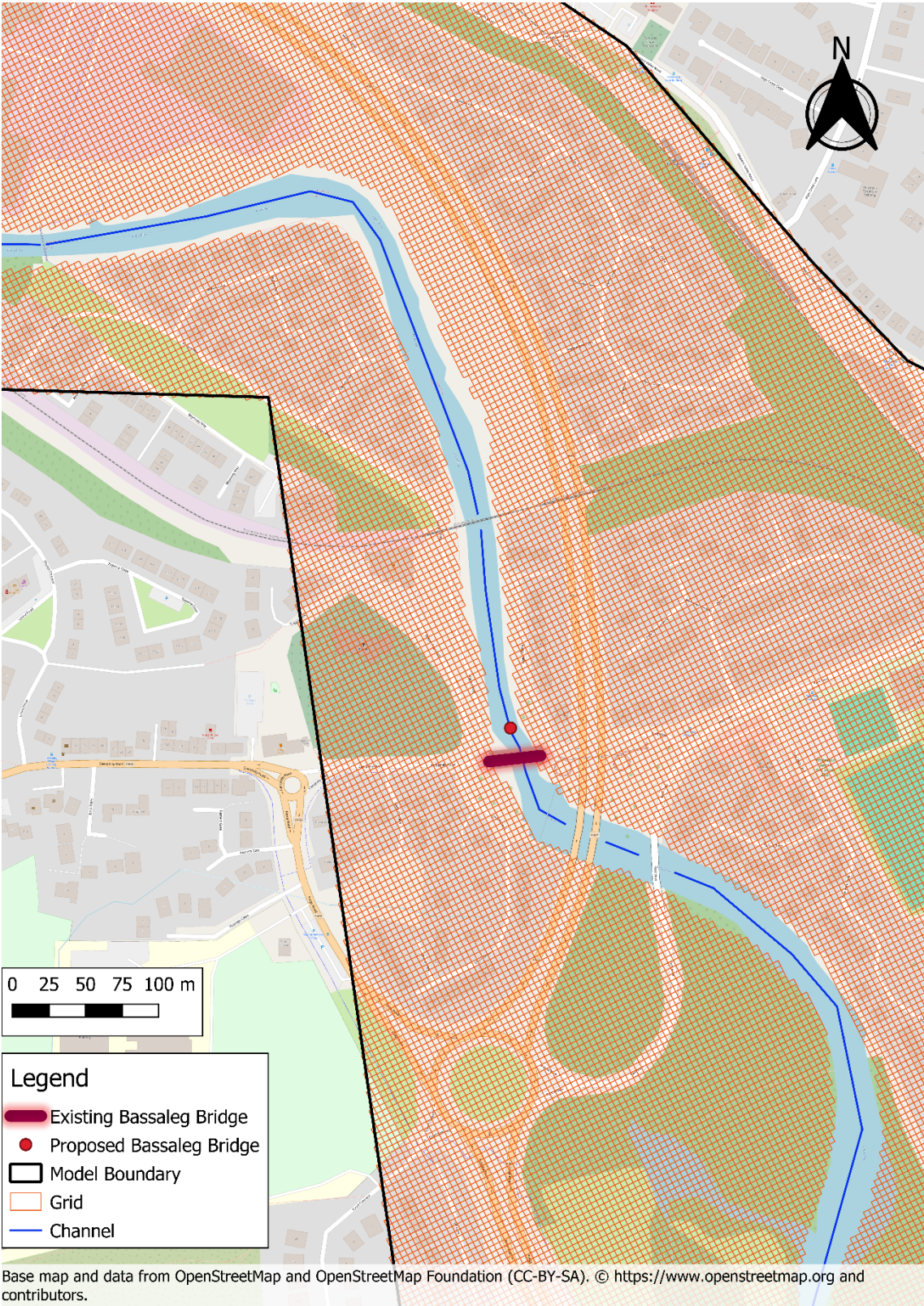
Figure 5.5: Existing bridge geometry (note section below is looking upstream)

Source: Bassaleg Bridge Detailed Design Planning Drawing Existing Plan and Elevation, 100119581-MMD-XX-XX-DR-PL-1001 P02.\

5.7 2D Grid Resolution and Orientation

The model 2D domain utilises a 4-metre grid resolution, shown in Figure 5.6. This remains unchanged from the existing model as this grid size is sufficient to accurately represent key hydraulic features, including the river channel, banks and bridge structures in the area of interest.

Figure 5.6: 2D grid resolution and orientation



Source: Mott MacDonald 2025

5.8 Topographic Phases (Cases)

The hydraulic model has been used to assess flood risk for three development phases (or cases) –

- **Baseline** – Existing Site with the ‘Old Bassaleg Bridge’ in place.
- **Proposed** –
 - **Permanent**: ‘New Bassaleg Bridge’ and a flood bund in place with the old bridge removed.
 - **Temporary**: Both the Old and New Bassaleg Bridges in place, with no flood bund, representing a precautionary short-term transitional phase of approximately one year before the old bridge is removed (due to seasonal constraints during construction).

Table 5.3 outlines the permanent and temporary cases assessed as part of this hydraulic modelling study. These cases have been developed to evaluate the hydraulic impacts of the scheme during different stages of construction and use.

Table 5.3: Proposed scheme – Model cases

Ref.	Model Case	Approach / model representation
PO	Permanent case	• New bridge with flat soffit level set at 21.58m. • Old bridge removed from the model. • Includes channel modifications at the new bridge location and immediate upstream and downstream sections. • Flood bund included at Churchmead.
TO	Temporary case	• New bridge with flat soffit level set at 21.58m. • Old bridge retained in the model. • Includes channel modifications at the new bridge location and immediate upstream and downstream sections.

Source: Mott MacDonald 2025

Figure 5.7 displays the proposed elevation of the New Bassaleg Bridge. For both the temporary and permanent cases, the New Bassaleg Bridge has been incorporated into the hydraulic model using the bridge unit (node EBBW_4055bu) within the 1D FM network. The new bridge is designed with a sloping soffit, increasing in elevation from left bank to right bank. It is not possible to explicitly represent the structure in the way within Flood Modeller therefore the structure was simplified to a flat soffit taken as the average level of 21.58mAOD.

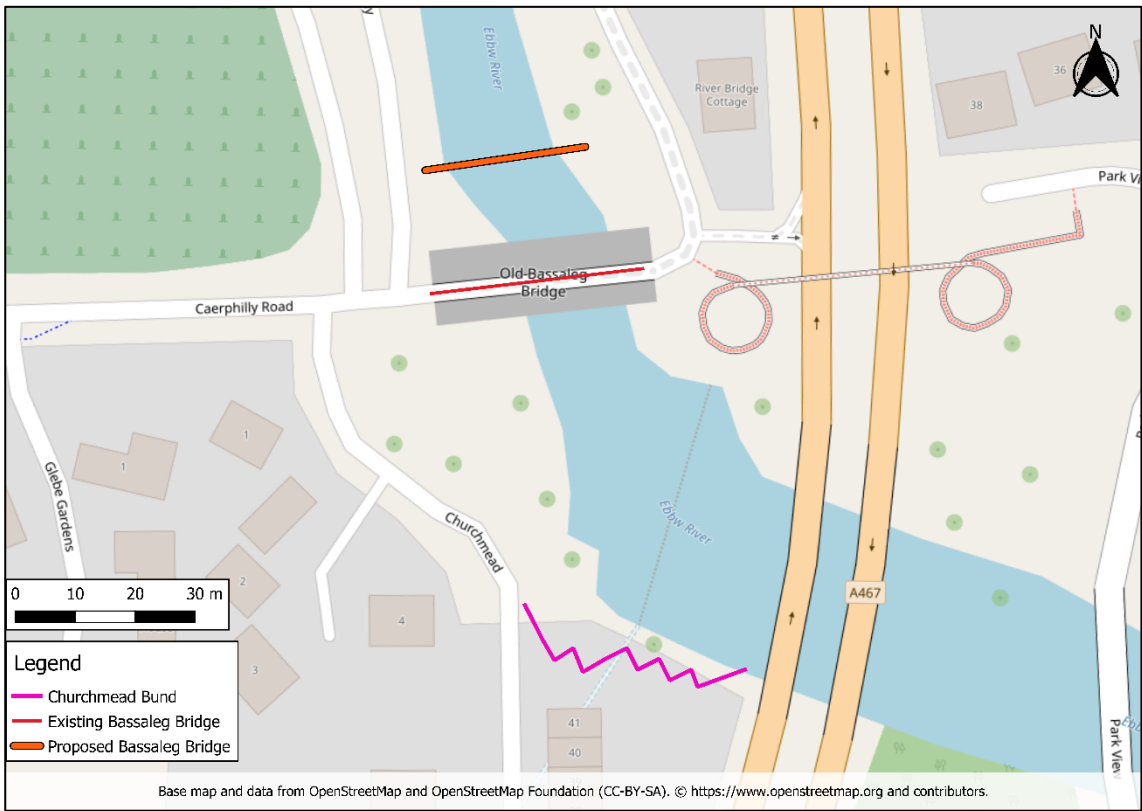
The bridge deck has been designed to align with the existing road surface levels on either side, therefore it is assumed that this eliminates the need for additional topographic adjustments to represent the approach roads. The approximate road surface elevation is 21.20mAOD on the left hand (Eastern) side of the bridge and 23.50mAOD on the right hand (Western) side.

[illegible]

Source: Bassaleg Bridge Detailed Design Planning Drawing Proposed Elevations, 100119581-MMD-XX-XX-DR-PL-1301 P02

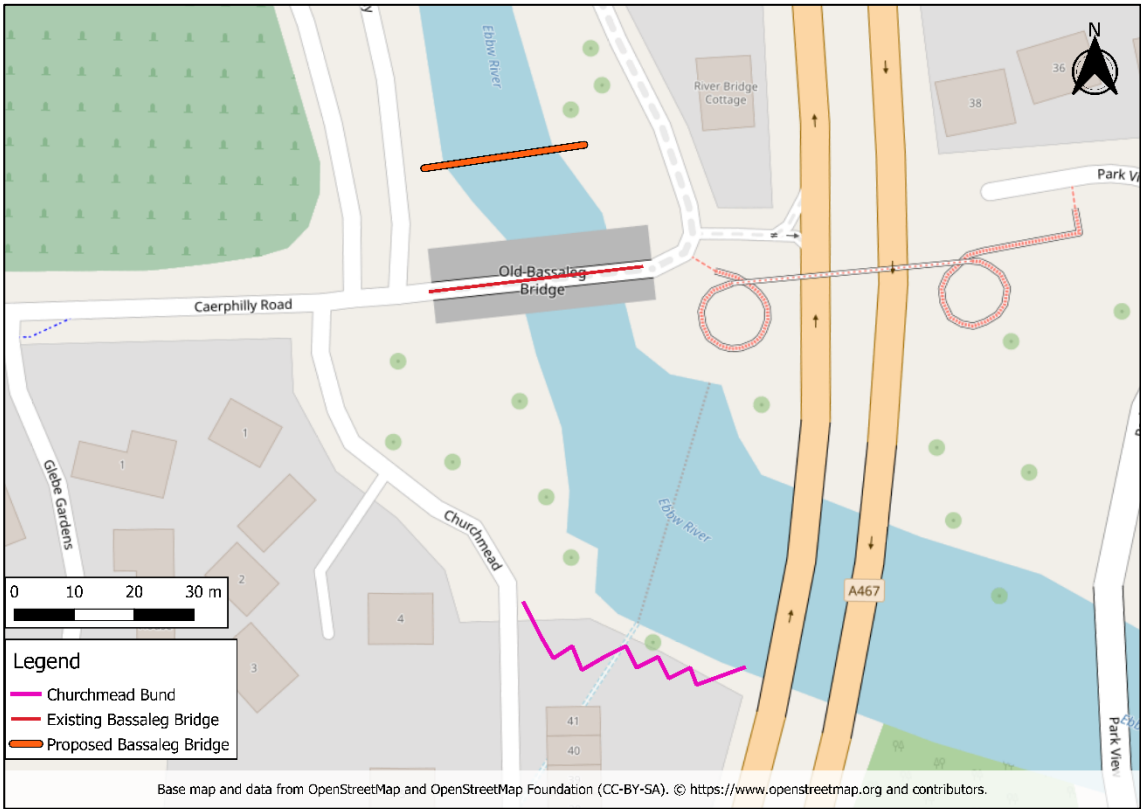
To help mitigate the potential of an increase in flood risk downstream of the new bridge during extreme events (between 0.5% and 0.1% AEP), a flood bund / wall has been incorporated into the proposals as a mitigation measure. The bund / wall will be situated on the right bank of the River Ebbw downstream of Old Bassaleg Bridge adjacent to properties on Churchmead. The structure will have a crest level of 22.5mAOD and will tie into higher ground along Churchmead and the A467. The bund / wall has been applied to the model using a z-line feature, as shown in Figure 5.8.

Figure 5.8: Flood bund at Churchmead



Source: Mott MacDonald 2025

Figure 5.8: Flood bund at Churchmead



Source: Mott MacDonald 2025

5.9 Design Flood Events

The model has been used to assess a range of fluvial events, as indicated in Table 5.4. The 25% and 70% climate change uplift scenarios are based on the climate change allowances published by NRW (Welsh Government, 2021). All flood events were run using a consistent storm duration of 25 hours.

Table 5.4: Design fluvial flood events

Case	Present day (2025)						Future (2080s)			
	50% AEP	10% AEP	3.33 % AEP	1% AEP	0.5% AEP	0.1% AEP	1% AEP + 25% CC	0.1% AEP + 25% CC	0.5% AEP + 70% CC	0.1% AEP + 70% CC
Baseline	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Permanent	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Temporary	✓	✓	✓	✓	✓	✓	X	X	X	X

Note: 'CC' stands for 'Climate Change' allowance.

Source: Produced by Mott MacDonald Ltd. 2025.

6 Baseline Model

The baseline model was developed to provide an improved understanding of the existing flood risk in the area and the foundation for assessing the proposed scheme. This section outlines the model simulations completed, and provides a summary of overall model performance and model results.

6.1 Baseline Model Simulations

Table 6.1 outlines the baseline model simulations completed to inform the assessment.

Table 6.1: Baseline model run log

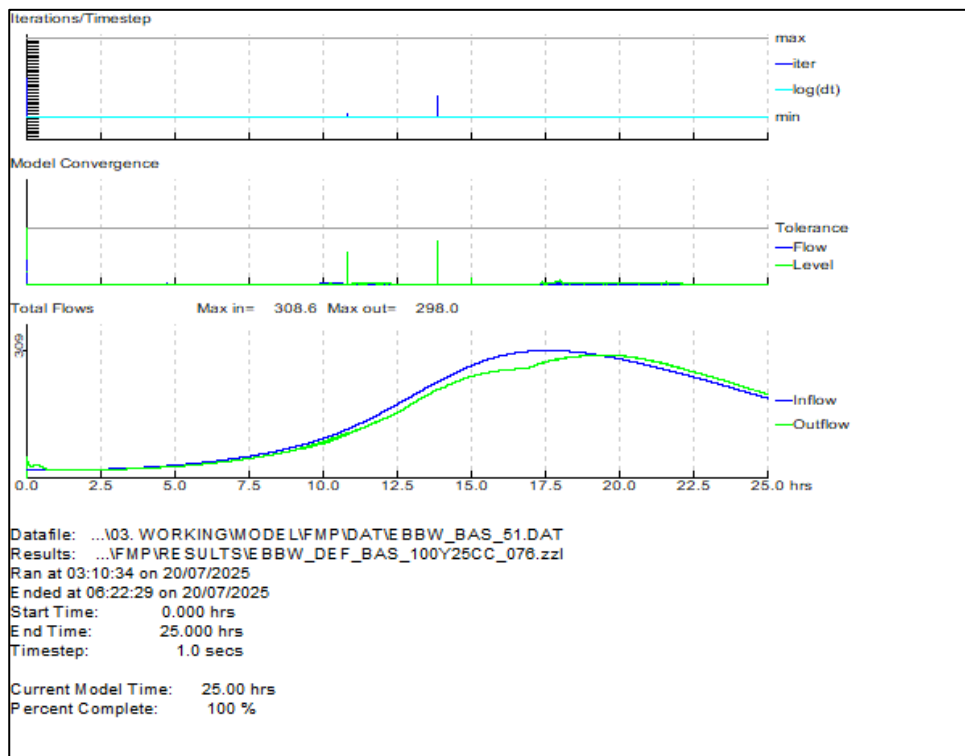
Topographic Case	Events	DAT file	Event Data (IED)	1D-2D Control Files
Baseline	50%, 10%, 3.33%, 1%, 0.5% and 0.1% AEP present day, 1% and 0.1% AEP with 25% climate change, and 1%, 0.5% and 0.1% AEP with 70% climate change	EBBW_BAS_51.dat	EBBW_L_RP_031.ied* and, EBBW_L_RP_2017_SD21h30_031.ied**	EBBW_DEF_BAS_RP_076.ief EBBW_~s1~_~s2~_~e1~_076.tcf

RP - Return period
* for 50%, 10%, 3.33%, 1%, 0.5% AEP present day events, and 1% AEP with 25% climate change and 1% AEP with 70% climate change, and 0.5% AEP with 70% climate change events.
** for 0.1% AEP present day, 0.1% AEP with 25% climate change, 0.1% AEP with 70% climate change events.

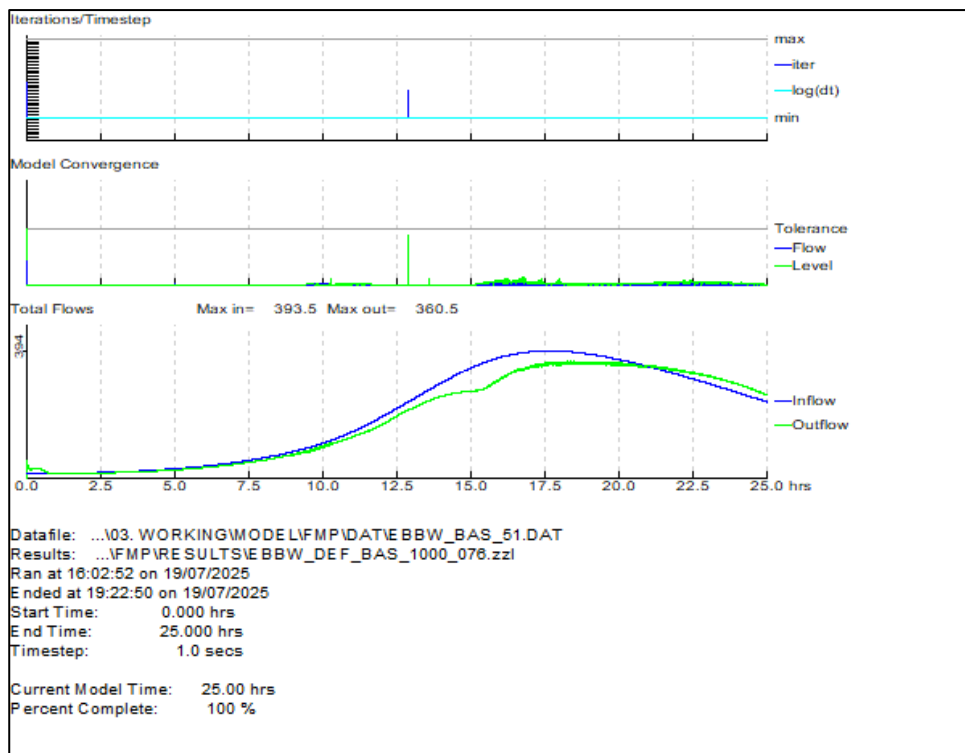
Source: Mott MacDonald 2025

6.2 Baseline Model Performance

Figure 6.1 and Figure 6.2 show that the model demonstrates good overall performance, with no significant periods of non-convergence observed in either the 1D components that would affect the reliability of the results. The 2D model mass balance remains within acceptable limits, not exceeding $\pm 1\%$ at any point during the simulation and the transfer of flow between the 1D and 2D models is smooth and stable.

Figure 6.1: FM simulation graphic – Baseline case – 1% AEP with 25% climate change.

Source: Mott MacDonald 2025

Figure 6.2: FM simulation graphic – Baseline case – 0.1% AEP event.

Source: Mott MacDonald 2025

Several messages are reported by FMP and TUFLOW during the model compilation and simulation. These are summarised in Table 6.2 and Table 6.3 respectively.

Table 6.2: FMP messages (from .exy results file)

Ref.	Message	Severity Rating*	Comments
3028	Data points omitted from deactivated section areas	5	Message indicates that deactivation markers have been used to 'trim' sections – these are intentional changes to the model sections.
2019	Water level rose beyond max level of channel section data	2	The model is a linked 1D / 2D model, and therefore water levels above the maximum channel section data would be expected.
3010	Simplified method used to compute solution at one or more sections	5	This message indicates that the 'simplified method' has been used where high Froude numbers have been attained, which may result in hydraulic jumps being smoothed out over several nodes, potentially leading to a less accurate solution. Results indicate that this message is appearing in relation to the final channel section in the 1D model and is therefore not likely to have a significant impact on the results within the area of interest.
2060	Conveyance decreases for increasing depth	2	This may be caused by a large increase in width with a small increase in area and can cause conversion problems near this depth. This warning is expected in complex or irregular cross-sections and does not affect model results unless it causes model stability issues which is not case.
2044	Different values (+/- 20 %) for Mannings n encountered in same panel	2	Differing values of Manning's n (of over 20%) have been entered within the same panel. It is common to assign different manning's values across the section, especially those with hard/soft bed material and vegetated banks. This can lead to a variation of more than 20% within a single panel. This warning is expected in sections with varying materials.
2238	Panel has very small width	2	A warning was generated for three cross sections where the panel

Ref.	Message	Severity Rating*	Comments
			beginning at a cross-chainage is less than 1 mm wide. These warnings are associated with vertical walls represented at the minimum chainage in the cross sections. However, this does not affect model stability or accuracy. No action is required in response to these warnings.
2206	Extrapolating pier curves, pier coefficient may not be reliable	2	The pier coefficient in a USBPR bridge unit is 1 which is greater than 0.4 and has been reset to its maximum, 0.4.
2204	Bridge is surcharged. Afflux calculation may be inaccurate	2	In higher return period events it is expected that some bridge may become surcharged (including Old Bassaleg bridge). This warning is expected under high flow conditions and does not compromise model accuracy.

*FMP Severity Ratings: 1 - Fatal Error

2 - Likely to affect results

3 – May affect results

4 – Unlikely to affect results

5 – Notes

Source: Mott MacDonald 2025

Table 6.3: TUFLOW messages

Ref.	Message	Comments
WARNING 0305	Projection of .mif file is different to that specified by the MI Projection == command.	A message appears for eight GIS layers and is related to the difference in file formats: the original model used the MIF format, while the current model uses the SHP format. Model checks were performed to ensure that all information from the SHP files is correctly incorporated and there are no issues do to the format change.
WARNING 0307	No GIS Projection specified. No output .prj file will be created.	This warning is informational only and this warning refers to previously defined output zones that have since been excluded from the model.
WARNING 1313	No inlet culvert connected to Manhole "M4Culvert.1". Manhole not used/applied.	This warning is triggered at the upstream end of a culvert where TUFLOW attempts to auto-generate a manhole connection. In this case, the culvert is not connected to a 1D manhole, but instead directly linked to the 2D domain via a 2D SX connection. The warning is

Ref.	Message	Comments
		simply a notification that a manhole was expected but not used.
WARNING 2073	Null Shape object ignored. Only Regions, Lines, Polylines & Multiple Polylines used.	The model layers were trimmed to suit a curtailed domain. In this process, some feature footprints were deleted, but the attribute data remained in the shapefile. The warning flags entries in the shapefile that lack spatial geometry (i.e., null shapes). These warnings have been checked and do not relate to any required input data.
WARNING 2118	Lowered SX ZC Zpt by x m to 1D node bed level.	This warning indicates that the Zpt (2D elevation point) at the SX connection was lowered to match the invert level of the connected 1D culvert. The original Zpt elevation may have been too high due to terrain data. TUFLOW automatically adjusts it using the Z flag to ensure proper flow exchange. This adjustment is intentional and necessary for accurate culvert representation.

Source: Mott MacDonald 2025

6.3 Baseline Results

6.3.1 Present-day

Flood extents for the baseline case from the 50% AEP up to the 0.1% AEP present-day fluvial flood events are shown in Figure 6.3.

The baseline case results indicate that in the area of the existing bridge, the river remains in bank for the 50% AEP present-day event and the Site is not predicted to be at risk of flooding during the 10% AEP present-day event. Flooding during the 3.3% AEP to the 0.1% AEP present-day events are shown to primarily affect the eastern part of the Site, with some flooding also depicted to the north of the Site along Viaduct Way.

From a review of the model results, it can be seen that the Old Bassaleg Bridge constricts flows on the River Ebbw. The results suggest that the bridge becomes surcharged for an event with an AEP between 3.33% and 1%. The soffit levels of the existing bridge are 21.50m and 21.70m for the two arch openings, whilst the predicted peak water levels are 21.30mAOD for the 3.33% AEP event and 22.54mAOD for the 1% AEP event.

Upstream and downstream of the Old Bassaleg Bridge, the nearest structures are much larger and are not surcharged for any of the events assessed (up to the 0.1% AEP flood event), although the Ebbw Weir, a short distance downstream of Old Bassaleg Bridge, does influence flow past the site.

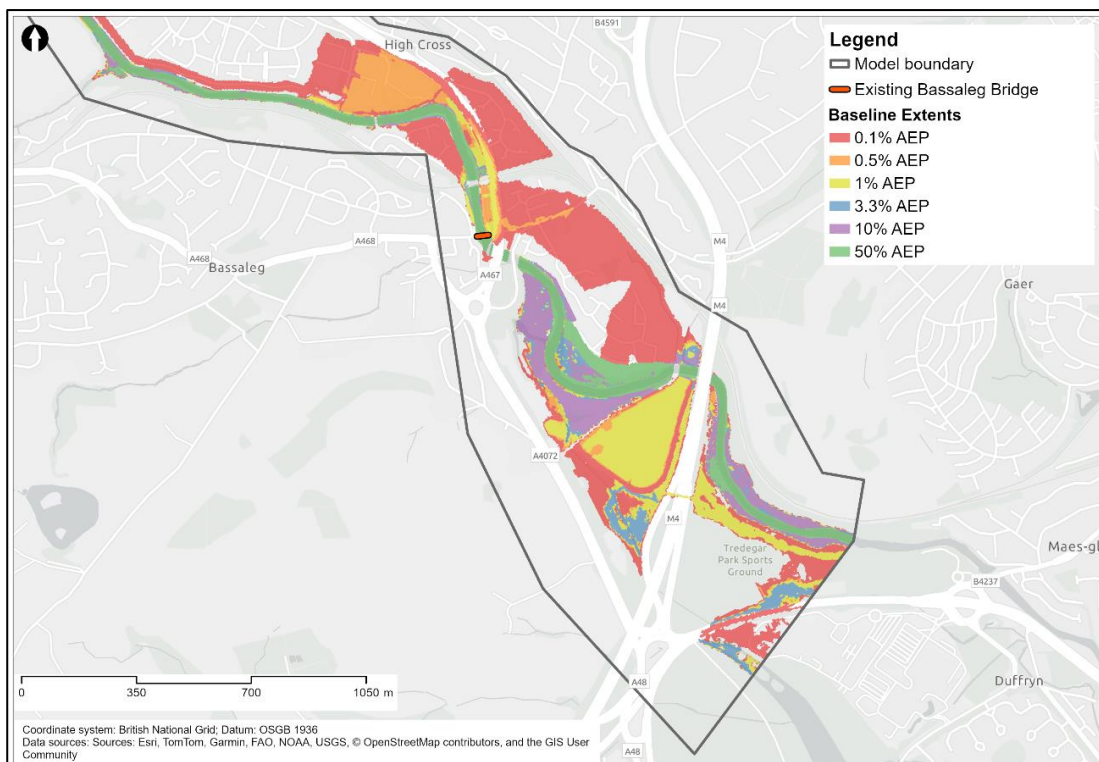
Assessing the wider site, the results indicate that there is no flooding predicted near the Old Bassaleg Bridge for events up to the 3.33% AEP flood event; while bank exceedance and overtopping is predicted to begin in the Tredegar Park area between 50% - 10% AEP flood events.

Upstream of the Bassaleg Viaduct, the left bank is predicted to breach with an overland flow route passing adjacent to the highway A467 during an event with an AEP between 3.33% and

1%. This flow path outflanks the left bank defences and is predicted to combine with the flow breaching the defence upstream of the Old Bassaleg Bridge (approximately 1% AEP). When this occurs the residential properties along Forge Mews are predicted to be at risk of flooding.

For larger events (approximately 0.5% AEP event), the highway A467 is predicted to become inundated with a flow path towards the developments to the east of the Bassaleg bridge. This causes a large area of residential properties to be predicted at risk during the during extreme events (between 0.5% - 0.1% AEP). Properties to the east of Churchmead are also predicted to be at risk during extreme events.

Figure 6.3: Baseline case flood extent for present day event



Source: Mott MacDonald 2025

6.3.1.1 Future (with climate change)

Figure 6.4 shows the predicted flood extents for the 1% and 0.1% AEP events with a central (25%) and upper (70%) climate change allowances and provides an indication of the increased flood risk at the end of the design life of the development. This indicates that this area is vulnerable to the impact of climate change.

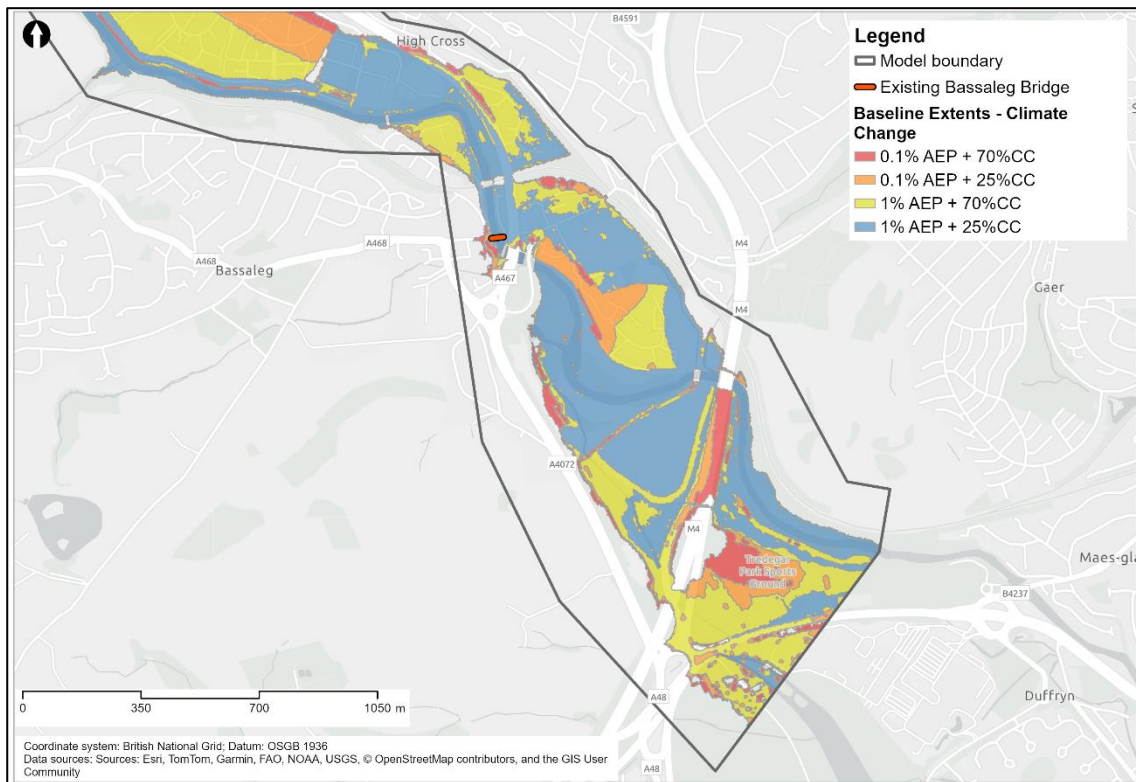
With a central (25%) climate change allowance the flow path towards the developments to the east of Old Bassaleg bridge is predicted to start to establish for events with AEP of less than 1% (approximately 0.5% AEP in present day). Flooding predicted for the future 1% AEP with higher (70%) climate change shows large areas of residential properties in the Park View and Deer Park Lane area predicted to be at risk with extents not dissimilar to that shown in the present day 0.1% AEP event.

The results for the 0.1% AEP event central (25%) and upper (70%) climate change show more modest increases in flood extent however flow depths are predicted to increase notably. For example, on Forge Mews depths are predicted to increase from 0.8m in the present day to approximately 1.0m and 1.4m with central and higher climate change allowances applied. A

similar magnitude of increase in depths are predicted on Viaduct Way and in the Park View and Deer Park Lane areas.

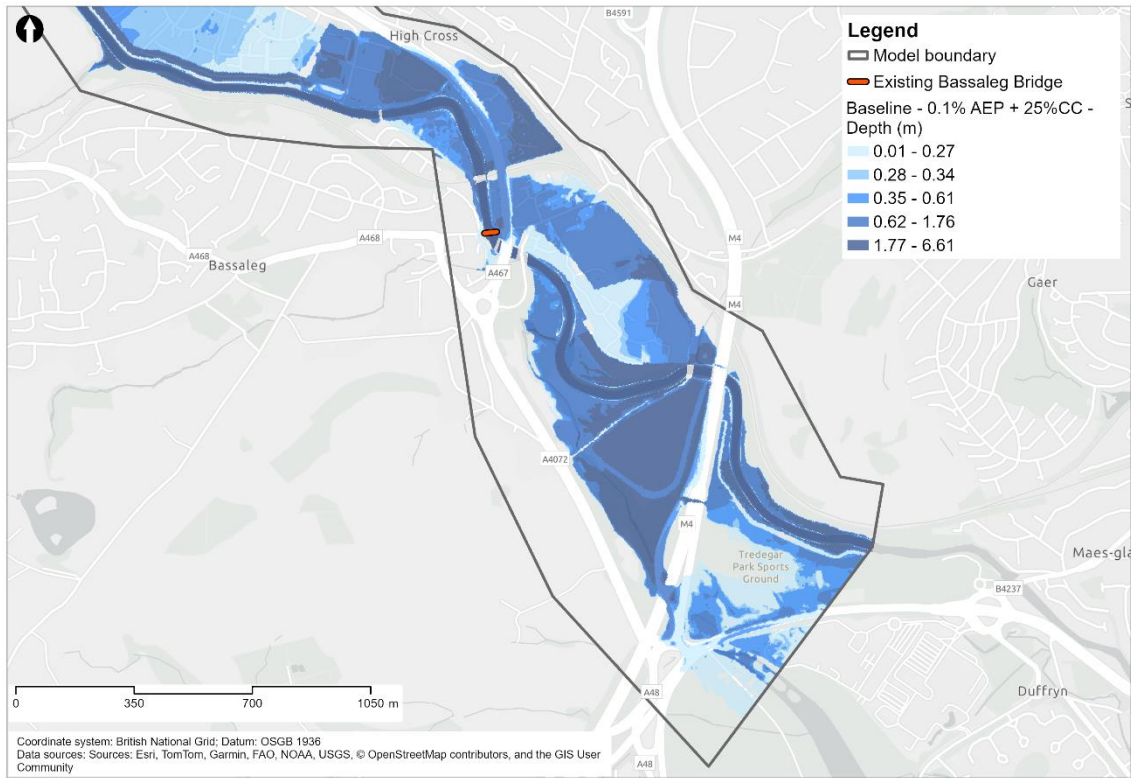
At Churchmead, nominal flooding is predicted to occur immediately adjacent to the channel in the present day 0.1% AEP event. However, this is predicted to increase notably in the future, with significantly more properties predicted to be at risk.

Figure 6.4: Baseline case flood extents for climate change events.



Source: Mott MacDonald 2025

Figure 6.5: Maximum flood depths for 0.1% AEP + 25% climate change event



Source: Mott MacDonald 2025

7 Proposed Scheme Model

The proposed scheme model cases were developed to assess the potential impact of the proposed scheme during construction (Temporary case) and once completed (Permanent case). This section outlines the model simulations completed and provides a summary of overall model performance and model results. Analysis of the suitability of the proposed development can be found in the Bassaleg Bridge Detailed Design Flood Consequence Assessment (100119581-MMD-XX-XX-RP-FL-0002).

7.1 Proposed Scheme Model Runs

Table 7.1: Proposed scheme model runs

Topographic Case	Events	DAT file	Event Data (IED)	1D-2D Control Files
Permanent	50%, 10%, 3.33%, 1%, 0.5% and 0.1% AEP present day, 1% and 0.1% AEP with 25% climate change, and 1%, 0.5% and 0.1% AEP with 70% climate change	EBBW_PO6_52.dat	EBBW_L_RP_031.ied * and, EBBW_L_RP_2017_S D21h30_031.ied**	EBBW_DEF_PO6_RP_080.ief EBBW_~s1~_~s2~_~e1 ~_080.tcf
Temporary	50%, 10%, 3.33%, 1%, 0.5% and 0.1% AEP present day	EBBW_TO6_52.dat	EBBW_L_RP_031.ied * and, EBBW_L_RP_2017_S D21h30_031.ied**	EBBW_DEF_TO6_RP_079.ief EBBW_~s1~_~s2~_~e1 ~_079.tcf

RP - Return period

* for 50%, 10%, 3.33%, 1%, 0.5% AEP present day events, and 1% AEP with 25% climate change and 1% AEP with 70% climate change, and 0.5% AEP with 70% climate change events.

** for 0.1% AEP present day, 0.1% AEP with 25% climate change, 0.1% AEP with 70% climate change events.

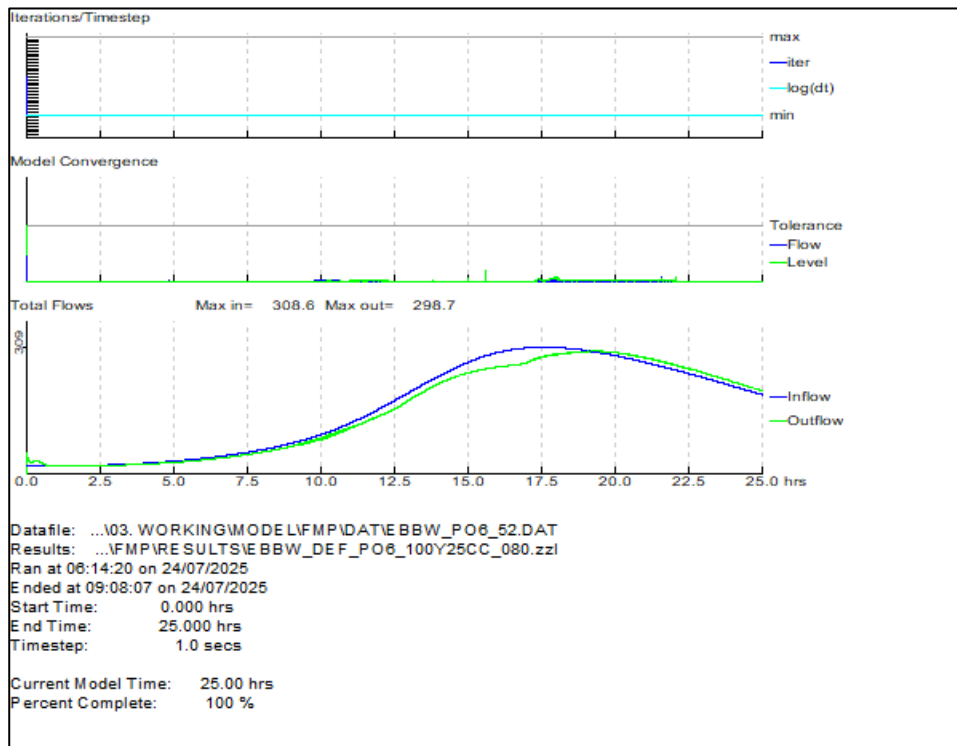
Source: Mott MacDonald 2025

7.2 Proposed Scheme Model Performance

The model demonstrates good overall performance, with no significant periods of non-convergence observed in either the 1D or 2D components that would affect the reliability of the results. Figure 7.1 and Figure 7.2 show FM simulation graphics for the 1% AEP with 25% climate change event and 0.1% AEP event respectively.

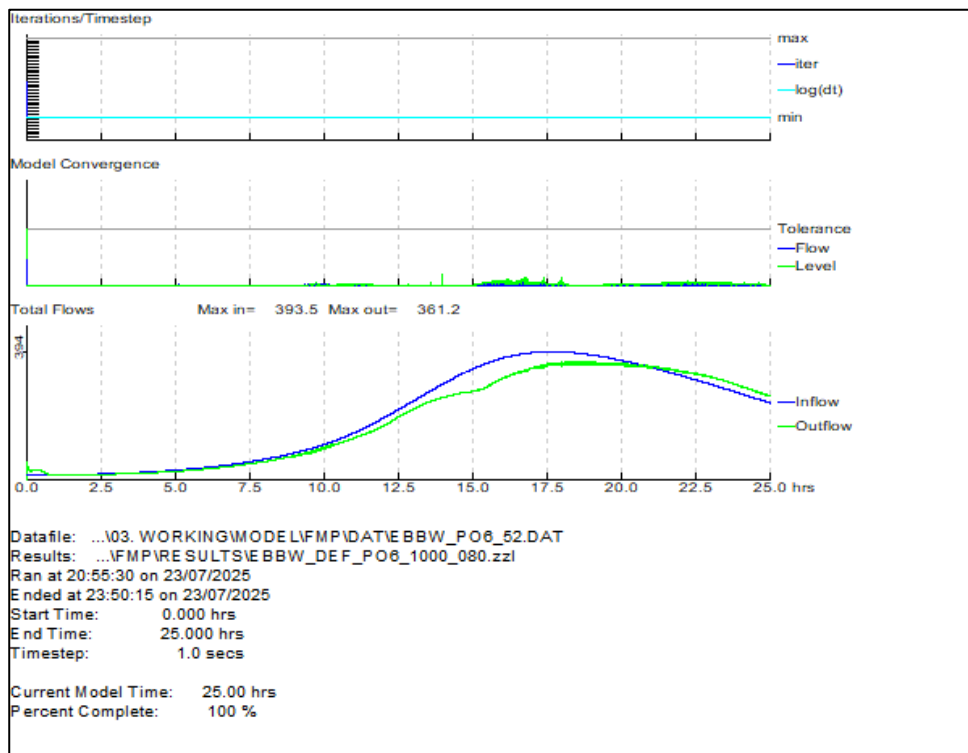
Several messages are reported by FMP and TUFLOW during the model compilation and simulation. These are consistent with those reported during the Baseline case simulations which are summarised in Table 6.2 and Table 6.3 respectively.

Figure 7.1: FM simulation graphic – Permanent case – 1% AEP with 25% climate change, with mitigation.



Source: Mott MacDonald 2025

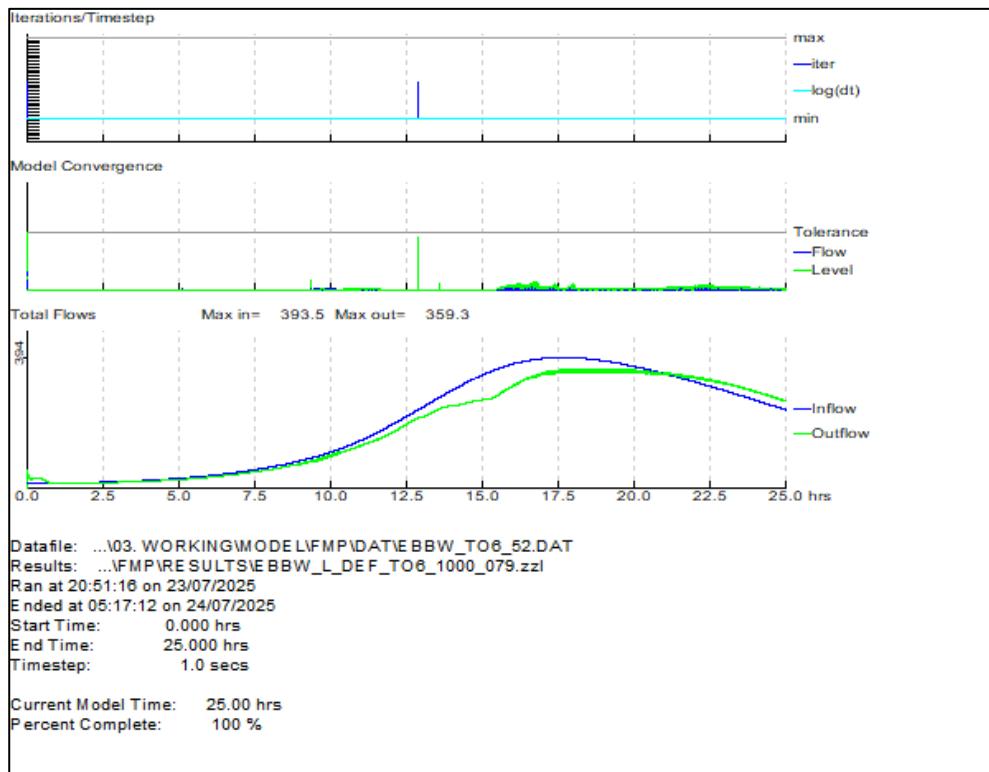
Figure 7.2: FM simulation graphic – Permanent case – 0.1% AEP, with mitigation



Source: Mott MacDonald 2025

Figure 7.3 shows the FM simulation graphic for the 0.1% AEP Temporary case simulation. The model is deemed to perform well, with good model convergence throughout the course of the simulation.

Figure 7.3: FM simulation graphic – Temporary case – 0.1% AEP, with mitigation



Source: Mott MacDonald 2025

7.3 Proposed Scheme Model Results

7.3.1 Definition of Change in Flood Risk

Modelling for Flood Consequence Assessments guidance provided on the Natural Resources Wales website (Natural Resources Wales, 2025) provides guidance relating to the appropriate numerical precision to be adopted for the assessment of change when comparing pre and post development flood modelling simulations. This guidance, as outlined in

Table 7.2, has been used to categorise when an increase or decrease to flood risk has occurred between the baseline and proposed scheme model cases.

Table 7.2: Definition of a change to flood risk relating to water level difference

Change to flood risk	Definition	Description
Decrease	$\geq 0.005\text{m}$ decrease in maximum water level	'Baseline' case has a higher maximum water level than the 'proposed scheme' case
No change	Between: < 0.005m decrease; and < 0.005m increase	Insignificant change in maximum water level between the 'Baseline' case and the 'proposed scheme' case
Increase	$\geq 0.005\text{m}$ increase in maximum water level	'Proposed scheme' case model has a higher maximum water level than the 'Baseline case'

Source: Mott MacDonald 2025

In accordance with TAN15, flood events up to and including the 0.1% AEP with 25% climate change allowance event have been modelled for the assessment of potential third party impacts. More extreme events (0.1% AEP with 70% climate change allowance event) have been simulated to assess the residual risks associated with exceedance flows. Further details of how this data has been used can be found in the FCA (Mott MacDonald, 2025a).

7.3.2 Permanent Case

7.3.2.1 Present-day

Flood extents for the Permanent case for present-day fluvial flood events ranging from the 50% to 0.1% AEP are shown in Figure 7.4. Figure 7.5 to Figure 7.10 provide a illustration of the predicted change in water level (Permanent minus Baseline) for these events.

A review of predicted change in flood levels between the baseline and permanent cases reveals that, overall, no significant increase in flood risk is anticipated up to the 0.5% AEP event. The minor exception to this is the 1% AEP event where localised change are observed at open space at Tredegar Park Bowl (shown in Figure 7.8). With the average soffit level of the new bridge at 21.58mAOD, the bridge will become submerged for an event with an AEP between 3.33% and 1% similar to the Baseline case.

For events up to the 0.5% AEP, the Permanent case generally predicts lower flood levels and reduced extents compared to the Baseline case. Several areas that are predicted to be at risk in the Baseline case are projected to remain dry in the Permanent case. In the 0.1% AEP event, flood levels and extents are predicted to decrease in key residential areas such as Forge Mews and the eastern bank of the River Ebbw.

The differences shown are due to the changes in flow through the new bridge opposed to the that of Old Bassaleg Bridge. This results in a small decrease in water levels upstream of the new bridge that leads to a reduction in out of bank flow over the left bank. Conversely, there would be a small increase in flow through the new bridge.

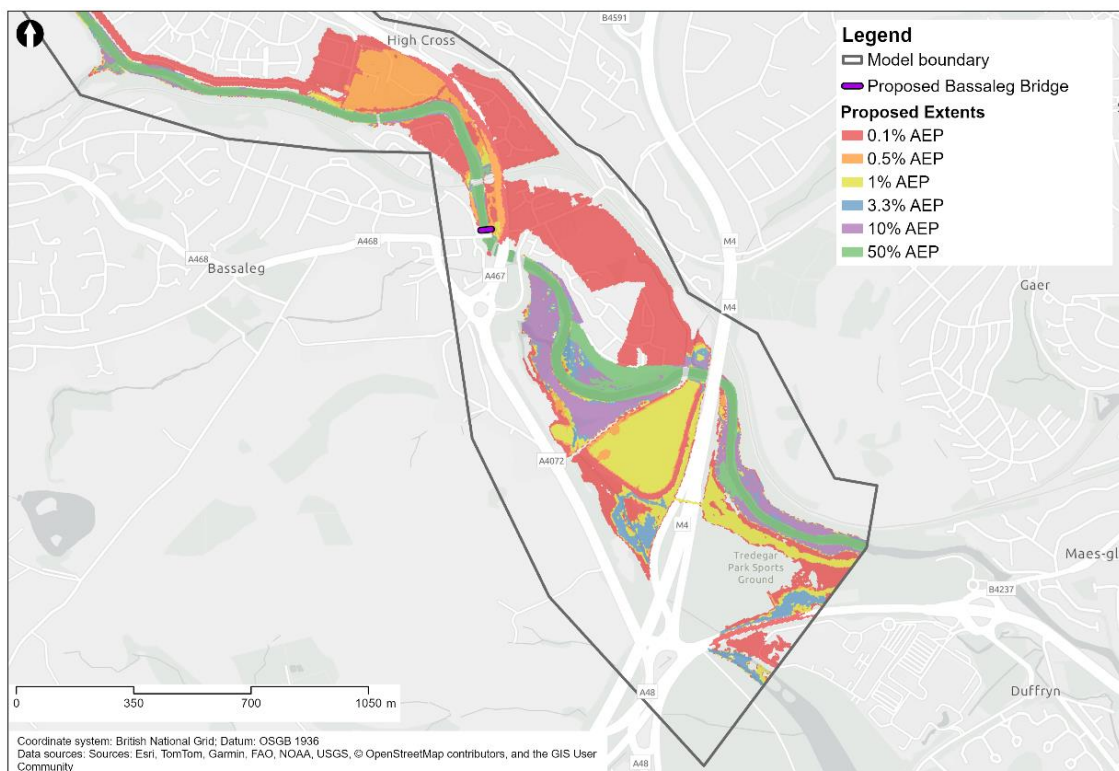
To address a potential increase to flood risk at Churchmead (on the right bank immediately downstream of Old Bassaleg Bridge) the scheme has incorporated a flood bund / wall to be constructed adjacent to the channel. With this in place Churchmead is predicted to flood free during all simulated present-day events.

Further downstream, any predicted flood level increases are mostly limited to open spaces along the river corridor. A small area near Fallow close and Deer Park Lane shows a predicted increase of around 0.05m. The residential properties and their gardens at this location are situated on a raised development platform, with ground elevations ranging from 19.1mAOD to 19.8mAOD, which is a minimum 0.2m above the predicted 0.1% AEP flood level. Consequently, these residential areas are not expected to be affected during this event and what is shown is an anomaly with the flood model digitisation.

It should be noted that the design and hydraulic assessment of the New Bassaleg Bridge is intrinsically linked to the comparative representation of the Old Bassaleg Bridge and proposed New Bassaleg Bridge design. As discussed in Section 5.6, the existing twin arched Old Bassaleg Bridge structure is currently understood to trap and accumulate debris, which can lead to blockages and, further to discussion with NRW, the structure has been represented as being 25% blocked in the Baseline case. The new bridge will have a slightly smaller overall aperture than then existing bridge but will be free spanning notably reducing the blockage risk to the structure.

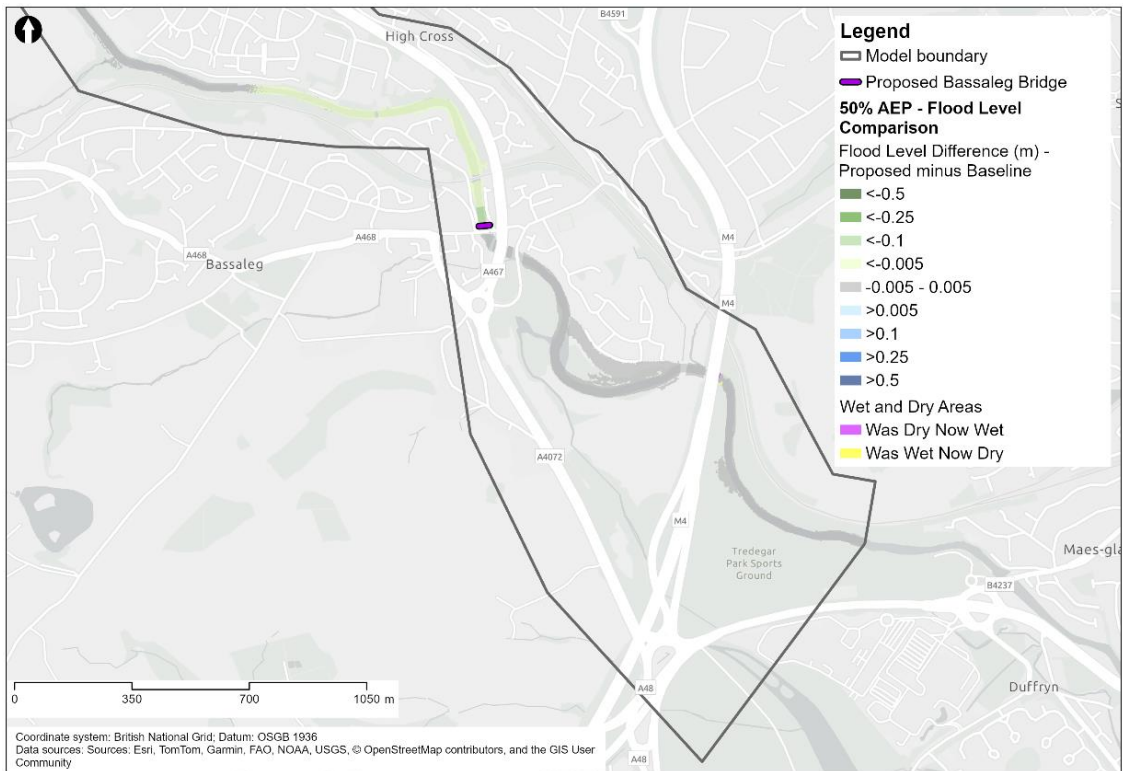
Changes to the design or representation of the new bridge or the baseline assumptions could alter the point at which flooding is predicted to commence over the left bank upstream of the bridge leading to changes the predicted flows in the channel (and flooding) downstream of the bridge, and therefore. affect the assessment of flood consequences.

Figure 7.4: Permanent case flood extents from the 50% AEP up to the 0.1% AEP present-day events



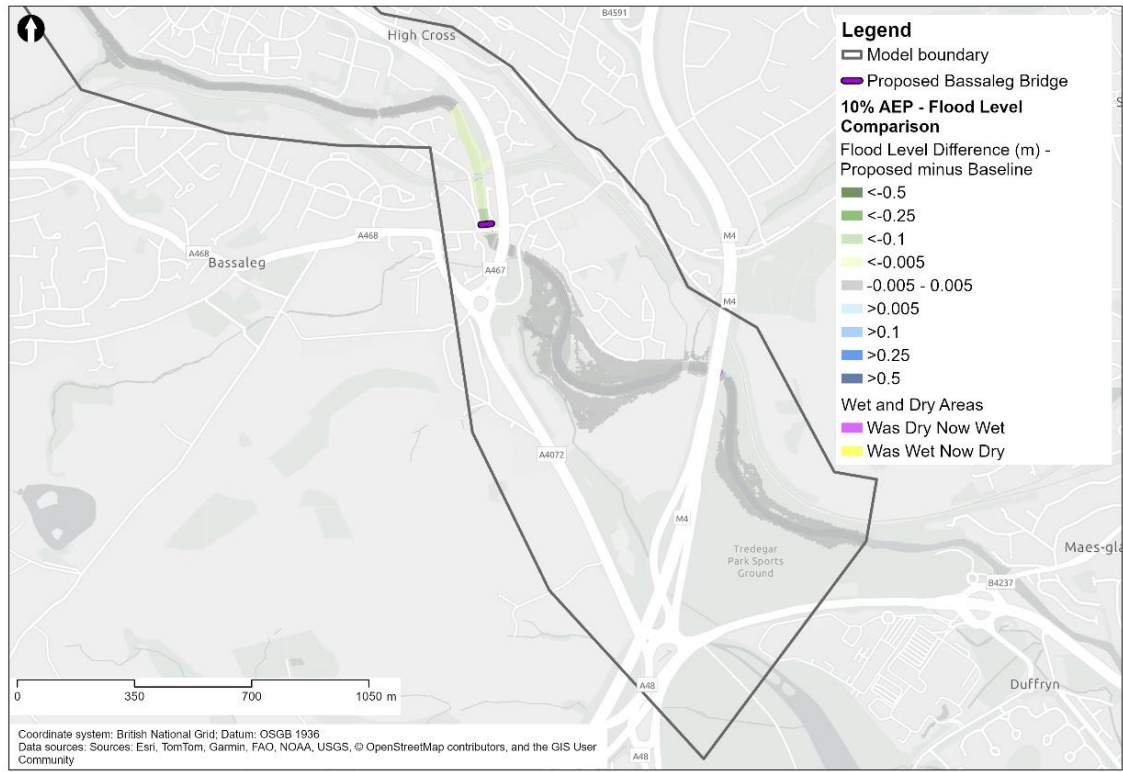
Source: Mott MacDonald 2025

Figure 7.5: Water level difference - Permanent minus Baseline cases - 50% AEP event (in m)



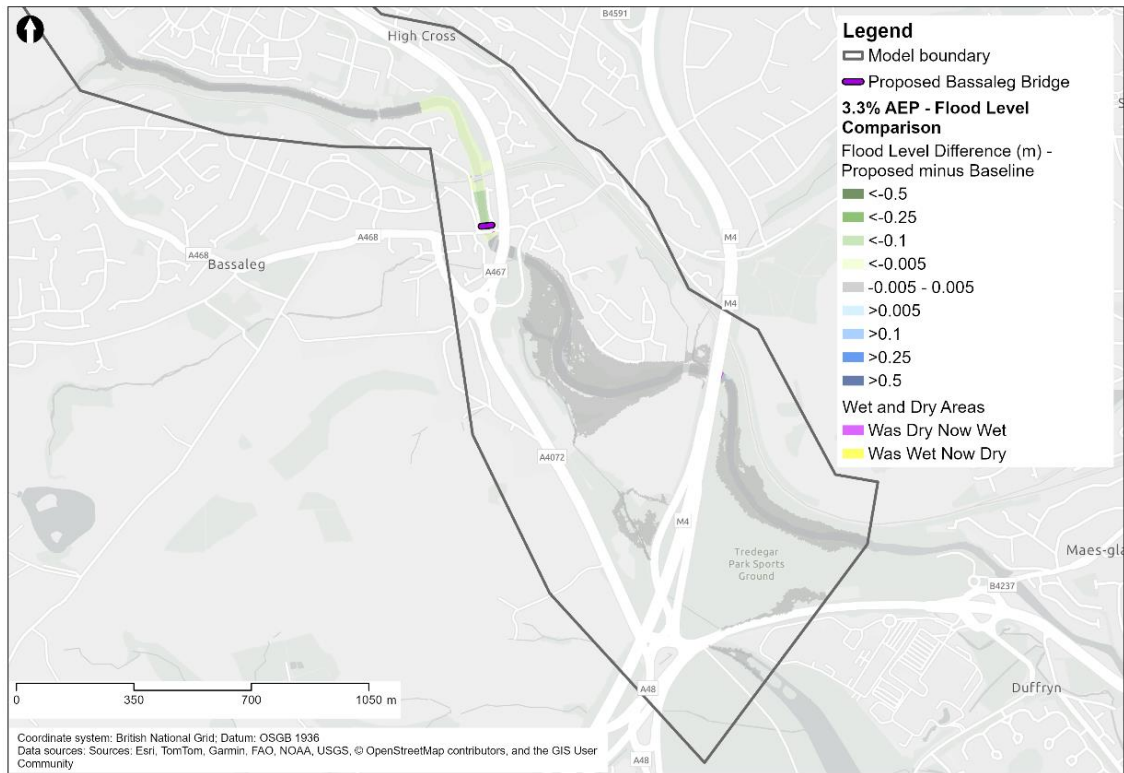
Source: Mott MacDonald 2025

Figure 7.6: Water level difference - Permanent minus Baseline cases - 10% AEP event (in m)



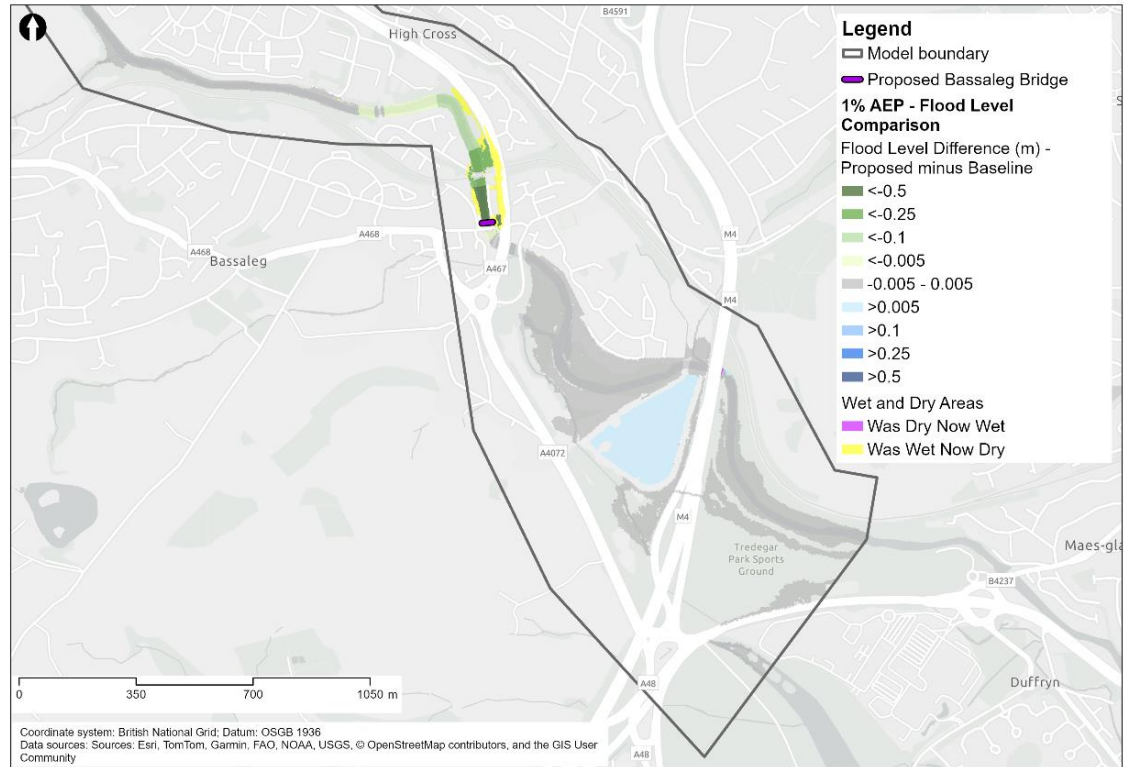
Source: Mott MacDonald 2025

Figure 7.7: Water level difference - Permanent minus Baseline cases - 3.33% AEP event (in m)



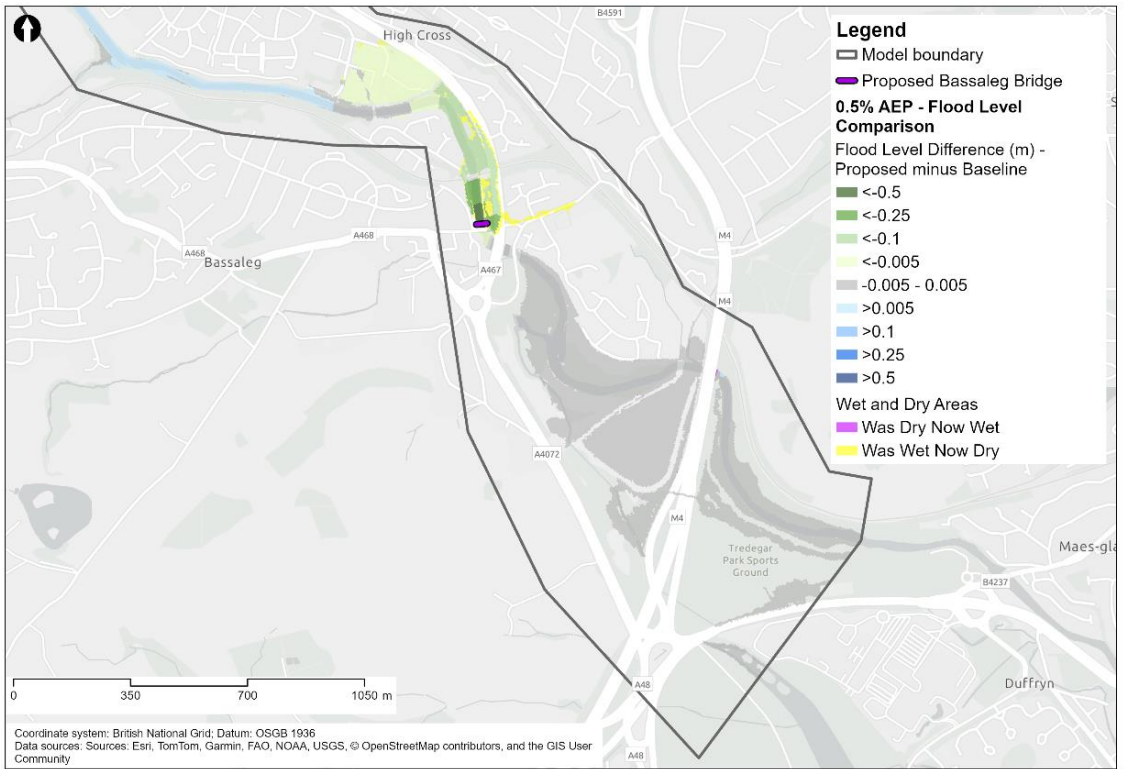
Source: Mott MacDonald 2025

Figure 7.8: Water level difference - Permanent minus Baseline cases - 1% AEP event (in m)



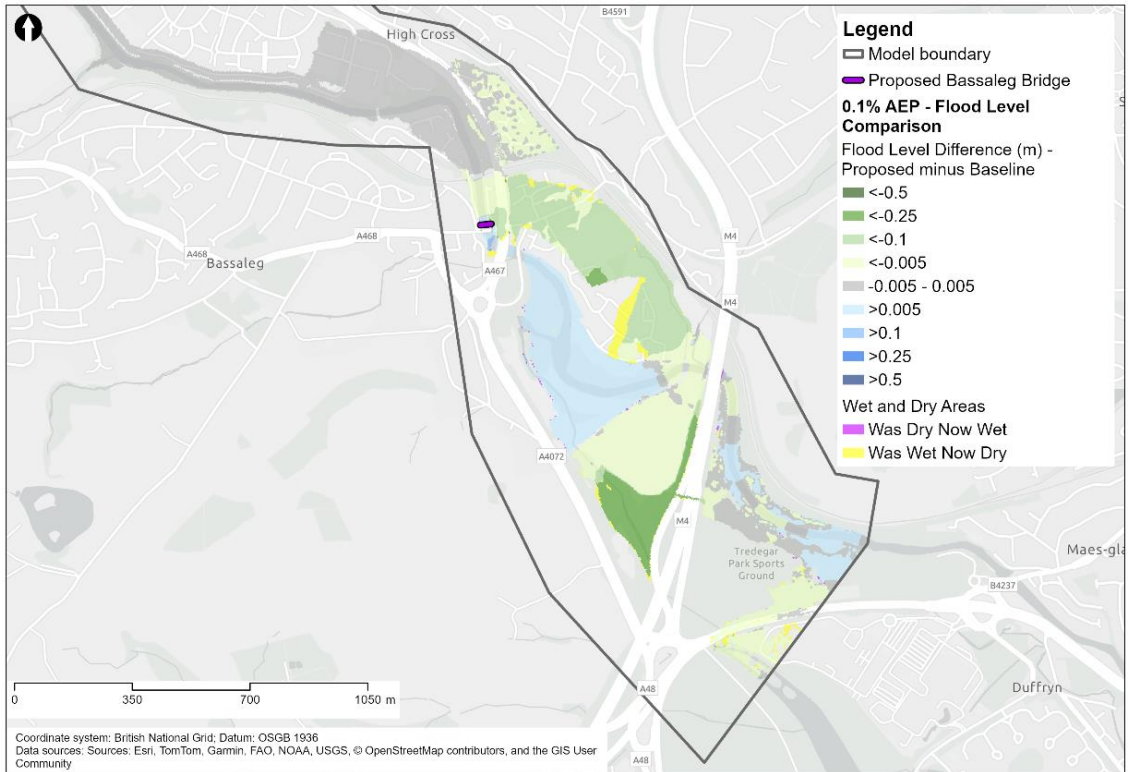
Source: Mott MacDonald 2025

Figure 7.9: Water level difference - Permanent minus Baseline cases - 0.5% AEP event (in m)



Source: Mott MacDonald 2025

Figure 7.10: Water level difference - Permanent minus Baseline cases - 0.1% AEP event (in m)



Source: Mott MacDonald 2025

7.3.2.2 Future (with climate change)

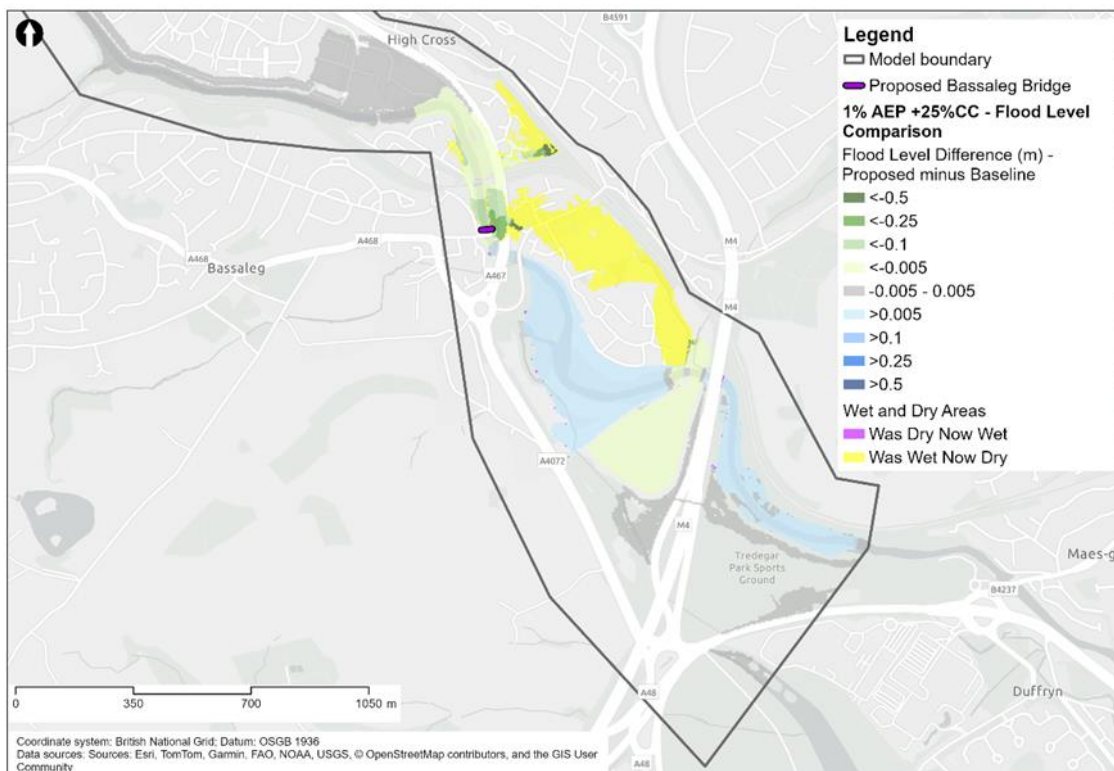
As discussed in Section 6.3.1.1 the flood modelling suggests that this area is vulnerable to the impact of climate change.

In the 1% AEP event with central (25%) climate change allowance a comparison of flood levels between the permanent and baseline cases reveals a notable reduction in flood levels in key residential areas, refer Figure 7.11. Specifically, flood depths in Forge Mews, are shown to decrease by up to approximately 0.42m in the Permanent case. Additionally, residential areas east of the River Ebbw, which are predicted to be inundated under the Baseline case, are predicted to lie outside the flood extent in the Permanent case.

Across the site and its immediate surroundings minimal to no increase in flood levels or extents is observed. Further downstream, slight increases in flood levels are predicted, primarily affecting open spaces along the River Ebbw. One exception is a localised rise of up to 0.03m near Fallow Close and Deer Park Lane. However, similar to the discussion in Section 7.3.2, no properties, or their gardens, are predicted to be at risk.

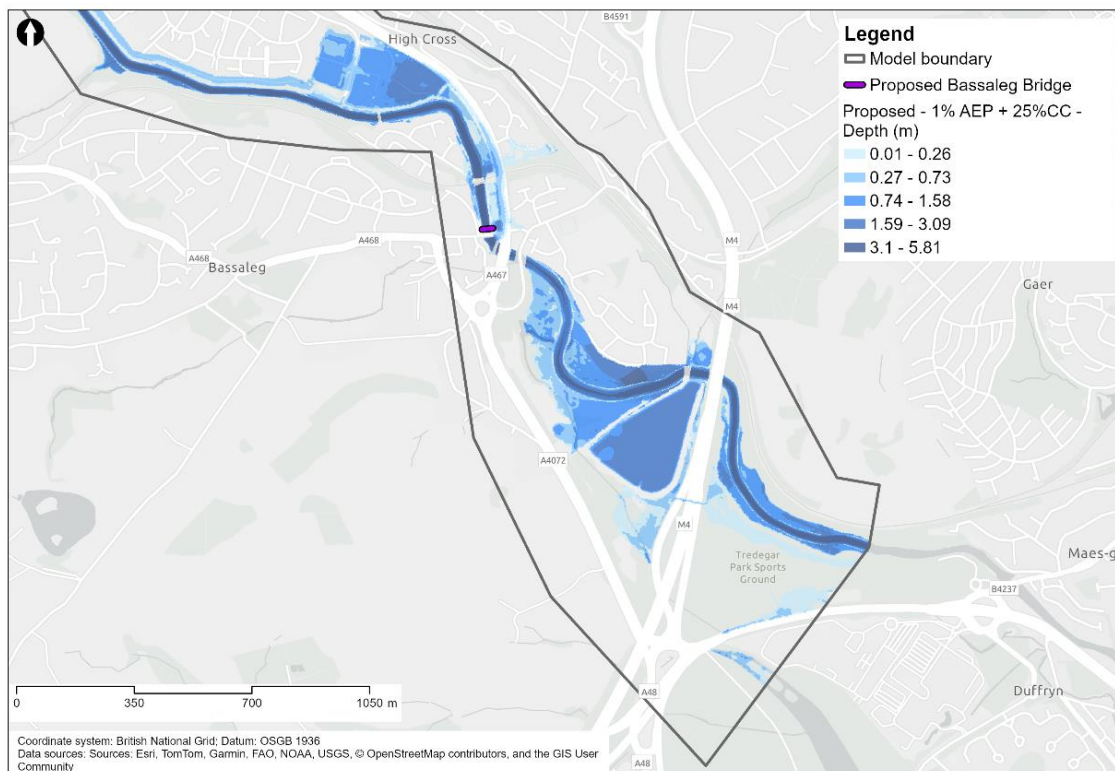
Most areas showing increased flood levels during this event are already subject to flooding in the Baseline case, indicating that the proposed development does not introduce new areas at risk.

Figure 7.11 Water level difference - Permanent minus Baseline cases -1% AEP with central (25%) allowance for climate change event (in m)



Source: Mott MacDonald 2025

Figure 7.12: Predicted flood depths for Permanent case during the 1% AEP with central (25%) allowance for climate change event – Depths (in m)



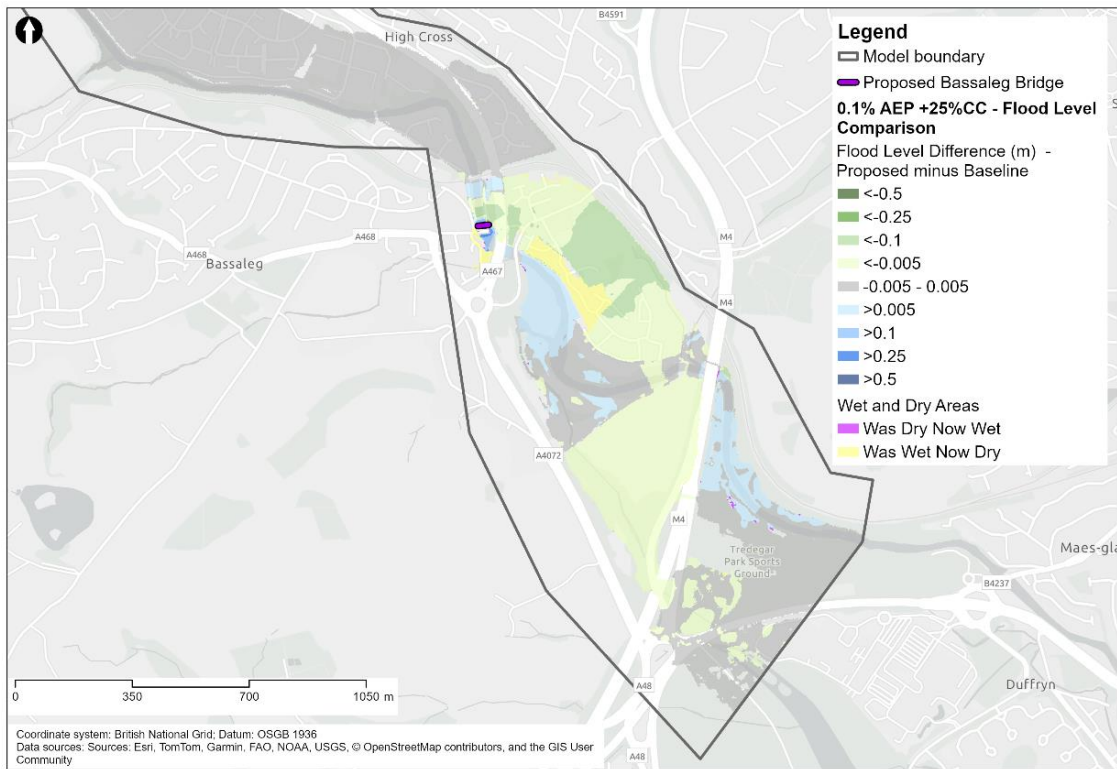
Source: Mott MacDonald 2025

In the 0.1% AEP event with central (25%) climate change allowance a comparison of flood levels between the permanent and baseline cases indicates a reduction in flood levels of approximately 0.15m in residential areas east of the River Ebbw, shown in Figure 7.13.

Furthermore, some residential areas along Churchmead and the eastern bank of the River Ebbw, which are shown to flood in the Baseline case, are now predicted to be flood-free in the Permanent case. Despite these improvements, increased flood levels are observed between site and M4 road. Notably, Forge Mews predicted to have a localised increase of around 0.09m in flood levels on top of the 1.2m during this event in the Baseline case. This increase is limited to the 0.1% AEP with central (25%) climate change event and does not impact the flood frequency.

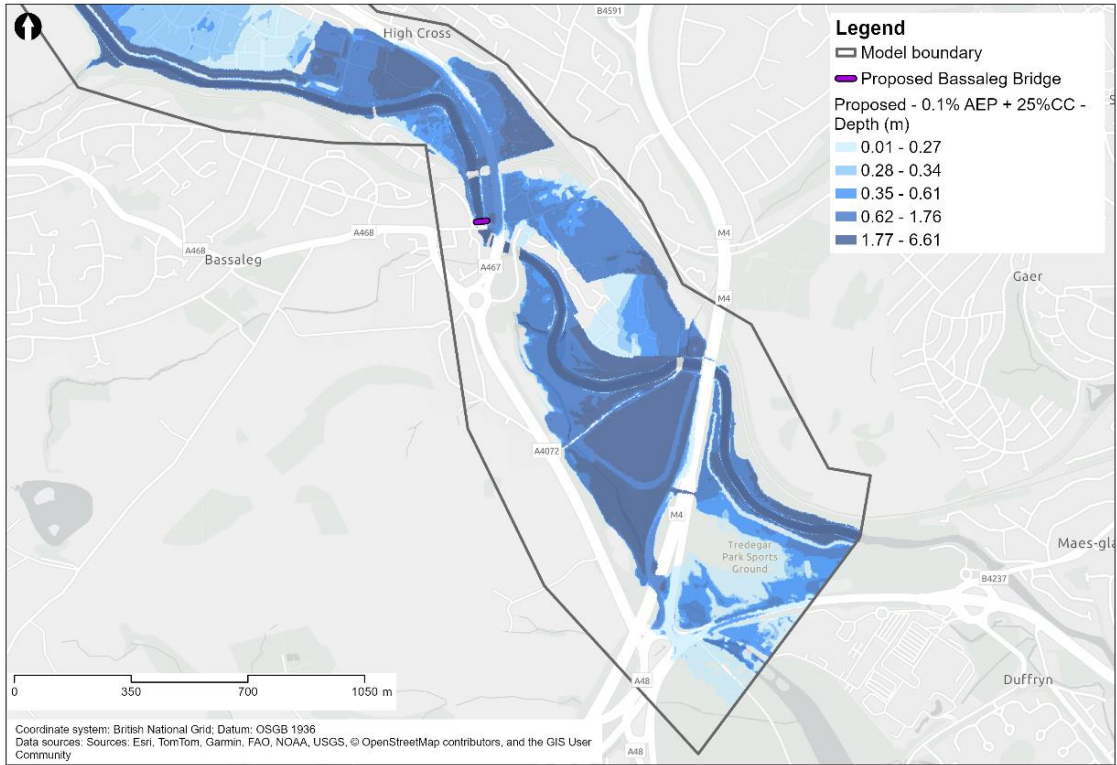
Additionally, small areas adjacent to the old bridge, which are predicted to remain dry in the Baseline case, are now shown to experience flooding in the Permanent case. Further downstream, minor increases in flood levels are predicted, primarily affecting open spaces along the River Ebbw, which are considered water compatible. One exception is a localised rise of up to 0.02m near Fallow Close and Deer Park Lane. However, similar to the discussion in Section 7.3.2, no properties, or their gardens, are predicted to be at risk.

Figure 7.13: Water level difference - Permanent minus Baseline cases - 0.1% AEP with central (25%) allowance for climate change event (levels in m)



Source: Mott MacDonald 2025

Figure 7.14: Permanent case during the 0.1% AEP with central (25%) allowance for climate change event – Depths (in m)

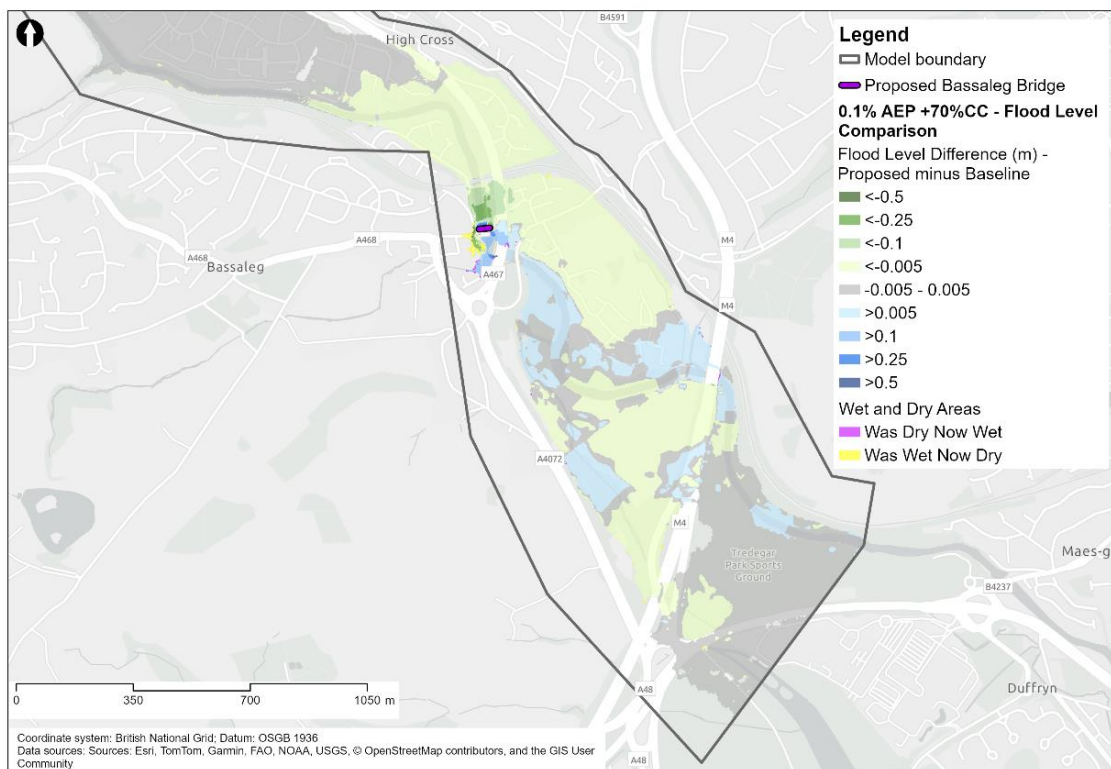


Source: Mott MacDonald 2025

In the 0.1% AEP event with central (70%) climate change allowance a comparison of flood levels between the permanent and baseline cases indicates a reduction in flood levels of approximately 0.4m in residential areas upstream of the site and east of the River Ebbw (see Figure 7.15). In contrast, increased flood levels are predicted within and downstream of the site, with the A467 and parts of Churchmead predicted to experience increases of up to 0.4m. Although some new areas near Churchmead are shown to flood in the Permanent case, with the benefit of the flood bund / wall the overall flood extent in the Churchmead area is reduced compared to the Baseline case. Further commentary regarding the flood risk to Churchmead and the associated design of the flood bund is provided in Section 7.3.2.3.

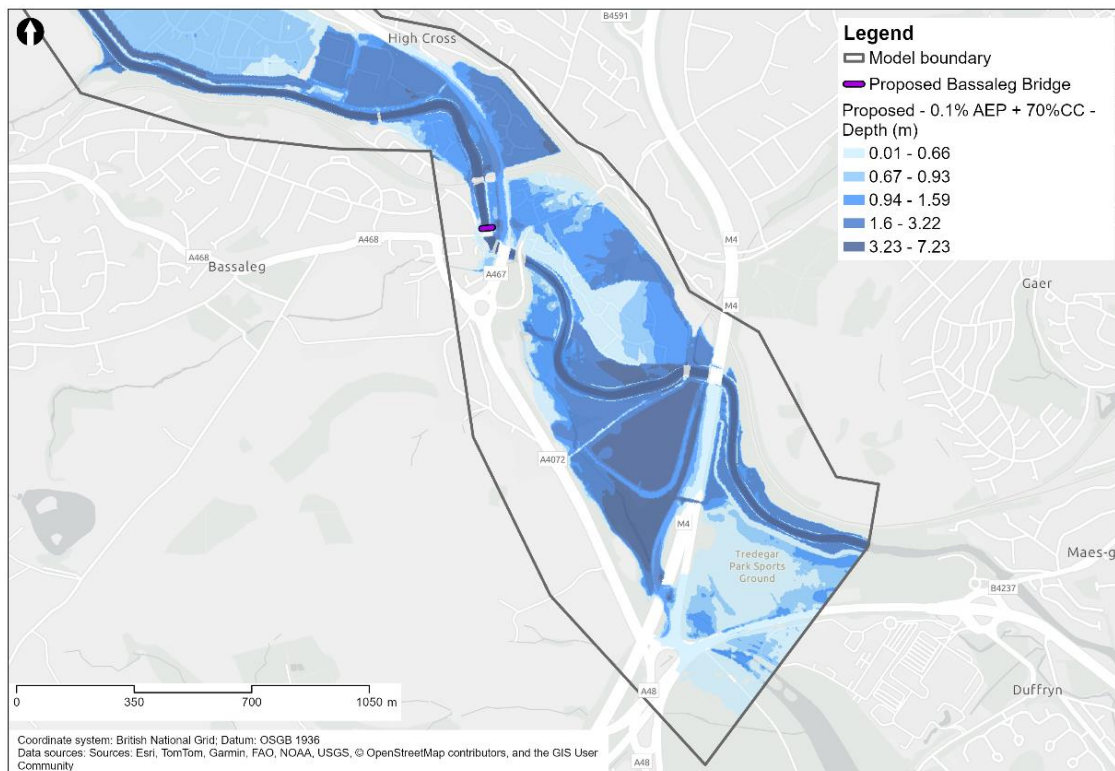
Further downstream, flood level increases are observed beyond the Park View bridge, primarily affecting open spaces along the River Ebbw. One minor exception is a localised increase of 0.01m near Fallow Close and Deer Park Lane. However, similar to the discussion in Section 7.3.2, no properties, or their gardens, are predicted to be at risk.

Figure 7.15: Water level difference - Permanent minus Baseline cases - 0.1% AEP with higher (70%) allowance for climate change event (levels in m)



Source: Mott MacDonald 2025

Figure 7.16: Permanent case during the 0.1% AEP higher (70%) allowance for climate change event – Depths (in m)



Source: Mott MacDonald 2025

7.3.2.3 Churchmead Flood Bund / Wall

The results from initial assessment indicated the potential for detrimental impacts on third party land at Churchmead Road. To address this potential increase to flood risk in this area a flood bund / wall was incorporated into the scheme design as a mitigation measure. The maximum water level near the bund location during the present day 0.1% AEP event is approximately 22.20m AOD (wider comparison of channel water levels is provided in Table 7.3). In line with standard design guidance, a freeboard of 0.30m should be applied to the bund crest level to account for uncertainties. Therefore a minimum design crest level of 22.50m AOD has assumed.

Set at this level the flood bund / wall is predicted to continue to provide a 0.1% AEP standard of protection in at the end of the scheme design life. The predicted 0.1% AEP with central (25%) climate change is approximately 22.40m AOD meaning the freeboard will over time to 0.10m as a minimum (refer Table 7.3).

It is estimated that in the event of exceedance flows, assessed using the 0.1% AEP with higher (70%) climate change allowance, the bund will be overtopped and also bypassed by water coming out of bank upstream of New Bassaleg Bridge flowing along Viaduct Way and onto Churchmead outflanking the bund / wall. Should this happen it is predicted that the flood bund / wall could impede flow returning to the main channel and nominally increase flood risk to properties on Churchmead. It is therefore important for the height of the flood bund to be set considering the residual risk posed by bypassing flow, hence the choice to set the bund / wall height above the present day 0.1% AEP water level rather than future predicted level.

The flood bund/wall is to be constructed adjacent to Ebbw Weir. The height has been set based on the predicted water level upstream of Ebbw Weir, however as the structure extends past, and slightly downstream, of the weir the water surface profile will vary along its length. This

variation has not been analysed in detail, with the use of the upstream level considered to be conservative. Sensitivity analysis considering variation in weir coefficient is discussed in Section 7.4.

Table 7.3: Peak water levels in the Baseline and Permanent bridge cases for 0.1% AEP present day and 1% and 0.1% AEP with central (25%) climate change events (highlighted line located at updated extent of proposed flood bund/wall)

Location	Nodes	Baseline Model results (mAOD)			Permanent Bridge Case (mAOD)		
		1% AEP + 25%CC	0.1% AEP	0.1% AEP + 25% CC	1% AEP + 25%CC	0.1% AEP	0.1% AEP + 25%CC
Immediate U/S of Bassaleg Viaduct	EBBW_4169	23.70	24.05	24.38	23.66	24.04	24.38
Immediate D/S of Bassaleg Viaduct	EBBW_4159.8	23.45	23.68	23.87	23.40	23.67	23.86
48m D/S of Bassaleg Viaduct	EBBW_4124	23.22	23.37	23.53	23.13	23.34	23.58
24m U/S of New Bassaleg Bridge	EBBW_4055	23.02	23.19	23.36	22.81	23.15	23.17
Immediate U/S of New Bassaleg Bridge	EBBW_4055u	22.91	23.14	23.30	22.65	23.27	23.65
New Bassaleg Bridge	EBBW_4055b u	-	-	-	22.65	23.27	23.65
Immediate D/S of New Bassaleg Bridge	EBBW_4055d	22.87	23.12	23.30	21.88	22.14	22.31
Immediate U/S of Old Bassaleg Bridge	EBBW_4008	23.18	23.52	23.81	21.83	22.33	22.56
Immediate D/S of Old Bassaleg Bridge	EBBW_00063	22.07	22.31	22.46	22.01	22.42	22.69
3m D/S of Old Bassaleg Viaduct	EBBW_3961	21.81	22.05	22.17	21.72	22.12	22.45
Immediate U/S of Weir	EBBW_3958s u	21.86	22.07	22.24	21.92	22.20	22.39
Immediate D/S of Weir	EBBW_3958s d	20.52	20.62	20.76	20.54	20.63	20.77
Immediate U/S of A467 road	EBBW_3943	20.47	20.52	20.59	20.49	20.56	20.67
Immediate D/S of A467 road	EBBW_3915.8	20.47	20.52	20.58	20.48	20.55	20.66
Immediate U/S of Park view road	EBBW_3886	19.94	20.08	20.20	19.97	20.14	20.26
Immediate D/S of Park view road	EBBW_3870.8	19.93	20.08	20.20	19.97	20.14	20.26

Source: Mott MacDonald 2025

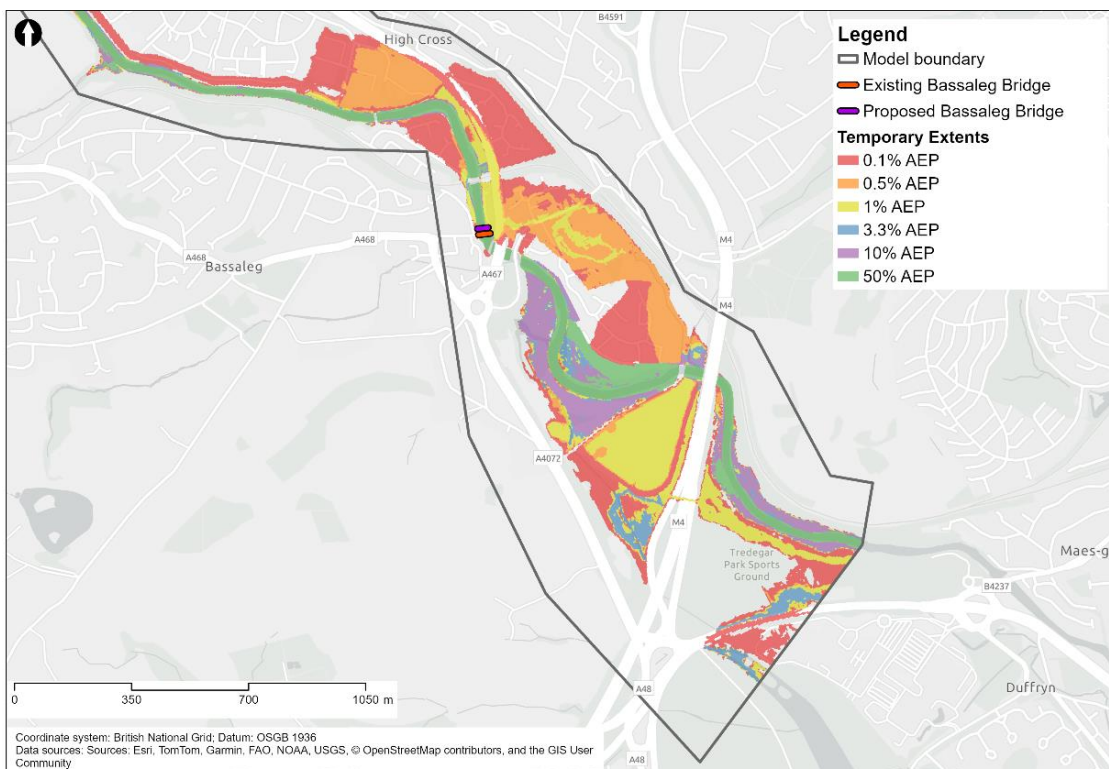
7.3.3 Temporary Case

Flood extents for the Temporary case, covering present-day fluvial flood events from the 50% AEP to the 0.1% AEP, are illustrated in Figure 7.17. The Temporary case results indicates that in general there is little to no increase in the predicted flood levels in the 50% AEP to 3.3% AEP present day events (see Figure 7.18 to Figure 7.20).

During the 1% AEP event, a reduction in flood levels is observed in open spaces downstream of the site. However, increased flood levels are predicted in the immediate vicinity of the site, as well as across the wider surrounding area. The residential area east of the site is predicted to be particularly affected (see Figure 7.21).

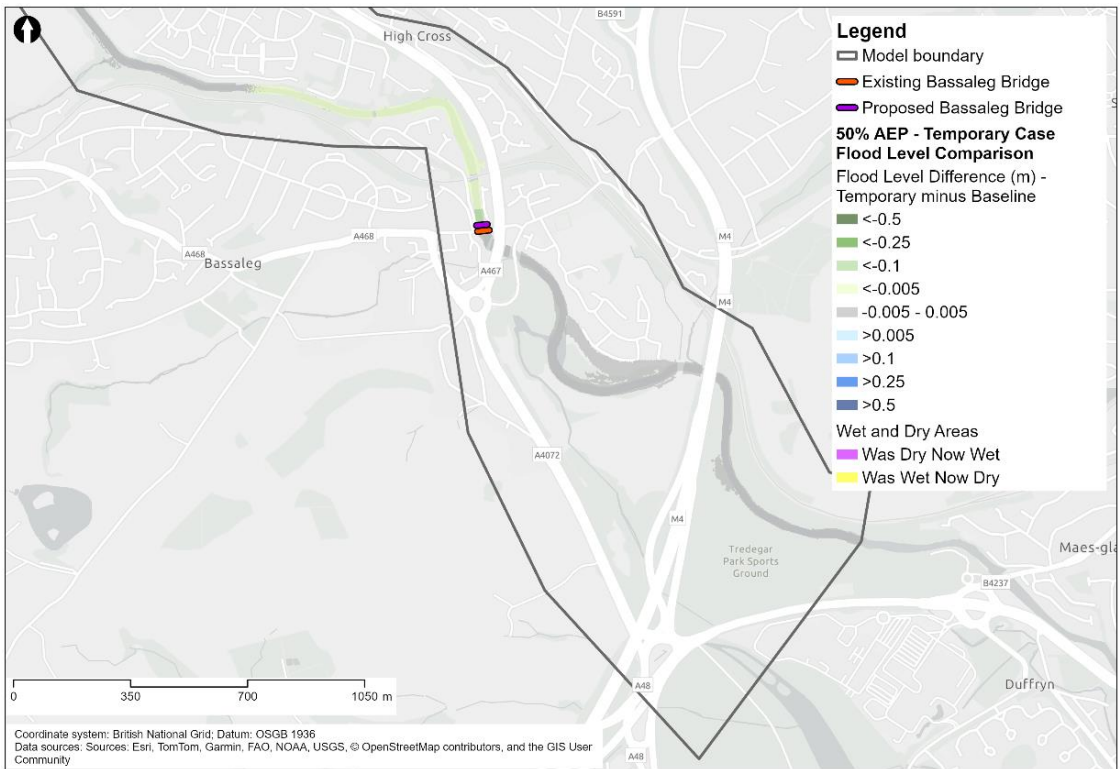
For the more extreme events (0.5% and 0.1% AEP events), flood levels are shown to increase across the site and its surroundings, including residential, industrial, and transport infrastructure with a further expansion of flood extents, particularly downstream and east of the River Ebbw, affecting a larger number of properties and assets (see Figure 7.22).

Figure 7.17: Temporary case flood extents from the 50% AEP up to the 0.1% AEP present-day events



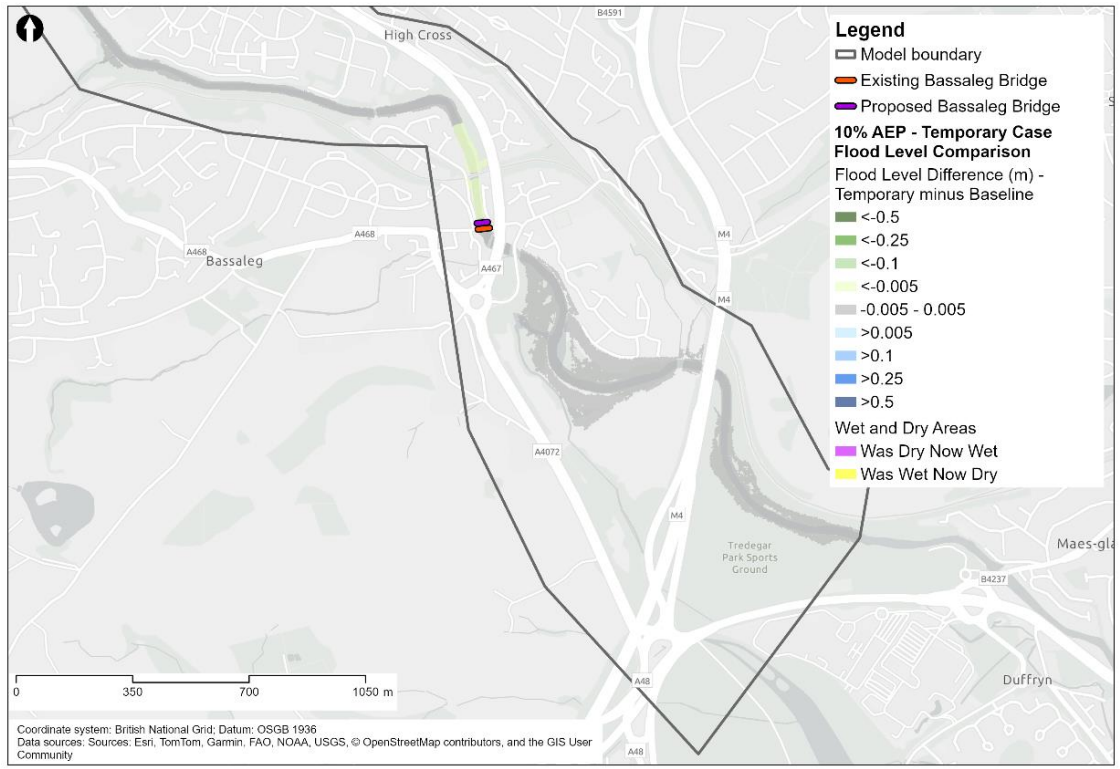
Source: Mott MacDonald 2025

Figure 7.18: Comparison of water levels – Temporary bridge case minus baseline for 50% AEP event.



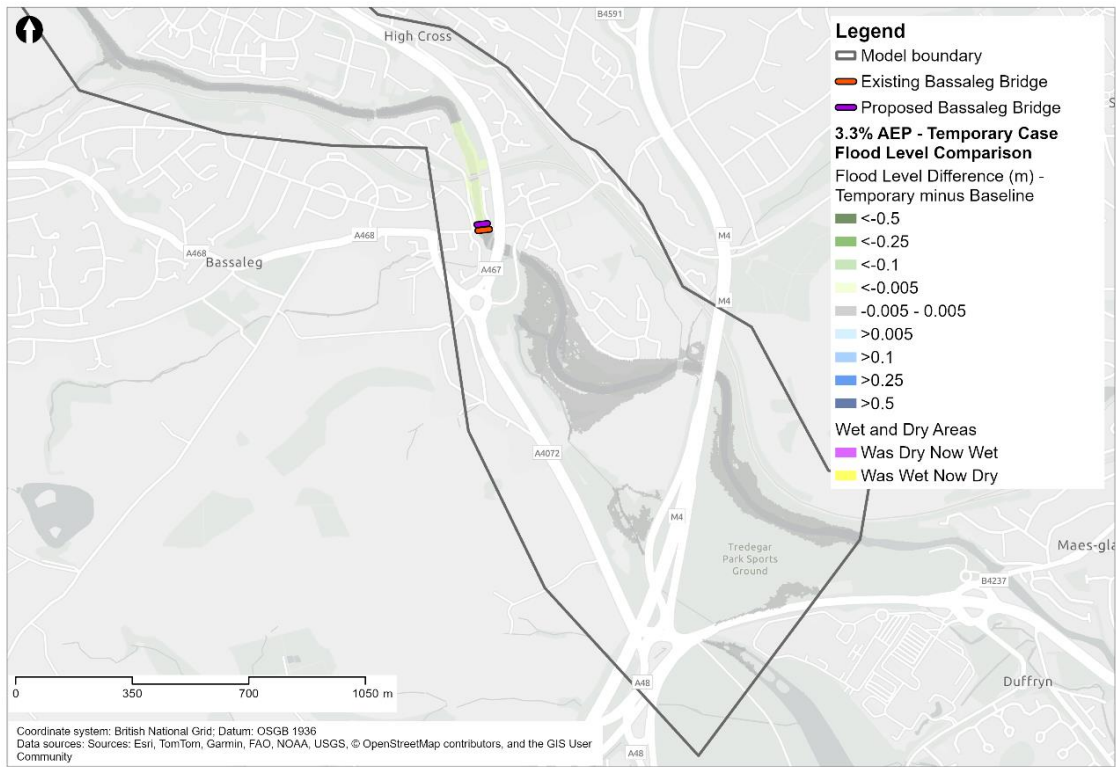
Source: Mott MacDonald 2025

Figure 7.19: Comparison of water levels – Temporary bridge case minus baseline for 10% AEP event.



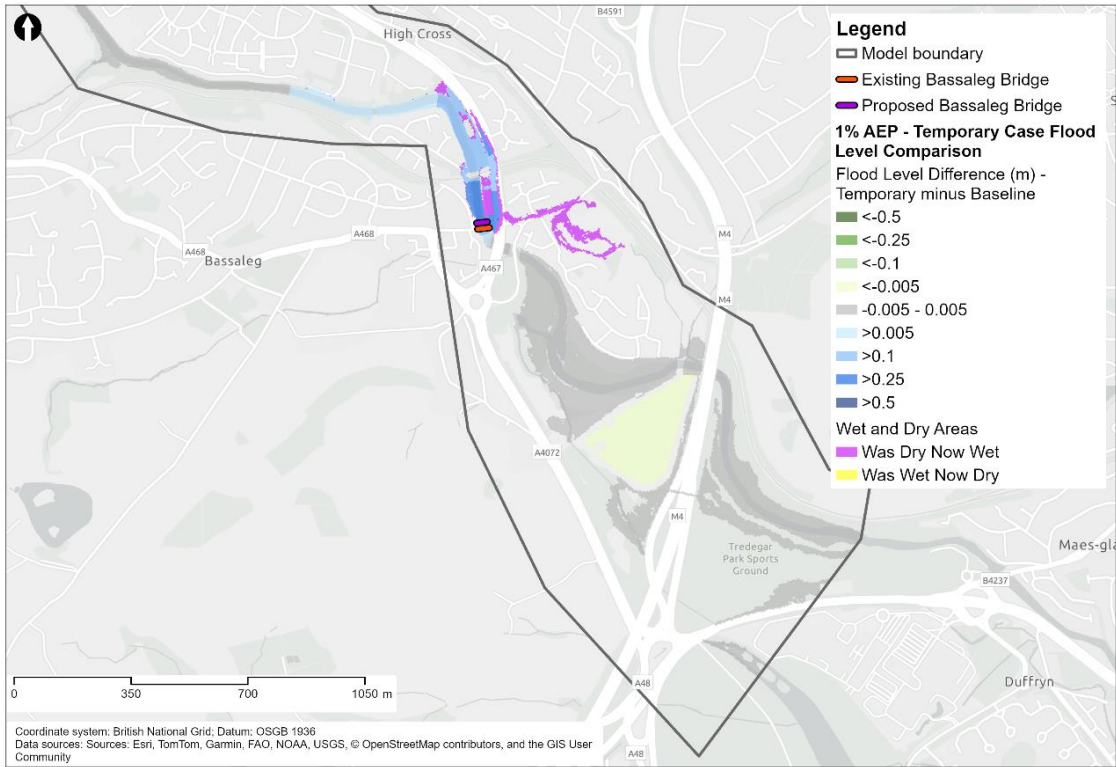
Source: Mott MacDonald 2025

Figure 7.20: Comparison of water levels – Temporary bridge case minus baseline for 3.3% AEP event.



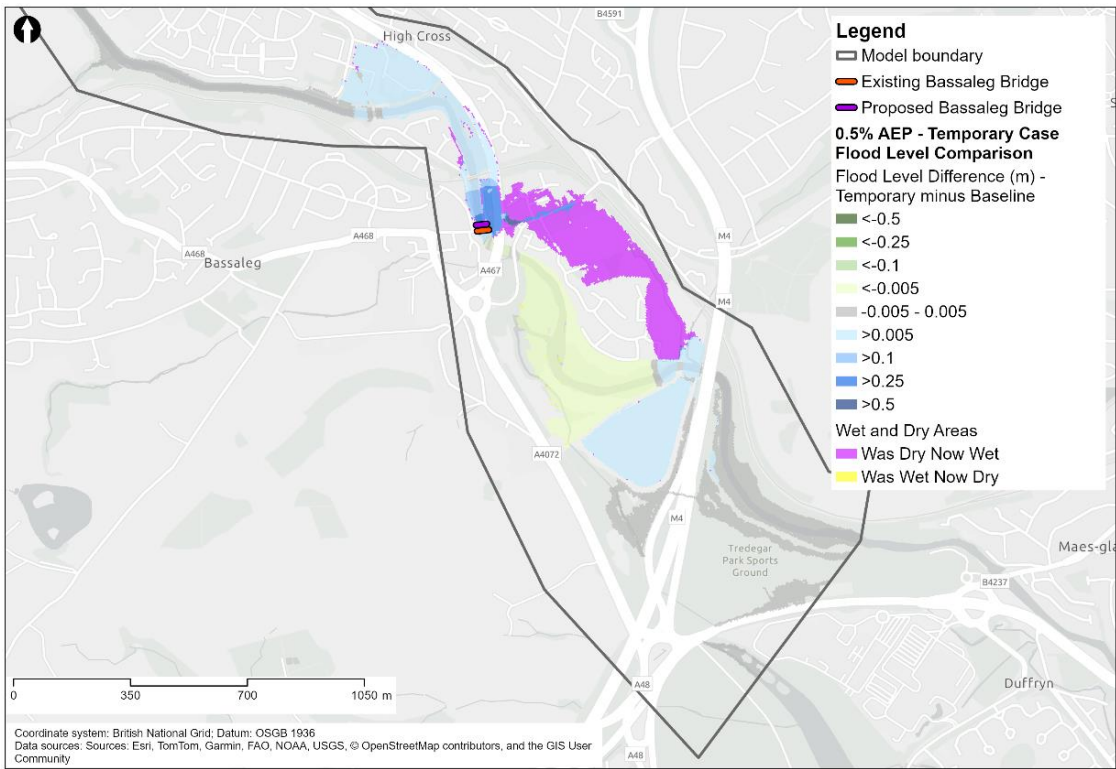
Source: Mott MacDonald 2025

Figure 7.21: Comparison of water levels – Temporary bridge case minus baseline for 1% AEP event.



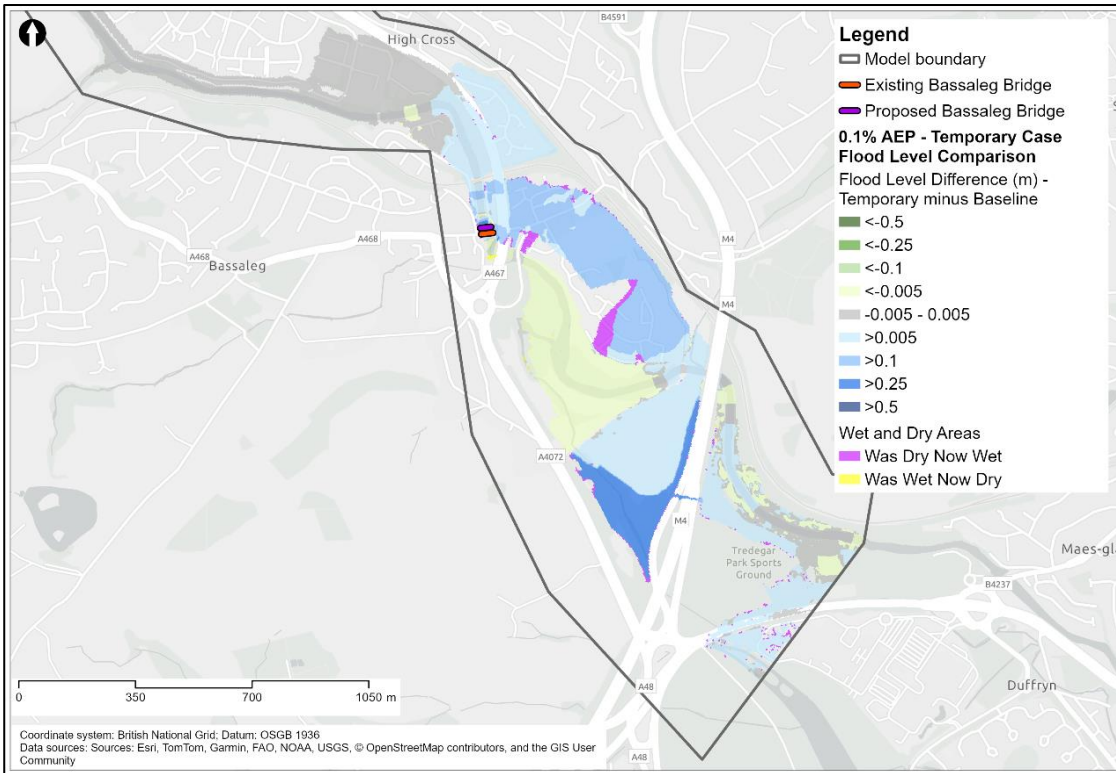
Source: Mott MacDonald 2025

Figure 7.22: Comparison of water levels – Temporary bridge case minus baseline for 0.5% AEP event.



Source: Mott MacDonald 2025

Figure 7.23: Comparison of water levels – Temporary bridge case minus baseline for 0.1% AEP event.



Source: Mott MacDonald 2025

7.4 Sensitivity Analysis

This section summarises the results of the sensitivity analysis undertaken for the Bassaleg Bridge model. Each parameter described below was varied by +/- 20% to assess the impact on predicated water levels. following sensitivity analysis has been completed for the 0.1% AEP design event.

1. Change in inflow in the model domain by +/- 20% for both upstream and lateral inflows
2. Change in Manning's roughness coefficient by +/- 20% in the model domain
3. Change in longitudinal gradient applied at 'Normal Depth' downstream boundary by +/- 20% applied in both 1D and 2D model domain.
4. Change in weir coefficient (Modular limit) by +/- 20% in 1D model.

As shown in Table 7.4 and the figures presented in Appendix A the model demonstrates high sensitivity to the changes in flow, with the predicted water levels +0.32m / -0.53m observed immediately upstream of the New Bassaleg Bridge. In the channel the impact is most pronounced upstream of bridge structures, particularly at the new and old Bassaleg Bridge locations which leads to a large change in the predicted flood extent to the east of Bassaleg Bridge with the change in in channel water level notably affecting the flow path over the right bank.

Table 7.4 and the figures presented in Appendix A indicate that the model is gernally not so sensitive to the changes in Manning's roughness over floodplain. A 20% increase in Manning's roughness led to in channel water level increases of up to 0.03m, while a 20% decrease resulted in reductions of up to 0.02m in the same areas upstream of the new bridge.

Table 7.4: Peak water levels in flow and manning's value sensitivity test for 0.1% AEP event.

Location	Nodes	Peak Water Levels (mAOD)				
		Permanent Case	Flow Sensitivity		Manning's 'n' Sensitivity	
			+20%	-20%	+20%	-20%
Immediate U/S of Bassaleg Viaduct	EBBW_4169	24.04	24.31	23.72	24.06	24.02
Immediate D/S of Bassaleg Viaduct	EBBW_4159.8	23.67	23.83	23.46	23.69	23.66
48m D/S of Bassaleg Viaduct	EBBW_4124	23.34	23.52	23.19	23.37	23.33
24m U/S of New Bassaleg Bridge	EBBW_4055	23.15	23.17	22.91	23.17	23.12
Immediate U/S of New Bassaleg Bridge	EBBW_4055u	23.27	23.59	22.74	23.29	23.24
New Bassaleg Bridge	EBBW_4055bu	23.27	23.59	22.74	23.29	23.24
Immediate D/S of New Bassaleg Bridge	EBBW_4055d	22.14	22.28	21.91	22.15	22.14
Immediate U/S of Old Bassaleg Bridge	EBBW_4008	22.33	22.53	21.88	22.32	22.33

Location	Nodes	Peak Water Levels (mAOD)				
		Permanent Case	Flow Sensitivity		Manning's 'n' Sensitivity	
			+20%	-20%	+20%	-20%
Immediate D/S of Old Bassaleg Bridge	EBBW_00063	22.42	22.65	22.06	22.40	22.44
3m D/S of Old Bassaleg Viaduct	EBBW_3961	22.12	22.40	21.76	22.08	22.18
Immediate U/S of Weir	EBBW_3958su	22.20	22.36	21.96	22.20	22.20
Immediate D/S of Weir	EBBW_3958sd	20.63	20.73	20.54	20.65	20.62
Immediate U/S of A467 road	EBBW_3943	20.56	20.64	20.49	20.57	20.54
Immediate D/S of A467 road	EBBW_3915.8	20.55	20.63	20.49	20.56	20.53
Immediate U/S of Park view road	EBBW_3886	20.14	20.24	19.99	20.15	20.13
Immediate D/S of Park view road	EBBW_3870.8	20.14	20.24	19.99	20.15	20.13

Source: Mott MacDonald 2025

Table 7.5 indicates that the model is not sensitive to the changes in the downstream boundary and weir coefficient. This suggests that the downstream boundary is sufficiently remote from the area of interest and does not exert a significant backwater effect under tested conditions. Also, during high flows the weir structure has limited influence on upstream water levels under the tested conditions. This conclusion is supported by the figures presented in Appendix A.

Table 7.5: Peak water levels in downstream boundary and Ebbw weir coefficient value sensitivity test for 0.1% AEP event.

Location	Nodes	Permanent Bridge Case	Peak Water Levels (mAOD)			
			Downstream Boundary Sensitivity		Weir Coefficient Sensitivity	
			+20%	-20%	+20%	-20%
Immediate U/S of Bassaleg Viaduct	EBBW_4169	24.04	24.04	24.04	24.04	24.04
Immediate D/S of Bassaleg Viaduct	EBBW_4159.8	23.67	23.67	23.67	23.67	23.67
48m D/S of Bassaleg Viaduct	EBBW_4124	23.34	23.34	23.34	23.34	23.34
24m U/S of New Bassaleg Bridge	EBBW_4055	23.15	23.15	23.15	23.15	23.15
Immediate U/S of New Bassaleg Bridge	EBBW_4055u	23.27	23.27	23.27	23.27	23.27
New Bassaleg Bridge	EBBW_4055bu	23.27	23.27	23.27	23.27	23.27

Location	Nodes	Permanent Bridge Case	Peak Water Levels (mAOD)			
			Downstream Boundary Sensitivity		Weir Coefficient Sensitivity	
			+20%	-20%	+20%	-20%
Immediate D/S of New Bassaleg Bridge	EBBW_4055d	22.14	22.14	22.14	22.14	22.14
Immediate U/S of Old Bassaleg Bridge	EBBW_4008	22.33	22.33	22.33	22.33	22.33
Immediate D/S of Old Bassaleg Bridge	EBBW_00063	22.42	22.42	22.42	22.42	22.42
3m D/S of Old Bassaleg Viaduct	EBBW_3961	22.12	22.12	22.12	22.12	22.12
Immediate U/S of Weir	EBBW_3958su	22.20	22.20	22.20	22.20	22.20
Immediate D/S of Weir	EBBW_3958sd	20.63	20.63	20.64	20.63	20.63
Immediate U/S of A467 road	EBBW_3943	20.56	20.56	20.56	20.56	20.56
Immediate D/S of A467 road	EBBW_3915.8	20.55	20.55	20.55	20.55	20.55
Immediate U/S of Park view road	EBBW_3886	20.14	20.14	20.14	20.14	20.14
Immediate D/S of Park view road	EBBW_3870.8	20.14	20.14	20.14	20.14	20.143

Source: Mott MacDonald 2025

8 Assumptions and Limitations

The model has been setup to meet the specific aims of the project, and the decisions and assumptions may not be appropriate for other purposes. The model should be reviewed before it is used for any other purposes. The assumptions made in the development of this model, and any limitations for future work are outlined below.

8.1 Flood Modelling

- The model is based on a curtailed version of NRW's River Ebbw ICM, with the domain trimmed to focus on the area surrounding the Bassaleg Bridge. This curtailment was undertaken to improve computational efficiency and focus on the area of interest. The model was validated against the original full-extent model to ensure consistency prior to completing updates to the model hydrology and topographic data. The truncated model has not undergone separate validation / calibration.
- Although newer LiDAR datasets (2023 and 2024) were reviewed during the study, they were not incorporated into the hydraulic model. The decision was based on limited spatial coverage within the model domain and the timing of data availability, which coincided with advanced stages of model development.
- The design and hydraulic assessment of New Bassaleg Bridge is intrinsically linked to the comparative representation of the Old Bassaleg Bridge and New Bassaleg Bridge design. The existing twin arched Old Bassaleg Bridge structure is currently understood to trap and accumulate debris, which can lead to blockages and, further to discussion with NRW, the structure has been represented as being 25% blocked in the Baseline case. The new bridge will have a slightly smaller overall aperture than then existing bridge but will be free spanning notably reducing the blockage risk to the structure and has been represented with zero blockage. Changes in the design of the new bridge or the baseline assumptions could alter the point at which flooding is predicted to commence over the left bank upstream of the bridge leading to changes the predicted flows in the channel (and flooding) downstream of the bridge, and therefore, affect the assessment of flood consequences.
- The model does not simulate sediment transport, erosion, or scour processes. These processes may affect long-term channel morphology and bridge stability and should be assessed separately. Any potential change in bed levels could affect the bridge flow area.
- The Permanent and Temporary case models assume that the proposed bridge deck ties in with existing road levels on both sides. No additional topographic adjustments have been made to represent approach roads.
- The soffit level of the new bridge has been modelled as flat due to limitations with the bridge units within Flood Modeller. This simplification may not fully capture the hydraulic behaviour under varying flow conditions. However, it is predicted that the new bridge will become submerged prior to flooding occurring upstream of the structure and therefore this simplification is not deemed to be significant.
- The flood bund/wall height has been assumed in the model and may not reflect final design specifications.
- The height of the flood bund / wall has been set based on the predicted water level upstream of Ebbw Weir. As the structure extends past, and slightly downstream, of the weir the water surface profile will vary along its length. This variation has not been analysed in detail, with the use of the upstream level considered to be conservative.
- The representation of the Ebbw weir in the model may influence the upstream water levels, particularly at the location of the bund/wall. Sensitivity analysis has been completed

considering variation in the weir coefficient, and this indicates that the model is relatively insensitive to this variation during high flows. Further refinement or validation may be necessary. This could affect predicted flood extents and protection levels.

- The model does not include representation of the oil pipeline located downstream of the old Bassaleg Bridge.
- Ebbw weir has been represented in the flood model using channel survey data collected in 2024. It is understood that the condition of the weir is deteriorating and therefore the geometry / functionality of the weir may change in the future. Should the weir fail, the geometry / bed slope of the upstream channel may also be affected. Any changes the weir and channel will affect the predicted water levels through the area of interest.
- The downstream boundary has been defined using a user defined bed slope. Sensitivity analysis indicates that the model results upstream of the M4 are not significantly influenced by changes to the downstream boundary however results from the reach of the model downstream of the M4 should be treated with caution as they may not be representative. This does not affect the assessment of flood consequences due to the proposed bridge works.

8.2 Hydrology

- The hydrological inflows applied at the upstream and lateral boundaries are based on the FEH statistical method for events up to the 1% AEP and ReFH2 growth factors for more extreme events. This approach is consistent with NRW guidance and builds on the methodology used in the 2018 WHS study.
- Peak flow estimates have been derived using updated rainfall and flow data at Rhiwderin. These estimates are assumed to be representative of the catchment hydrology at the Bassaleg Bridge location.
- The model does not include calibration against observed flood events. However, the model has been validated against the existing ICM and is considered to provide a reasonable representation of flood behaviour.
- The model applies the downstream flow estimate at the upstream boundary of the curtailed model domain. This simplification omits lateral inflows (e.g., AE10) that were present in the original ICM model. While this approach was validated through flow comparisons, it may underrepresent localised contributions between the upstream and downstream extents. However, with this approach the modelled flows at Bassaleg Bridge are considered to be nominally conservative.
- A constant inflow of 0.1 m³/s was retained at AE11, consistent with the original model. This inflow is located downstream of the Ebbw weir and is not expected to significantly influence flood levels at the bridge.
- Climate change allowances of +25% (central) and +70% (higher) have been applied in accordance with Welsh Government guidance (Welsh Government, 2021a). These allowances are subject to change and should be reviewed periodically throughout the project lifecycle.

9 Conclusions and Recommendations

The key conclusions and recommendations from this study are as follows:

9.1 Conclusions

- A baseline model was created through the curtailment of NRW's River Ebbw Integrated Catchment Model. Additional survey data was collected to increase the model accuracy in the vicinity of the scheme. The curtailed model demonstrates good performance and is considered suitable to inform scheme design and the Flood Consequence Assessment.
- The model demonstrates that Old Bassaleg Bridge constricts flows on the River Ebbw. The results suggest that the bridge becomes surcharged for an event with an AEP between 3.33% and 1%. The soffit levels of the existing bridge are 21.50m and 21.70m for the two arch openings, whilst the predicted peak water levels are 21.30mAOD for the 3.33% AEP event and 22.54mAOD for the 1% AEP event. With an average soffit level of 21.58mAOD the new bridge will similarly become submerged for an event with an AEP between 3.33% and 1%.
- The Permanent case results in improved conveyance through the bridge section, with a slight reduction in upstream water levels compared to the Baseline case.
- A review of predicted change in flood levels between the baseline and permanent cases reveals that, overall, no significant increase in flood risk is anticipated up to the 0.5% AEP event. The minor exception to this is the 1% AEP event where localised change are observed at open space at Tredegar Park Bowl.
- For events up to the 0.5% AEP, the Permanent case generally predicts lower flood levels and reduced extents compared to the Baseline case. Several areas that are predicted to be at risk in the Baseline case are projected to remain dry in the Permanent case. In the 0.1% AEP event, flood levels and extents are predicted to decrease in key residential areas such as Forge Mews and the eastern bank of the River Ebbw.
- In more extreme events (0.1% AEP event or future 1% AEP and 0.1% AEP with central climate change), flood levels and extents are predicted to decrease in key residential areas such as Forge Mews and the eastern bank of the River Ebbw, but some slight increases are predicted downstream however these are mostly limited to open spaces along the river corridor.
- A flood bund has been proposed as mitigation measure with crest level 22.50mAOD to the potential for increased flood risk at Churchmead Road. It is predicted that the bund effectively mitigate third-party detriment for events up to an including the 0.1% AEP event with central (25%) climate change. However a small increase in flooding is predicted at Churchmead during the exceedance 0.1% AEP with higher (70%) climate change when the bund/wall is outflanked by flow passing along the highway.
- In the temporary bridge case, representing a transitional phase with both bridges in place, there is little to no increase in the predicted flood levels in the 50% AEP to 3.3% AEP present day events, however there is an increased risk during larger events particularly affecting residential areas east of the site.
- Several modelling assumptions and limitations have been identified that may influence results. Most notably The design and hydraulic assessment of the New Bassaleg Bridge is intrinsically linked to the comparative representation of the Old Bassaleg Bridge and New Bassaleg Bridge design. Changes in the design or representation of the new bridge or the baseline assumptions have the potential to alter the point at which flooding is predicted to commence over the left bank upstream of the bridge which would alter the predicted flows in

the channel (and flooding) downstream of the bridge, and therefore, affect the assessment of flood consequences.

9.2 Recommendations

- The proposed flood bund at Churchmead road should be taken forward for detailed design, with a minimum crest level of 22.50mAOD to allow for freeboard above the present day and future (central) 0.1% AEP events.
- Further assessment of scour risk and structural resilience should be undertaken, particularly in light of the bridge submergence and increased flow velocities through the bridge.
- The model should be updated if any significant changes are made to the bridge design, floodplain layout, or hydrological inputs.
- The model should not be used for other purposes without review and potential revalidation, particularly if applied to areas outside the current domain or for different design scenarios.

10 References

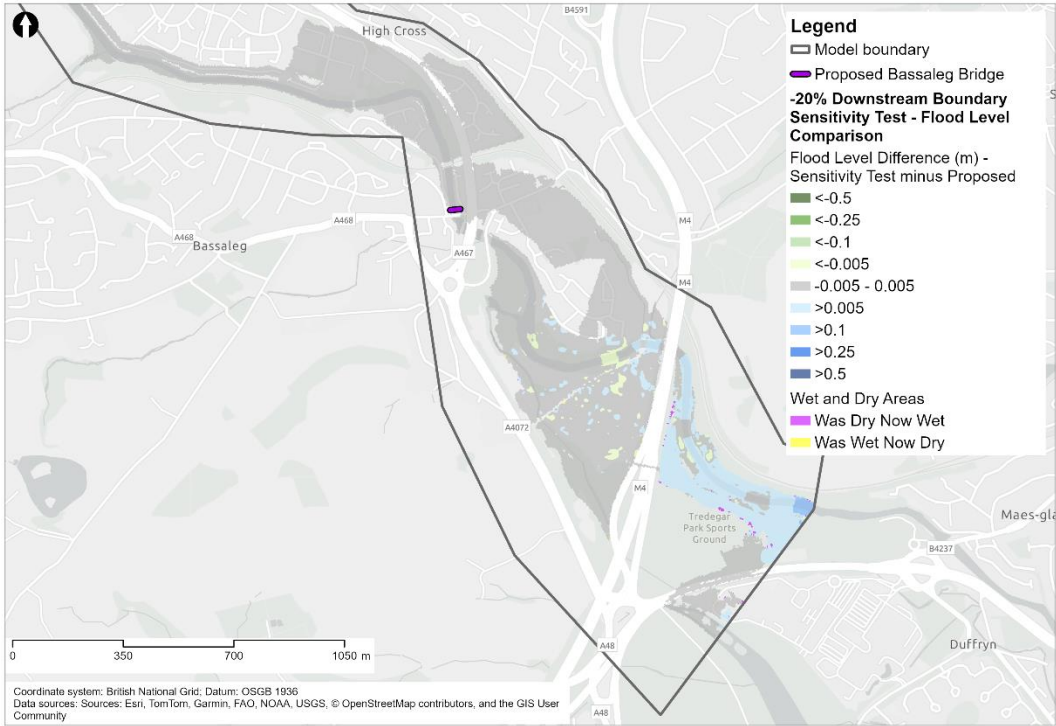
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Appendices

A.	Sensitivity Testing - Depth Difference Figures	69
B.	Hydrology Assessment	74

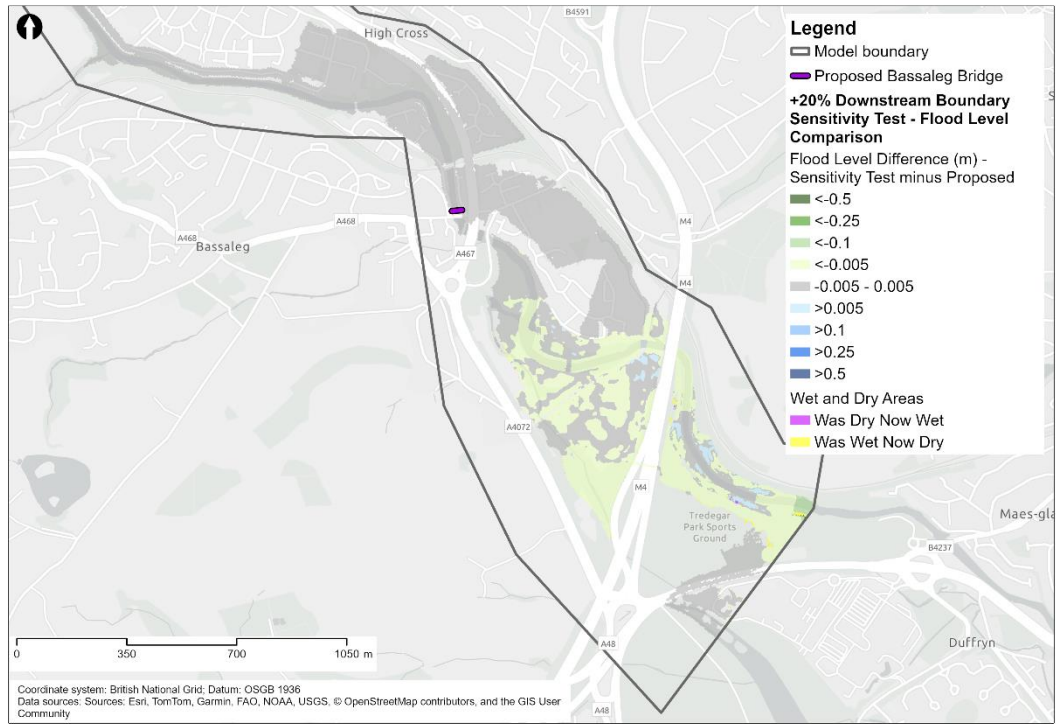
A. Sensitivity Testing - Depth Difference Figures

Figure A.1: Water level difference – Sensitivity test minus permanent case – Downstream boundary gradient -20%



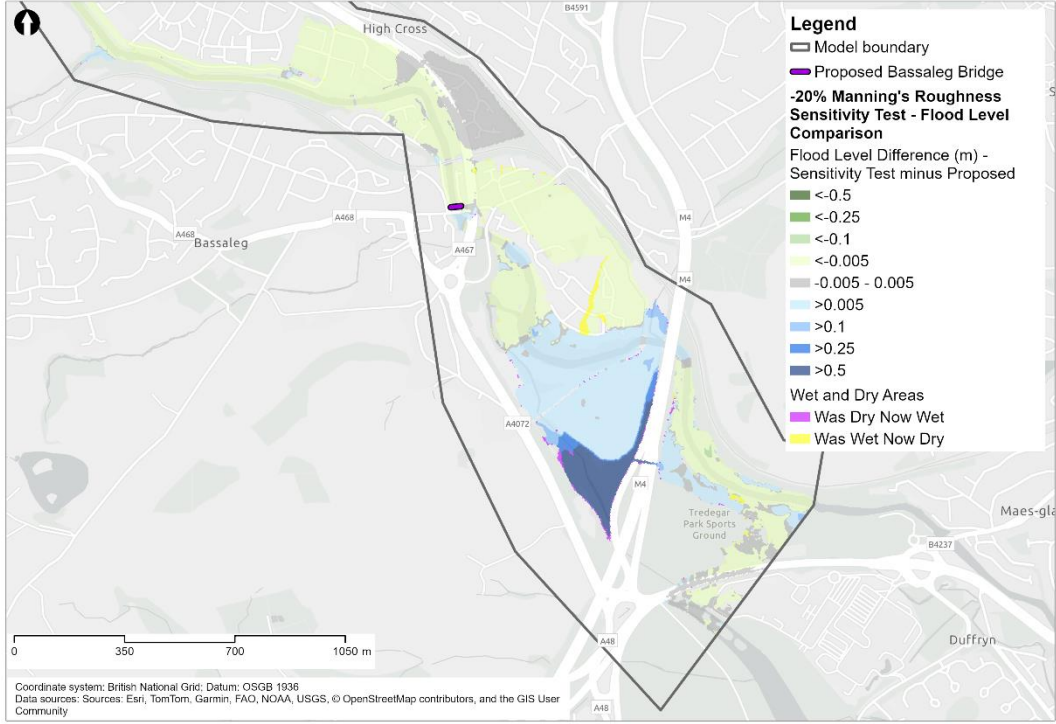
Source: Mott MacDonald 2025

Figure A.2: Water level difference – Sensitivity test minus permanent case – Downstream boundary gradient +20%



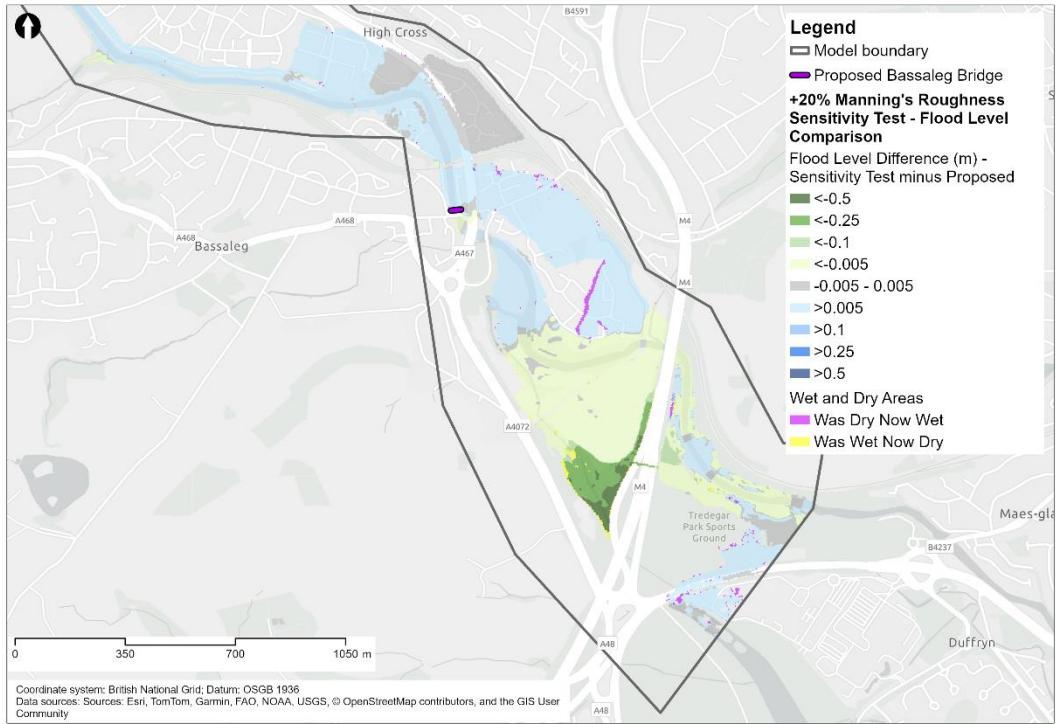
Source: Mott MacDonald 2025

Figure A.3: Water level difference – Sensitivity test minus permanent case – Manning's roughness coefficient -20%



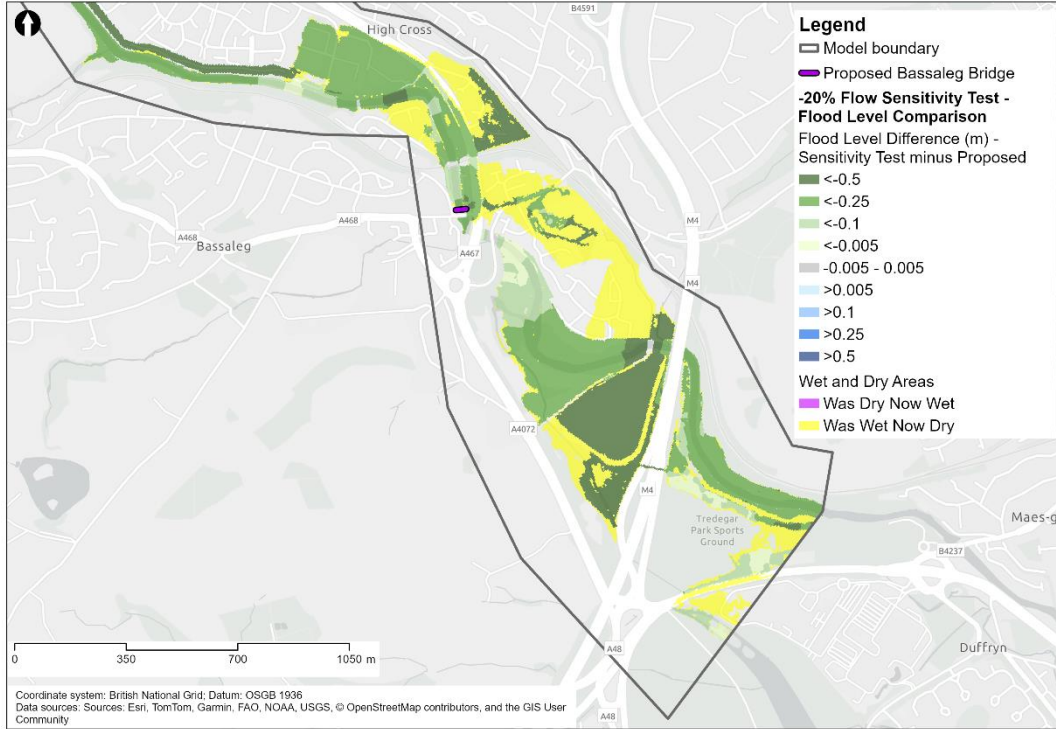
Source: Mott MacDonald 2025

Figure A.4: Water level difference – Sensitivity test minus permanent case – Manning’s roughness coefficient +20%



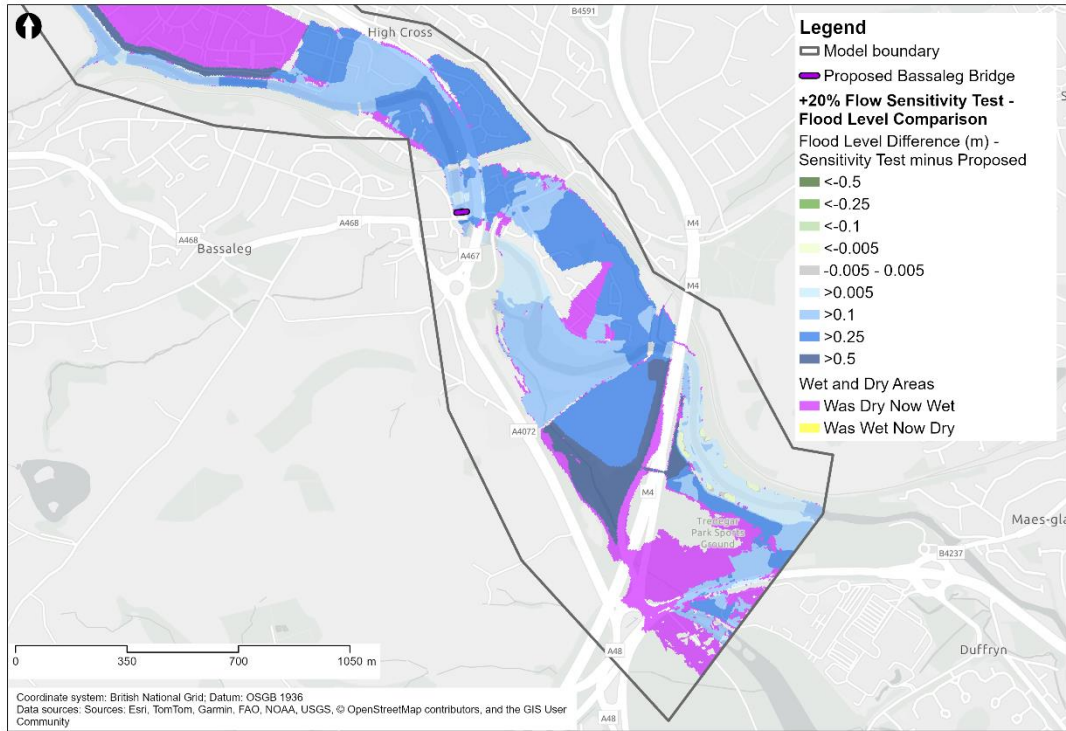
Source: Mott MacDonald 2025

Figure A.5: Water level difference – Sensitivity test minus permanent case – Flow -20%



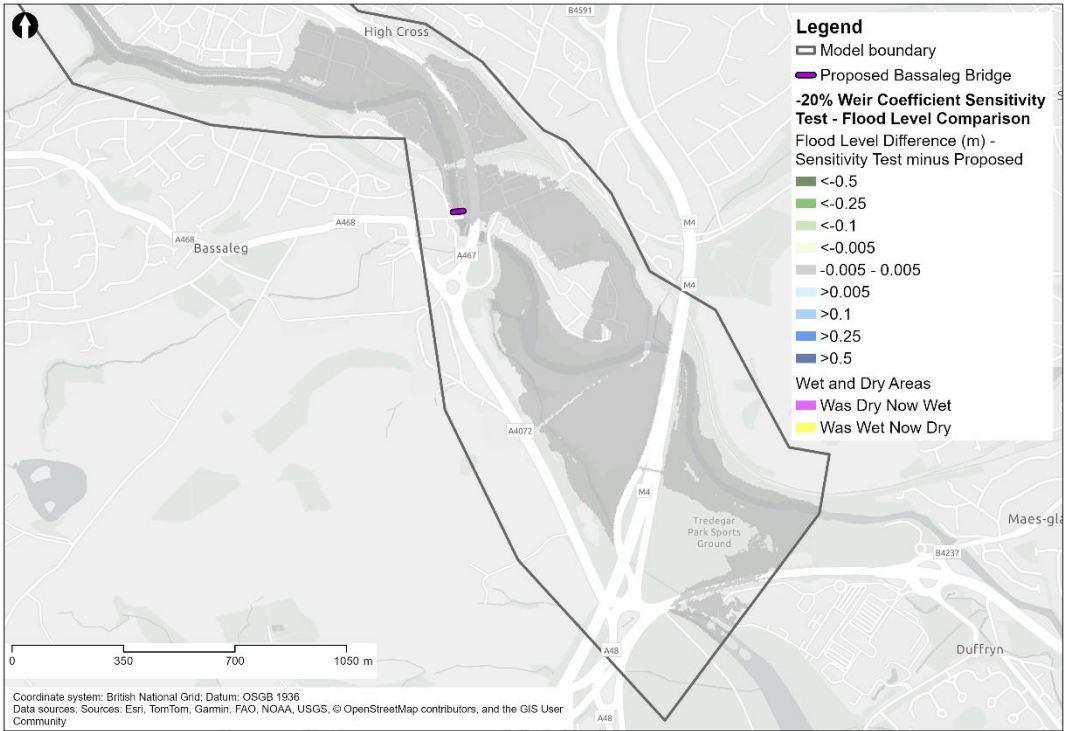
Source: Mott MacDonald 2025

Figure A.6: Water level difference – Sensitivity test minus permanent case – Flow +20%



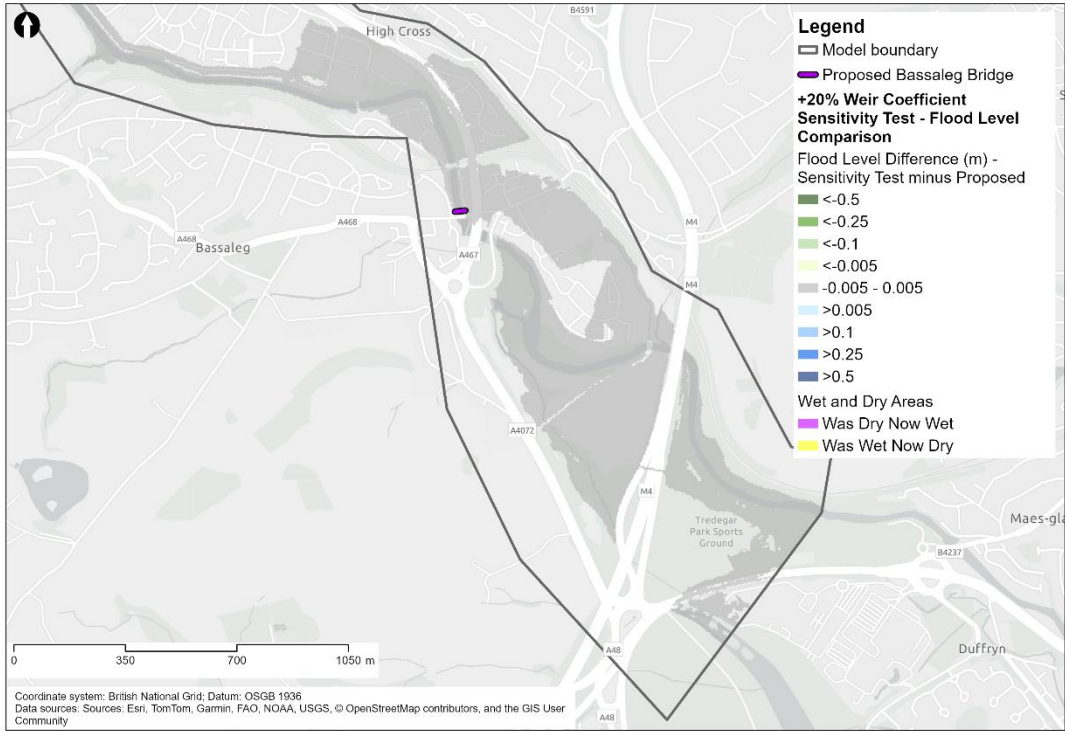
Source: Mott MacDonald 2025

Figure A.7: Water level difference – Sensitivity test minus permanent case – Weir coefficient -20%



Source: Mott MacDonald 2025

Figure A.8: Water level difference – Sensitivity test minus permanent case – Weir coefficient -20%



Source: Mott MacDonald 2025

B. Hydrology Assessment

Flood estimation report: Bassaleg Bridge - Rhiwderin

Introduction

This report template is a supporting document to the Environment Agency’s Flood Estimation Guidelines. It provides a record of the hydrological context, the method statement, the calculations and decisions made during flood estimation and the results. This document can be used for one site or multiple sites. If only one site is being assessed, analysts should remove superfluous rows from tables.

Guidance notes (in red text) are included throughout this document in column titles or above tables. These should be deleted before finalising the document. Where relevant, references to specific sections of the Flood Estimation Guidelines document are included to indicate where further useful information can be found.

Note: Column size / page layout can be adapted, where necessary, to best present relevant information, for example, maps do not need to be within the tables if they would be better as a separate page.

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1	SUMMARY OF ASSESSMENT -----	2
2	METHOD STATEMENT -----	3
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4	STATISTICAL METHOD -----	10
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6	DISCUSSION AND SUMMARY OF RESULTS -----	14
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Approval

Revision stage	Analyst / Reviewer name & qualifications	Amendments	Date
Method statement preparation	E Fox		13/09/2024
Method statement sign-off	R Hughes		13/09/2024
Initial calculations preparation	E Fox		13/09/2024
Initial calculations sign-off	R Hughes		16/09/2024
Calculations - Revision 1 preparation	E Fox		11/07/2025
Calculations - Revision 1 sign-off	L Nicholson		04/09/2025

Abbreviations

AEP	Annual Exceedance Probability
AM.....	Annual Maximum
AREA	Catchment area (km ²)
BFI	Base Flow Index
BFIHOST	Base Flow Index derived using the HOST soil classification
CPRE.....	Council for the Protection of Rural England
FARL.....	FEH index of flood attenuation due to reservoirs and lakes
FEH.....	Flood Estimation Handbook
FSR.....	Flood Studies Report
HOST	Hydrology of Soil Types
NRFA	National River Flow Archive
OS	Ordnance Survey
POT.....	Peaks Over a Threshold
QMED	Median Annual Flood (with return period 2 years)
ReFH	Revitalised Flood Hydrograph method
ReFH2	Revitalised Flood Hydrograph 2 method
SAAR	Standard Average Annual Rainfall (mm)
SPR.....	Standard percentage runoff
SPRHOST	Standard percentage runoff derived using the HOST soil classification
Tp(0)	Time to peak of the instantaneous unit hydrograph
URBAN	Flood Studies Report index of fractional urban extent
URBEXT1990	FEH index of fractional urban extent
URBEXT2000	Revised index of urban extent, measured differently from URBEXT1990
WINFAP-FEH	Windows Frequency Analysis Package – used for FEH statistical method

1 SUMMARY OF ASSESSMENT

1.1 Summary

This table provides a summary of the key information contained within the detailed assessment in the following sections. The aim of the table is to enable quick and easy identification of the type of assessment undertaken. This should assist in identifying an appropriate reviewer and the ability to compare different studies more easily.

Catchment location	River Ebbw is a tributary of the River Usk, draining in a south-easterly direction. The site of interest is the River Ebbw catchment at Rhiwderin, with a catchment area of 212.27km ² .
Purpose of study and scope	Previous peak flow estimates were undertaken by WHS in 2018 at Rhiwderin on the River Ebbw. The purpose of the hydrological assessment is to consider additional peak flow data between 2018 and the present to ensure peak flow estimates are up to date to provide inputs for the hydraulic model. The study is considered moderate, as the catchments are large (212.27km²), and there is a flow gauge located at Rhiwderin to improve confidence in the assessment.
Key catchment features	The catchment is large with a BFIHOST value of 0.538 and predominately (85%) sandstone bedrock geology with small areas of mudstone. The catchment is considered moderately urbanised, with developments along the valley floor, and in lower and upper reaches, providing an URBEXT value of 0.0743. The FARL value of 0.975 indicates the presence of reservoirs or ponds, but is not thought to represent a significant influence at the location of interest.
Flooding mechanisms	Fluvial and surface water
Gauged / ungauged	Gauged flow at Rhiwderin Gauging Station, in operation since 1976.
Final choice of method	The method of estimating peak flows is in line with that undertaken by WHS (2018) detailed in the Ebbw Baseline Hydrology ¹ . The statistical method is used to derive peak flows below the 1%AEP. For the 0.5% and 0.1%AEP, ReFH2 peak flow ratios were applied to the 1%AEP peak flow derived using the statistical method.
Key limitations / uncertainties in results	<u>Storm Duration</u> The assumed storm duration used in this assessment is 21.5 hours. This was found to be the critical storm duration by the WHS (2018) modelling. However, REFH2 recommends a more suitable storm duration of 12.5 hours. It is therefore recommended that this uncertainty is further investigated during hydraulic modelling to demonstrate <u>NRFA Peak flow dataset</u> The WHS (2018) study uses the NFRA v11 dataset for the FEH statistical method. This study uses v12. The main differences are the addition of water years and changes in gauging station suitability. After completing the calculations, NFRA v13 was released. The gauge stations used in this assessment were checked in v13, confirming that none of the stations within the pooling groups or QMED estimation had changed in suitability. Therefore, it was deemed unnecessary to update further, as the likely impact of the new water year data would be negligible and would not influence the concluded estimates

1.2 Note on flood frequencies

The frequency of a flood can be quoted in terms of a return period, which is defined as the average time between years with at least one larger flood, or as an annual exceedance probability (AEP), which is the inverse of the return period.

¹ WHS, 2018. Ebbw Baseline Hydrology – Natural Resource Wales.

Return periods are output by the Flood Estimation Handbook (FEH) software and can be expressed more succinctly than AEP. However, AEP can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval. Results tables in this document contain both return period and AEP titles; both rows can be retained or the relevant row can be retained and the other removed, depending on the requirement of the study.

The table below is provided to enable quick conversion between return periods and annual exceedance probabilities.

Annual exceedance probability (AEP) and related return period reference table

AEP (%)	50	20	10	5	4	3.3	2	1	0.5	0.1
Return period (yrs)	2	5	10	20	25	30	50	100	200	1,000

2 METHOD STATEMENT

2.1 Requirements for flood estimates

Overview	Previous peak flow estimates were undertaken by WHS in 2018, at Rhiwderin on the River Ebbw. The purpose of the hydrological assessment is to update peak flow estimates to provide inputs for a hydraulic model for the assessment of Bassaleg Bridge, Bassaleg, South Wales. The purpose of this report is to document decision-making and methodology in peak flow estimation. Flow estimates are required for the following AEPs: • 50%AEP, (1 in 2 year) • 20% AEP (1 in 5 year) • 10% AEP (1 in 10 year) • 5% AEP (1 in 20 year) • 4% AEP (1 in 25 year) • 3.3% AEP (1 in 30 year) • 2% AEP (1 in 50 year) • 1% AEP (1 in 100 year) • 1% AEP +25% CC (1 in 100 year +CC) • 1% AEP +75% CC (1 in 100 year +CC) • 0.5% AEP (1 in 200 year) • 0.1% AEP (1 in 1000 year)
Project scope	The study is considered moderately complex, as the catchments are large (212.27km²). There is gauged data available at Rhiwderin to improve confidence in the assessment. The method of estimating peak flows is the same as that undertaken by WHS (2018), detailed in Ebbw Baseline Hydrology². The FEH statistical method is used to derive peak flows below the 1%AEP. For 0.5% and 0.1%AEP, ReFH2 peak flow ratios were applied to the 1%AEP peak flow derived using the FEH statistical method.

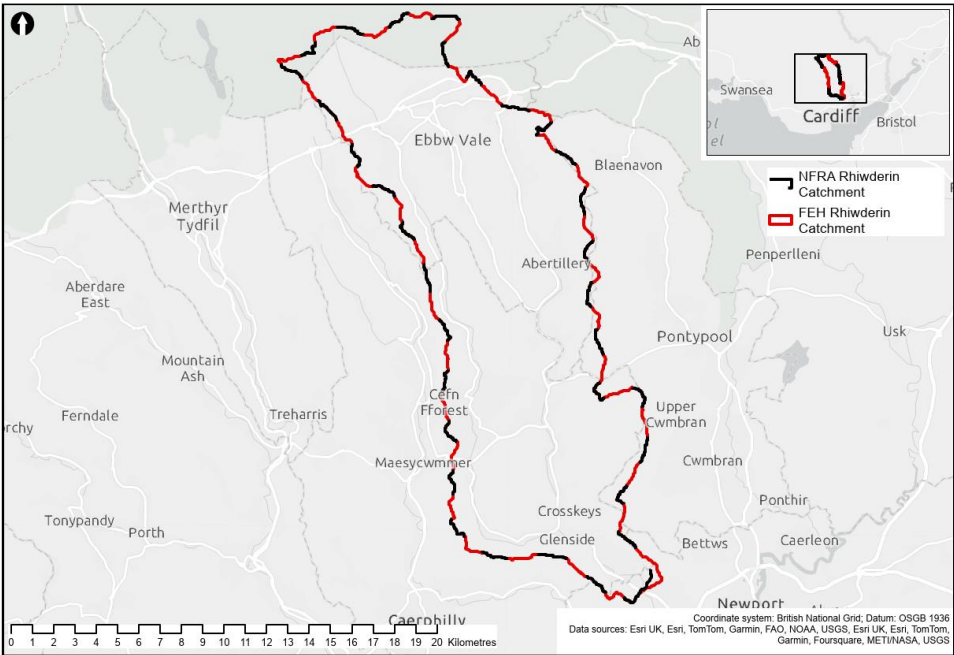
2.2 The catchment

Description	Figure 2-1 shows the FEH River Ebbw at Rhiwderin catchment area assessed
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² WHS, 2018. Ebbw Baseline Hydrology – Natural Resource Wales.

within this report, compared against the NFRA Rhiwderin catchment.

Figure 2-1: River Ebbw catchment at Rhiwderin



River Ebbw is a tributary of the River Usk, draining in a south-easterly direction. The site of interest is the River Ebbw catchment at Rhiwderin, with a catchment area of 212.27km². Note there is a difference in catchment areas at Rhiwderin, NFRA stated 216.5km², WINFAP FEH data files state this is 211.8km², FEH Catchment Descriptors uses 212.27km². There is a small difference between WINFAP and FEH catchment area estimates and the variation is considered minor overall. For this assessment, the FEH catchment area is to used within calculations.

The catchment is large with a BFIHOST value of 0.538. The underlying geology is predominately (85%) sandstone bedrock with small areas of mudstone. The upper catchment is characterised by steep sides and narrow valleys. The catchment is moderately urbanised with small towns and development throughout the valleys (URBEXT value of 0.0743). The remaining catchment landuse is predominantly agricultural land.

2.3 Source of flood peak data

Source	NRFA peak flows dataset, Version 12, released October 2023.
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2.4 Gauging stations (flow or level)

Water-course	Station name	Gauging authority number	NRFA number	Catchment area (km ²)	Type (rated / ultrasonic / level...)	Start of record and end if station closed
River Ebbw	Rhiwderin	056002	56002	211.8	Flow	1976-present

2.5 Data available at each flow gauging station in Table 2.4

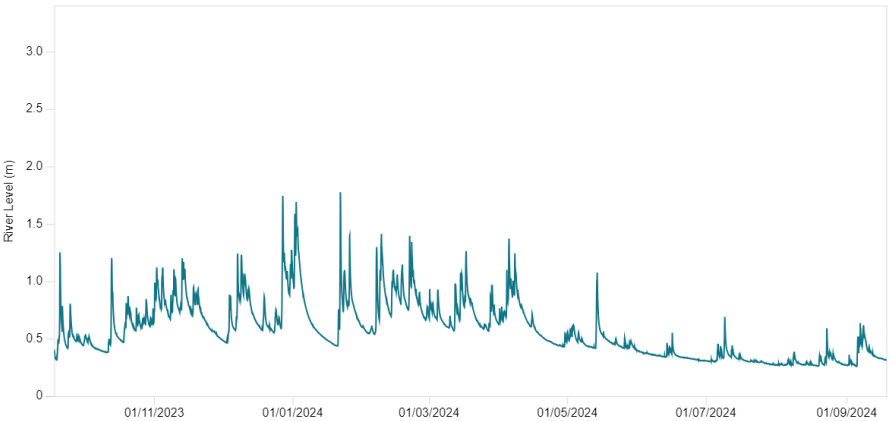
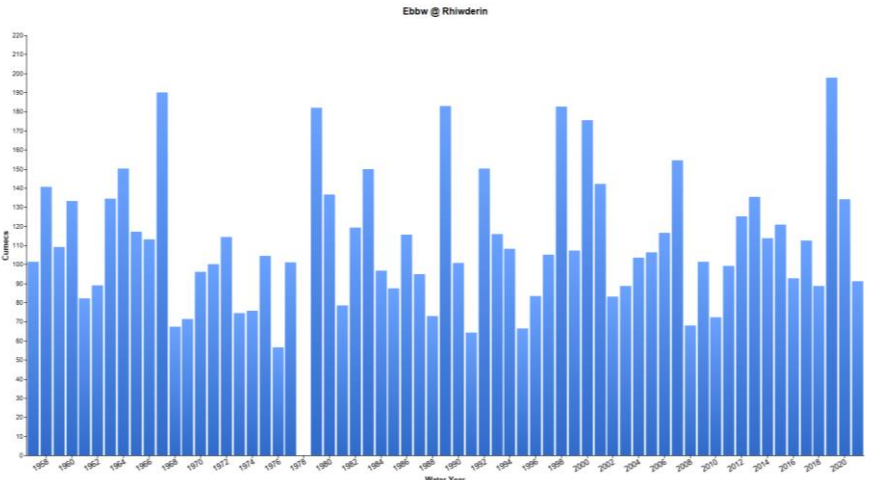
Station name	Start and end of NRFA flood peak record	Update for this study?	OK for QMED?	OK for pooling ?	Data quality check needed?	Other comments on station and flow data quality
Rhiwderin	1976	No	Yes	Yes	No	Weir refurbishment in 1996 but did not alter the weir level or geometry

2.6 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available?	Source of data	Details
Check flow gaugings		No		
Historical flood data		No		
Flow or river level data for events		Yes	NFRA NRW	- Daily flow data available at Ebbw @ Rhiwderin gauging station from NRFA - NRW - (Preceding 1-year data at a 15-minute resolution only)
Rainfall data for events		No		
Potential evaporation data		No		
Results from previous studies		Yes	WHS (2018)	Ebbw Baseline Hydrology
Other data or information		No		

2.7 Hydrological understanding of catchment

Plots of flow data and interpretation	Figure 2-2 presents the flow data for November 2023 to present. The plot demonstrates that the hydrograph response is characterised by sharp and rapid rises typical of the steep-sided catchment.
---------------------------------------	--

	Figure 2-2: Observed river level time series from Rhiwderin Gauging Station 
Plots of flood peak data and interpretation	Figure 2-3 presents the AMAX series data from Rhiwderin Gauging Station, note data is missing from 1978. Flows from 1977 were reprocessed in 2013 due to rating changes (including a new modelled high flow rating). This resulted in a significant reduction in the largest peak flows and minor reduction in daily mean and monthly maximum flows, particularly for period 1997-2000. Flow peaks occur regularly every 10 years. Figure 2-3 shows that AMAX 1 occurred in 2020, and as such falls in the period after the WHS study in 2018. This supports the update of 2018 calculations to the present day. Figure 2-3: AMAX series from Rhiwderin Gauging Station 

Conceptual model	The main sources of flooding in the catchment are fluvial caused by high runoff within the upper catchment and tributaries. These high runoff events are likely to result in localised surface water flooding, which is exacerbated by high fluvial conditions restricting discharge of these smaller tributaries.
Unusual catchment features	BFIHOST is suitable for the catchment of 0.538, and moderately urbanised with URBEXT value of 0.0743.

2.8
Initial choice of approach

Is FEH appropriate?	Yes, the FEH catchment was extracted at Rhiwderin, in line with the method used by WHS (2018). This was reviewed and it was determined that FEH methods were still appropriate for this assessment.
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Initial choice of method(s) and reasons How will hydrograph shapes be derived if needed? Will the catchment be split into sub-catchments? If so, how?	The method of estimating peak flows is the same as that undertaken by WHS (2018) detailed in the 'Ebbw Baseline Hydrology' report. As the site is gauged, the QMED was estimated directly from the AMAX series at Rhiwderin Gauging Station. An Enhanced Single Site Analysis (ESS) and FEH Statistical pooled analysis will be undertaken and compared to the WHS 2018 study. The ReFH2 0.5%:1%AEP and 0.1:1%AEP peak flow ratios will be applied to the 1%AEP peak flow derived using the FEH statistical method, as there is not enough reliable flow record data available to have confidence in the statistical method for derivation of peak flows above the 1%AEP event.
Software to be used (with version numbers)	FEH Web Service ³ / WINFAP 5 ⁴ / ReFH2.2

³ CEH 2015. The Flood Estimation Handbook (FEH) Online Service, Centre for Ecology & Hydrology, Wallingford, UK.

⁴ WINFAP 5 © Wallingford HydroSolutions Limited 2024.

3 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED

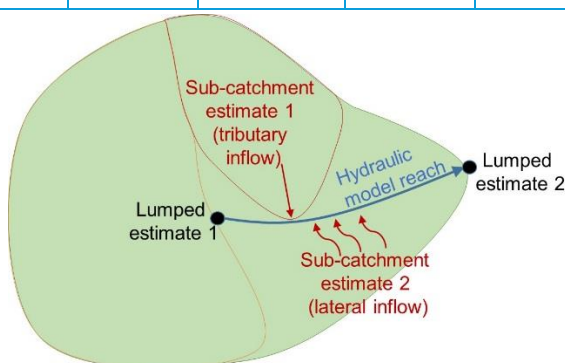
The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space.

3.1 Summary of subject sites

Site code	Type of estimate L: lumped catchment S: Sub-catchment	Watercourse	Name or description of site	Easting	Northing	AREA on FEH CD-ROM (km ²)	Revised AREA if altered
1	Lumped	River Ebbw	Rhiwderin	325850	188850	212.27	-
2	Lumped	River Ebbw	Rhiwderin DS	328950	186100	223.12	-
Inter	Sub-catchment	River Ebbw	Rhiwderin Intervening catchment			-	10.85

Note: Inter (intervening area) has been presented to show the intended model application, no estimates for this site have been produced.

Note: Lumped catchments (L) are complete catchments draining to points at which design flows are required. Sub-catchments (S) are catchments or intervening areas that are being used as inputs to a semi-distributed model of the river system. There is no need to report any design flows for sub-catchments, as they are not relevant: the relevant result is the hydrograph that the sub-catchment is expected to contribute to a design flood event at a point further downstream in the river system. This will be recorded within the hydraulic model output files. However, catchment descriptors and ReFH model parameters should be recorded for sub-catchments so that the results can be reproduced. The schematic diagram illustrates the distinction between lumped and sub-catchment estimates.



3.2 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	URBEXT 2000	FPEXT
1	0.975	0.49	0.538	22.32	182.3	1454	0.0743	0.0392
2	0.976	0.49	0.543	26.21	177.5	1438	0.0796	0.0431
Inter	1.00	0.49	0.538	3.69	182.3	1454	0.5032	0.0392

Note: Catchment descriptors for the intervening area were calculated using the area weighting ratio method detailed in FEH Volume 5⁵. Calculated catchment descriptors for the intervening areas were comparable to those from site 1 (Rhiwderin). Site 1 descriptors were retained barring URBEXT and DPLBAR values which were manually calculated as follows:

$$\text{URBEXT2000} = \text{URBAN} \times 0.629$$

$$\text{DPLBAR} = \text{AREA}^{0.548}$$

⁵ FEH, 2008. Volume 5 Catchment Descriptors [Flood-Estimation Handbook-5-Catchment-Descriptors](#) Adrian-Bayliss.pdf (ceh.ac.uk)

3.3 Checking catchment descriptors

Record how the catchment boundary was checked and describe any changes	The catchment boundary at Rhiwderin was not adjusted, in line with WHS (2018) methodology. The FEH catchment area was compared against the catchment area from DTM. A difference of less than 2% was noted however, there were no topographic discrepancies, and therefore FEH catchment was retained.
Record how other catchment descriptors were checked and describe any changes.	Catchment descriptors were checked by WHS in 2018 for Rhiwderin, the approach to retain values is agreed. BFIHOST value is 0.538, with 0.55 reported by NFRA which is close to the FEH record. OS mapping was used to check URBEXT2000, little difference was noted and the URBEXT2000 deemed valid. No adjustment was carried out on SAAR or FARL.
Source of URBEXT	URBEXT2000
Method for updating of URBEXT	URBEXT updated to 2024

4 STATISTICAL METHOD

4.1 Application of Statistical method

What is the purpose of applying this method?	The purpose of the hydrological assessment is to update peak flow estimates to provide inputs for the hydraulic model, following the same methodology as WHS (2018). As the catchment is gauged, Rhiwderin Gauging Station AMAX series will be used to inform QMED. Growth factors and peak flow will be estimated and compared from pooling group and Enhanced single site (ESS) analysis. Results from this pooling group analysis will be compared, and final peak flows compared against WHS (2018) and ReFH2 outputs. For Rhiwderin DS, a ratio of the catchment area between Rhiwderin and DS is applied to estimate the QMED.
--	---

4.2 Overview of estimation of QMED at each subject site

Site code	QMED (rural) from CDs (m ³ /s)	Final method	Data transfer					Urban adjustment factor UAF	Final estimate of QMED (m ³ /s)
			NRFA numbers for donor sites used (see 4.3)	Distance between centroid s d _{ij} (km)	Moderate d QMED adjustment factor, (A/B) ^a	If more than one donor			
						Weight	Weighted ave. adjustment		
1	92.97	AMAX	56002	0.0	N/A	N/A	N/A	1.08	105.75
2	-	Scaled Area ratio of site 1	N/A	N/A	N/A	N/A	N/A	N/A	110.20
Are the values of QMED spatially consistent?						N/A			
Method used for urban adjustment for subject and donor sites						Taken direct from observed AMAX data and urbanised using WINFAP v5 automatic feature (Kjeldsen 2010)			
Parameters used for WINFAP v4 urban adjustment if applicable									
Impervious fraction for built-up areas, IF			Percentage runoff for impervious surfaces, PR _{imp}			Method for calculating fractional urban cover, URBAN			
Default value (0.3)			Default value (0.7)			Calculated using URBEXT 2000 (1.567 x URBAN2000)			
Notes									
Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer (with urban adjustment); CD – Catchment descriptors alone (with urban adjustment); BCW – Catchment descriptors and bankfull channel width (add details); LF – Low flow statistics (add details).									
The QMED adjustment factor A/B for each donor site is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is (A/B) ^a times the initial (rural) estimate from catchment descriptors.									
Important note on urban adjustment									
The method used to adjust QMED for urbanisation published in Kjeldsen (2010) in which PRUAF is calculated from BFIHOST is not correctly applied in WINFAP-FEH v3.0.003. Significant differences occur only on urban catchments that are highly permeable. This is discussed in Wallingford HydroSolutions (2016).									

4.3 Search for donor sites for QMED (if applicable)

Comment on potential donor sites	N/A - Rhiwderin Gauging Station AMAX series used to inform QMED. Rhiwderin DS catchment area is approximately 5% greater than Rhiwderin. This ratio was applied to the Rhiwderin QMED to estimate DS value.
----------------------------------	---

4.4 Derivation of pooling groups

Name of group	Site code from whose descriptors group was derived	Subject site treated as gauged?	Changes made to default pooling group, with reasons	Weighted average L-moments	
Group 1	1	No	Initial pooling group was suggested by WINFAP with 12 stations. Stations were added and removed to replicate the pooling group as detailed by WHS (2018) (Final stations used: 49001 / 60013 / 79005 / 72005 / 76021 / 25018 / 63001 / 54038 / 15013 / 56006 / 47006 / 71008).	L-CV	0.183
				L-Skew	0.206
Group 2	1	Yes – Enhanced Single Site (Urbanised)	Initial pooling group was suggested by WINFAP with 12 stations. Stations were added and removed to replicate the pooling group as detailed by WHS (2018) (Final stations used: 49001 / 60013 / 79005 / 72005 / 76021 / 25018 / 63001 / 54038 / 15013 / 56006).	L-CV	0.169
				L-Skew	0.186
Stations 83004 and 82001 were used in pooling groups in WHS (2018) when using NFRA v11 database. These stations in NFRA v12 have been downgraded to QMED only, so were excluded from pooled assessments. Sites were removed and added to align with those used by WHS (2018). WHS (2018) stated the default pooling groups suggested by WINFAP were used with no station adjustments or checking of whether the stations are suitable. However, as NFRA v12 is used in this project, there is a change in station suitability and addition of water years, therefore changing the default pooling group.					
Note: Pooling groups were derived using the procedures from Science Report SC050050 (2008).					

4.5 Derivation of flood growth curves at subject sites

Site code	Method	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution		Growth factor for 100-year return period
1	P	Group 1	GL – distribution used in WHS (2018)	N/A	Location	1	2.39
					Scale	0.181	
					Shape	-0.206	
					Bound	0.12	
1	ESS	Group 2	GL –	Urbanised using	Location	1	2.2

Site code	Method	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban adjustment or permeable adjustment	Parameters of distribution		Growth factor for 100-year return period
			distribution used in WHS (2018)	the automatic feature in WINFAP v5 software (Kjeldsen 2010)	Scale	0.169	
					Shape	-0.186	
					Bound	0.093	

The above results highlight peak flows for Rhiwderin from ESS urban and pooled groups. Pooled peak flows are higher than ESS estimates. However, the ESS is deemed preferential for estimating flood peaks as it utilises an at site gauging station and supplements this with a wider dataset from other sites. Therefore, the ESS urban peak flows are used for final peak flows.

All methods used the GL distribution to estimate growth curves and flood peaks. Whilst GEV and KAP3 were indicated as ok for use, GL is preferred as it both provides a direct comparison with previous estimates, is generally preferential for UK catchments and provides a more conservative estimate. Although conservatism is not the primary determining factor, a certain level of conservatism is considered appropriate and beneficial for the subsequent modelling assessment.

Table 1: Peak flow estimates for Rhiwderin from ESS and Pooled Groups

Return Period	Rhiwderin		Rhiwderin DS
	ESS Peak Flow estimates urban (m ³ /s)	Pooled Peak Flow estimates (m ³ /s)	ESS Peak Flow estimates urban (m ³ /s)
2	105.8	105.8	110.20
10	154.2	158.9	139.63
20	175.7	183.3	160.67
25	183.1	191.6	183.04
50	207.6	220.0	190.76
100	235.2	252.2	197.15
200*	266.4	289.1	216.33
1000*	356.2	397.9	371.16

*Outwith recommended limit of flow estimation for FEH statistical method.

Notes

Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis
Urban adjustments are all carried out using the method of Kjeldsen (2010).
Growth curves were derived using the procedures from Science Report SC050050 (2008).

4.6 Flood estimates from the statistical method

Site code	Flood peak (m ³ /s) for the following return periods (in years)									
	2	5	10	20	25	30	50	100	200	1000
	Flood peak (m ³ /s) for the following AEP (%) events									
	50	20	10	5	4	3.33	2	1	0.5	0.1
1	105.8	134.0	154.2	175.7	183.1	189.2	207.6	235.2	266.4	356.2
2	110.2	139.6	160.7	183.0	190.8	197.2	216.3	245.1	277.6	371.2

5 REVITALISED FLOOD HYDROGRAPH 2 (REFH2) METHOD

5.1 Application of ReFH2 method

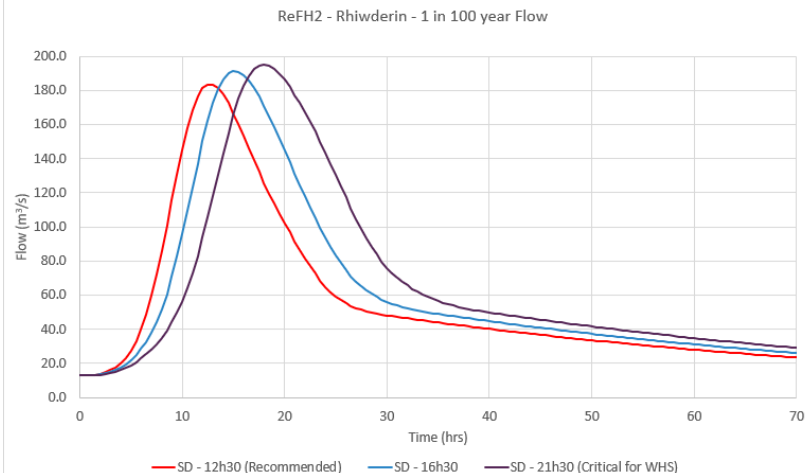
What is the purpose of applying this method?	The ReFH2 0.5%:1%AEP and 0.1:1%AEP peak flow ratios will be applied to the 1%AEP peak flow derived using the statistical method, as there is not enough of a reliable flow record available to have confidence in the statistical method for derivation of peak flows above the 1%AEP event. This method has been used in order to provide a comparison to the preferred FEH statistical method.
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5.2 Catchment sub-divisions for ReFH2 model

A single lumped inflow for the upper catchment is proposed, with the intermediate catchment applied to “top-up” the model as obtain the desired target flow at the downstream of the model. The catchment is considered moderately urban with an URBEXT value of 0.0743. However no adjustment to urban parameters was carried out by WHS (2018), so was not undertaken in this project.

Flows for the intervening catchment were not calculated, catchment descriptors are listed above. Flows for site code 2 were adjusted by an area ratio (determined by comparing site 1 to 2), not through ReFH2.

5.3 Parameters for ReFH2 model

Site code	Method	T _p _{rural} (hours)	C _{ini} (mm)	C _{max} (mm)	PR _{imp}	BL (hours)	BR
1	CD	4.90	91.13	377.20	0.70	55.55	2.24
Brief description of any flood event analysis carried out			No calibration was undertaken for this project. However, WHS (2018) calibrated the model through a trade-off between QMED (via adjusting C _{ini}) and the subsequent fit obtained for Q(1%AEP) by adjusting the T _p hours.				
			For Rhiwderin a storm duration of 12.5 hours was recommended, while WHS (2018) used a storm duration of 21.5 hours critical for the purpose of their modelling. Figure 5-1 shows peak flows for the 1%AEP, there is approximately a 6% difference in flow between 12.5hours and 21.5hours. For the purpose of this assessment the 21.5 hour storm duration was retained as the critical duration. However it is recommended that this assumption is tested within the hydraulic modelling assessment. Figure 5-1: 1% AEP hydrograph for Rhiwderin from ReFH2  Table 2 presents rural and urban peak flow estimates from ReFH2, as expected urban peak flow values are higher than rural.				

Site code	Method	T _p _{rural} (hours)	C _{ini} (mm)	C _{max} (mm)	PR _{imp}	BL (hours)	BR
			Table 2: Rural and urban ReFH2 peak flow estimates at Rhiwderin				
			Return Period		Rhiwderin		
					Rural peak flow (m ³ /s)	Urban peak flow (m ³ /s)	
			2		90.0	93.9	
			10		131.4	136.9	
			20		148.2	154.3	
			25		153.9	160.2	
			50		172.8	179.7	
			100		195.2	202.7	
			200		223.1	231.4	
			1000		312.9	323.1	
Methods: OPT: Optimisation, BR: Baseflow recession fitting, CD: Catchment descriptors, DT: Data transfer (give details)							

5.4 Design events for ReFH2 method: Lumped catchments

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)
1	Urban	Winter	21.5 (Critical SD for WHS) 12.5 (Recommended ReFH SD)

5.5 Flood estimates from the ReFH2 method

Site code	Flood peak (m ³ /s) for the following return periods (in years)									
	2	5	10	20	25	30	50	100	200	1000
	Flood peak (m ³ /s) for the following AEP (%) events									
	50	20	10	5	4	3.33	2	1	0.5	0.1
1	93.9	119.4	136.9	154.3	160.2	165.1	179.7	202.7	231.4	323.1
2	98.5	125.3	143.6	161.8	168.0	173.2	188.4	212.5	242.6	338.8

6 DISCUSSION AND SUMMARY OF RESULTS

6.1 Comparison of results from different methods

Site code	Ratio of peak flow to FEH Statistical peak					
	Return period 2 years / 50% AEP			Return period 100 years / 1% AEP		
	FEH Catchment Descriptors	FEH	ReFH2	FEH Catchment Descriptors	FEH	ReFH2
Rhiwderin	93.15	105.75	93.95	101.38	235.19	202.67

6.2 Final choice of method

Choice of method and reasons	The catchment is gauged so AMAX data at Rhiwderin station was used to determine QMED. The FEH statistical method was then used to estimate growth factors and peak flows up to 1%AEP. This was done using both an ESS and pooling approach. The pooling group produced higher peak flow estimates than ESS
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	group, however, ESS was used. This approach utilises the observed data within the flood growth curve estimates while ensuring that a sufficient pooled set of data is used to supplement and provide greater confidence in the estimates. GL distribution was used with ESS to estimate flood peaks. ReFH2 was used to estimate flood peaks and were compared to FEH statistical method estimates. FEH statistical method flood peak estimates will be used up until the 1%AEP event. Then ReFH2 0.5%:1%AEP and 0.1:1%AEP peak flow ratios will be applied to the 1% AEP peak flow derived using the statistical method, as there is not enough reliable flow record data available to have confidence in the statistical method for derivation of peak flows above the 1%AEP.
How will the flows be applied to a hydraulic model?	The 21.5 hour storm was deemed to be the critical duration for this assessment. Hydrographs will be produced using ReFH2. It is intended that: • Site 1: Inflows will be applied using ReFH2 hydrographs and then scaled to the final peak flow derived by this assessment. • Site 2: Intermediate flows using ReFH2 will be applied and adjusted to match target flows at the downstream extent of the hydraulic model.

6.3 Assumptions, limitations and uncertainty

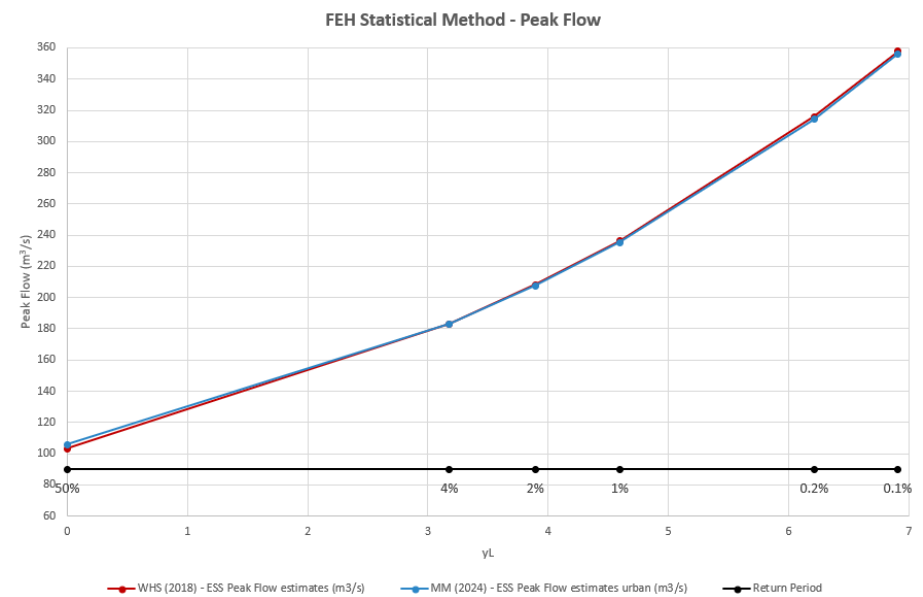
List the main assumptions made (specific to this study)	The assumed storm duration was 21.5 hours, which was critical for the WHS (2018) modelling for the ICM routing model. This enabled the model to match peak flows at Rhiwderin. However, ReFH2 recommends a storm duration of 12.5 hours. The latter does not consider the impact of model routing, therefore it is recommended for the critical duration to be re-tested during hydraulic modelling. The NFRA v12 database has been used, Rhiwderin gauging station uses flow rating factors to derive rating curves, curves are suitable and confident with the data used.
Discuss any particular limitations	The WHS (2018) study used the NFRA v11 dataset to derive the FEH pooling groups, this study used v12. Stations 83004 and 82001 used in the WHS assessment have since been downgraded to QMED (from pooling). This means that, in v12, pooling groups can not be exactly replicated or compared between the two studies. This has meant that the intended approach, to replicate previous pooling groups, has not been carried out. However, the use of an updated peak flow dataset within this assessment is deemed preferential and of higher confidence.
Provide information on the uncertainty in the design peak flow estimates and the methodology used	The presence of gauged flows up to QMED, provides confidence in the value used. However, Rhiwderin AMAX 1 is approximately equivalent to bank full. No spot gaugings above ~130m³/s have been recorded, and therefore the AMAX flows recorded for this gauge rely on the most up-to-date rating relationship. However, the gauge and method form the most appropriate use of data and are deemed to be the best available for this assessment scope.
Comment on the suitability of the results for future studies	The peak flows presented in this assessment should be reviewed in future studies. This should check Whether key decisions and methods, such as peak flow datasets or the use of an ESS approach are still valid.

	It is recommended that if significant flood events are observed within the catchment, these peak flow estimates are reviewed and, where necessary, updated. To improve ReFH2 peak flow estimates, storm duration testing should be carried out.
Give any other comments on the study	This assessment has been produced to support the Bassaleg Bridge updates only and may not be appropriate for use in other hydraulic modelling or hydrological assessments. It is recommended that these hydrological estimates are reviewed during and following the completion of hydraulic modelling.

6.4 Checks

Are the results consistent, for example at confluences?	Not relevant for this study.																				
What do the results imply regarding the return periods / frequency of floods during the period of record?	The biggest flow peak observed recorded at Rhiwderin gauging station was in 2020 at 197m³/s, this is between a 3.3%AEP and 2%AEP final flow estimate. Therefore, the flow estimates are comparable to the observed peak flow data. As no flow above this has been observed (based on the up-to-date observed record) there is a lower confidence in peak flow estimates above the 1%AEP year event.																				
What is the range of 100-year / 1% AEP growth factors? Is this realistic?	Yes, 2.22 for Rhiwderin, which is within the typical national range of 2.1 to 4.0.																				
If 1000-year / 0.1% AEP flows have been derived, what is the range of ratios for 1000-year / 0.1% AEP flow over 100-year / 1% AEP flow?	ReFH ratio for 0.5%AEP/1%AEP is 1.14 and this was applied to 100-year FEH Statistical value to derive 0.5%AEP flows. Ratio for 0.01%AEP/1%AEP is 1.59 and this was applied to 100-year FEH Statistical value to derive 0.01%AEP flows.																				
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	FEH Statistical Method Table 3 highlights differences in QMED values from catchment descriptors and AMAX data from WHS (2018) and updated hydrology. Updated hydrology QMED values are higher than WHS (2018) data, this is expected due to NFRA v12 dataset used with increased data record (NFRA v11 for WHS (2018) previous estimate). Table 3: QMED Estimates from catchment descriptors and AMAX series (from Rhiwderin Gauging Station) <table><tr><th></th><th colspan="2">WHS (2018)</th><th colspan="2">MM (2024)</th></tr><tr><th></th><th>Catchment Descriptors (m³/s)</th><th>AMAX (m³/s)</th><th>Catchment Descriptors (m³/s)</th><th>AMAX (m³/s)</th></tr><tr><td>Rural</td><td>82.2</td><td>90.10</td><td>93.15</td><td>97.16</td></tr><tr><td>Urban</td><td>94.3</td><td>103.3</td><td>101.38</td><td>105.75</td></tr></table> Figure 6-1 shows peak flow from WHS (2018) and MM (2024) using the ESS urban pooling group, updated peak flow estimates are slightly less than WHS (2018) estimates. However, the difference are between -0.5% and 2%, the 2% difference is observed for the 50%AEP.		WHS (2018)		MM (2024)			Catchment Descriptors (m³/s)	AMAX (m³/s)	Catchment Descriptors (m³/s)	AMAX (m³/s)	Rural	82.2	90.10	93.15	97.16	Urban	94.3	103.3	101.38	105.75
	WHS (2018)		MM (2024)																		
	Catchment Descriptors (m³/s)	AMAX (m³/s)	Catchment Descriptors (m³/s)	AMAX (m³/s)																	
Rural	82.2	90.10	93.15	97.16																	
Urban	94.3	103.3	101.38	105.75																	

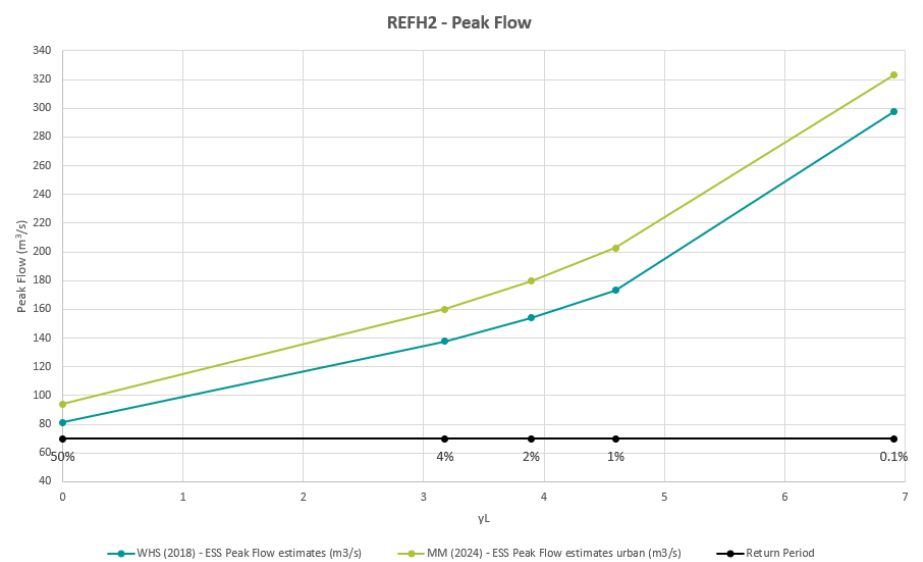
Figure 6-1: Peak flow from FEH Statistical Method



ReFH2 Method

Figure 6-2 shows peak flow from WHS (2018) and MM (2024) using ReFH2, updated peak flow estimates for are higher than WHS (2018) estimates. With difference between 5% and 11%, the percentage differences decreases as the return periods increase. Flood peak data for WHS (2018) has not been provided, so ReFH2 ratios can not be compared. WHS (2018) ReFH2 ratio for 0.1%AEP/1%AEP for is 1.72, compare to the updated ratio of 1.59, therefore there is a small reduction in ratio approximately 7%.

Figure 6-2: Peak flow from ReFH2



Are the results compatible with the longer-term flood history?

The biggest flow peak observed recorded at Rhiwderin gauging station was in 2020 at 197m³/s, this is between a 3.3%AEP and 2%AEP final flow estimate. Therefore, the flow estimates are comparable to the observed peak flow data.

As no flow above this has been observed (based on the up-to-date observed record) there is a lower confidence in peak flow estimates above the 2%AEP year event.

Describe any other checks on the results

No other checks are complete, only against the 2018 hydrology.

6.5 Final results

Site code	Flood peak (m ³ /s) for the following return periods (in years)											
	2	5	10	20	25	30	50	100	200	1000	100+ 25CC	100+ 75CC
	Flood peak (m ³ /s) for the following AEP (%) events											
	50	20	10	5	4	3.3	2	1	0.5	0.1	1+25 CC	1+75 CC
1	105.8	134.0	154.2	175.7	183.1	189.2	207.6	235.2	268.5	375.0	294.0	411.6
2	110.9	140.5	161.7	184.2	192.0	198.4	217.7	246.6	281.6	393.2	308.3	431.6
Inter	5.1	6.5	7.5	8.5	8.9	9.2	10.1	11.4	13.1	18.2	14.3	20.0

6.6 Uncertainty bounds

This table reports the flows derived from the uncertainty analysis detailed in Section 6.3. The 'true' value is more likely to be near the estimate reported in Section 6.5 than the bounds. However, it is possible that the 'true' value could still lie outside these bounds.

Site code	Flood peak (m³/s) for the following return periods (in years)							
	2		20		100		1,000	
	Flood peak (m³/s) for the following AEP (%) events							
	50		5		1		0.1	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
1	104.94	106.56	173.66	177.64	231.84	238.54	367.90	382.01

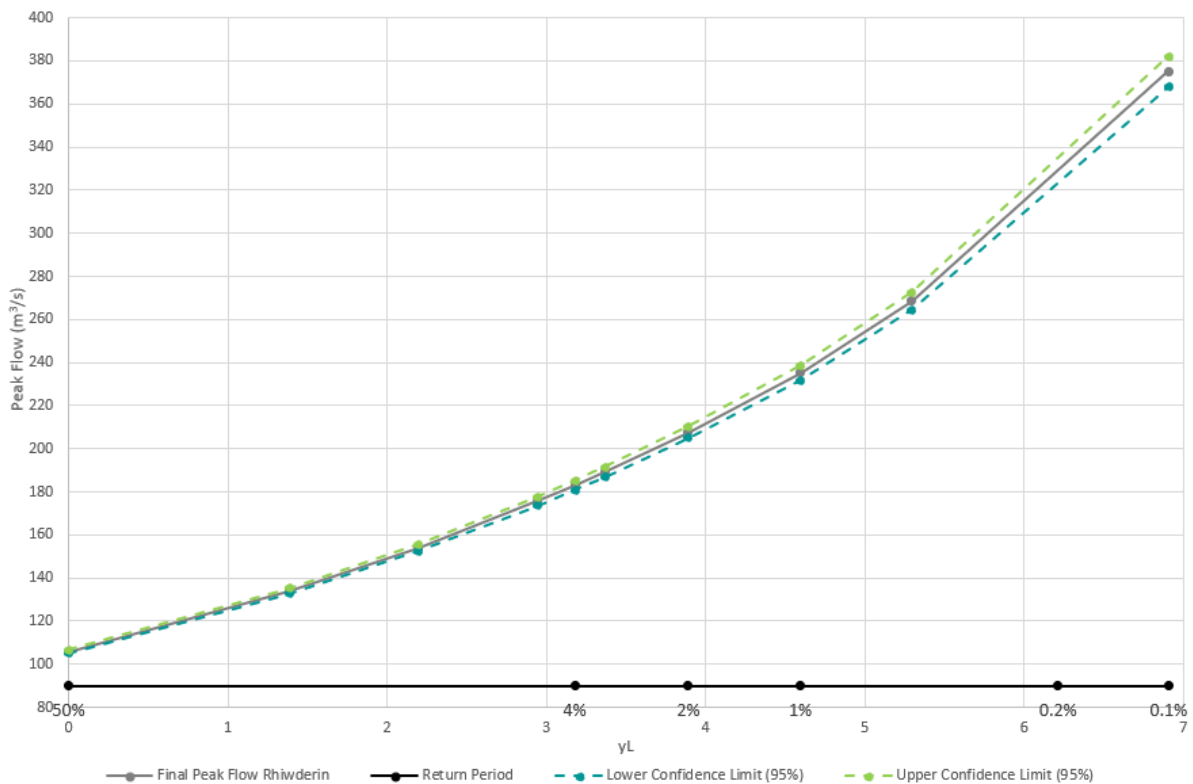
Final peak flow at Rhiwderin are presented below in Figure 6-4, with upper and lower limits. Peak flows are within upper and lower limits, at higher return periods the difference between peak flow and limits is greater. Uncertainty bounds for enhanced single site have been calculated using Hammond (2021) as follows:

$$var(Q_T) = \frac{(QMED \times LCV)^2}{N} \exp(1.3125 + 0.599y + 0.00399y^2)$$

where:

- *QMED* is the median of the annual maximum flows.
- *LCV* is the L-coefficient of variation of the annual maximum flows at the site (not from the pooling group).
- *N* is the number of annual maximum flows at the site.
- *y* is the logistic reduced variate: $y = \ln(T - 1)$

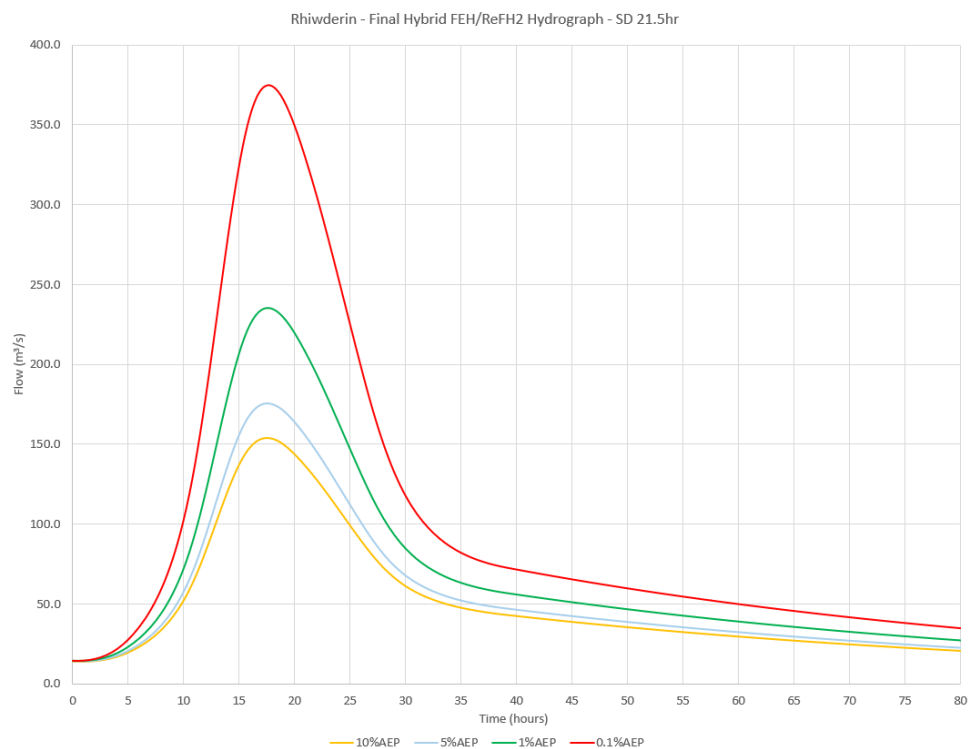
Figure 6-3: Final peak flows at Rhiwderin with upper and lower uncertainty bounds.



If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, hydraulic model, or reference to table below)

Final hydrographs are presented below in Figure 6-4.

Figure 6-4: Final hydrograph from FEH/ReFH2



7 ANNEX

