BRIDGE OF EARN
SURFACE WATER FLOOD STUDY

1. Welcome & overview

The **Bridge of Earn Surface Water Flood Study** (SWFS) has been carried out to understand the current and future flood risk locally, and to identify options to potentially mitigate flood risk where possible.

Flooding can cause a serious disruption to homes, businesses, infrastructure, and the environment. By studying how flooding happens in Bridge of Earn, we can make informed decisions about the most effective ways to manage and mitigate flood risk.

Who is involved?

Binnies (part of RSK Group) on behalf of **Perth & Kinross Council** (PKC) has completed a draft **Surface Water Flood Study**.

We would appreciate your involvement in the development of this Surface Water Flood Study as local knowledge and community feedback are an important part of this work.

What does the study cover?

- **How** and **why** flooding happens in Bridge of Earn.
- How flood risk might evolve in the future due **climate change**.
- **Possible measures** to mitigate the impacts of flooding.
- **Understand and assess** the suitability of the existing flood defences in Bridge of Earn.
- **Produce recommendations** for next steps.

What are the key objectives of the study?

- **Reduce the risk of flooding,** where possible, to homes, business and main transport links from both surface water and watercourses.
- **Prepare for climate change**, which is predicted to produce more intense and frequent rainfall events in the future.
- Help to **protect watercourses** from pollution.
- **Improve local green spaces**, habitats and biodiversity, contributing to enhanced placemaking.
- **Enable economic development**.

This Surface Water Flood Study has been developed in consultation with key organisations such as **SEPA** and **Scottish Water** to define a strategy identifying the most appropriate and cost-effective opportunities to mitigate flood risk.

Where are we now?

We have completed the technical analysis and reviewed a range of possible flood risk management options. These posters share the results and our recommendations, and explain what happens next.

Your views

We value your input and want to ensure your views are heard. This consultation event gives you the opportunity to share your thoughts on the proposed flood risk management options, helping us test the acceptability of the proposals and ensure they reflect local knowledge and understanding of flood risk. Your feedback will play an important role in shaping how the options progress.

Figure 1. Deich Burn at Bridge of Earn

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2. Understanding flooding at Bridge of Earn

When it rains, that **water has to go somewhere**. If rainwater cannot soak into the ground or evaporate, it flows overland into drains leading to **watercourses** or the **sewer system**.

Impervious surfaces present a significant challenge as they not only replace vegetated cover, reducing water retention and infiltration into the ground, but also generate increased runoff that flows more rapidly into the sewer network. As the town grows, new roads, roofs and pavements are built. That means increasing rapidly the impermeable surfaces and therefore the amount of **runoff** into the sewer system. Putting more pressure on its capacity, increasing the magnitude of **floods** and the amount of **pollution** in the watercourses.

Within most urban areas in the UK the majority of the existing sewer network is "**combined**", receiving **foul** water from toilets and other domestic, commercial and industrial usage, as well as **rainwater** runoff from roads, pavements and roofs. Flooding from these combined sewers poses a particular **pollution** and **flood** damage problem.

Figure 2. Example of surface water flooding

River flows, return periods & probabilities

River flows are measured in **cubic metres per second** (m^3/s), and we often refer to the largest flow during a flood event as the "**peak flow**".

To describe how **unusual** or **likely** a flood is, we use the terms "**return period**" and "**annual exceedance probability**" (AEP). These are simply ways of expressing the **chance** of a flood of a certain size happening in **any given year**.

For example: a 1 in 200-year flood (also called a 0.5% AEP event) means that the estimated peak flow at the River Earn would be around $565m^3/s$. This does not mean such flow happens only once every 200 years. Instead, it means that in any single year, there is a 0.5% chance of a flow of that size (or larger) occurring.

Flooding is a natural process, and chance does not follow a strict calendar. It is entirely possible to experience two "1 in 200-year" floods within just a few years –or even within the same year.

In short: Return periods and AEP are statistical tools to describe how likely a flood is, not a prediction of when it will happen. Floods can occur at any time, and their frequency is based on probability, not fixed timelines.

Figure 3. Example of SuDS (source: NatureScot)

SUSTAINABLE DRAINAGE SYSTEMS (SuDS)

Traditional drainage systems are designed to move stormwater away from streets and properties as quickly as possible by directing runoff into the combined sewer network, burns, or rivers. As towns grow and impermeable areas expand, increasing volumes of water are directed into these systems. Relying solely on this approach can place significant pressure on the sewer network and watercourses, raising the **risk of flooding** and **pollution** and leading to an increasingly costly and unsustainable system that cannot keep pace with **urban growth** or **climate change**.

Modern approaches take a different direction. For new developments, the strategy is to reduce pressure on the sewer network by **imitating natural drainage processes** through the use of **SuDS.** In these areas, runoff from roads, roofs, and footpaths is deliberately captured and managed within SuDS features, rather than being discharged directly into the combined sewer network. SuDS can take many innovative forms that collect, store, and treat surface water before releasing it slowly back into the environment.

Most SuDS are types of **green infrastructure,** which provide habitat that enhances the **ecology** and **amenity** of the area, creating **attractive spaces** for living, working and playing for the local community. However, older urban areas that rely on a traditional combined sewer system still face challenges, as surface water continues to enter the sewer network and contribute to flooding.

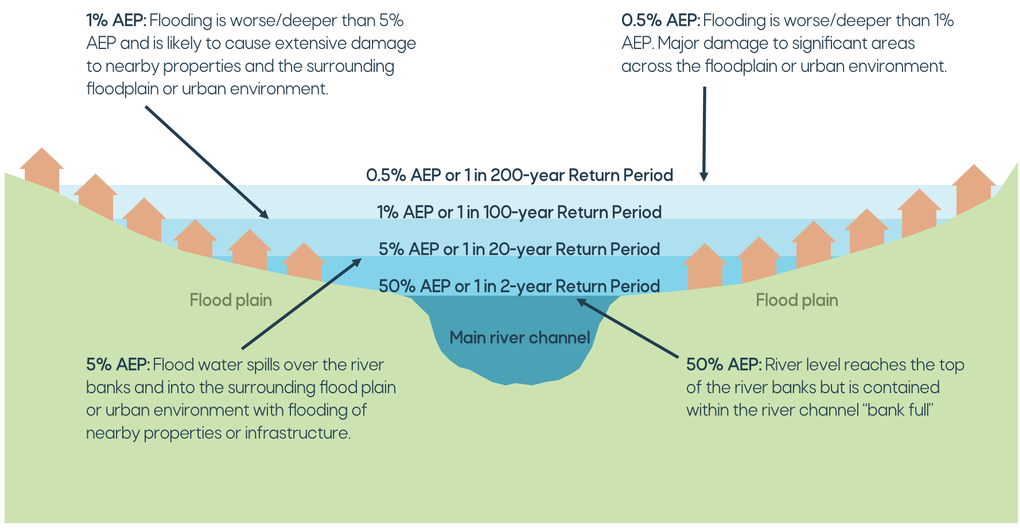

Figure 4. Visual representation of AEP and return periods

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Bridge of Earn was affected by **significant localised flooding** in 2012, 2015, 2016, 2020 and 2022, and therefore has been identified as a **Potentially Vulnerable Area**, which makes it a national priority for flood risk management.

Main sources of flooding in Bridge of Earn

Flooding happens when heavy rain causes the sewer network and rivers/burns to exceed their capacity to convey flow away. As a consequence, water may flow via different routes overland and pond at localised low ground. The SWFS looks specifically at:

- **River flooding** — Bridge of Earn's location on the River Earn means that it is exposed to flooding during significant storm events. Certain parts of the village are also crossed by other minor watercourses (Deich Burn and Yellow Burn) making them vulnerable when water rises above their banks during periods of heavy and prolonged rainfall.
- **Surface water flooding** — When intense rainfall overwhelms the drainage system and water cannot flow away quickly. As a result, runoff flows overland, causing disruption and localised flooding in parts of Bridge of Earn.
- **Interaction between rivers and surface water**— When high river levels make it harder for surface water to drain away, causing water to back up in streets and low-laying areas.

Climate change and future risk

The study also considers how climate change could affect flooding in the future. Higher rainfall intensity and more frequent extreme weather events may increase the **likelihood** and **severity** of flooding over time.

Under the **Flood Risk Management (Scotland) Act 2009**, Bridge of Earn was designated as a **Potentially Vulnerable Area** (PVA 02/08/14) due to river and surface water flooding within the **Tay Local Plan District** (LPD 8).

Actions to manage flood risk are contained within the published Tay Flood Risk Management Strategy, and this includes the requirement for a Surface Water Flood Study (Ref: 20501).

Further information at https://www.pkc.gov.uk/frmplans

Figure 5. Flooding at Kintillo (2012)

Figure 6. Flooding at Old Edinburgh Road (2012)

Figure 7. Flooding at Back Street (2016)

Figure 8 High water levels at Deich Burn (2024)

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3. Predicted flood risk

To understand Bridge of Earn's current and future flood risk, we used a **hydraulic model**. This computer-based tool simulates how water moves through the River Earn, local burns, sewer network and over-land during heavy rainfall and high river flows.

What the model tells us

- It predicts where flooding is most likely to occur, how deep the water could get, and how fast it might flow.
- It allows us to test different storm scenarios, including those that are more likely (e.g.: 1 in 10-year events) and those that are rarer but more severe (e.g.: 1 in 200-year events).
- It helps identify which areas are most at risk today and how this could change in the future.

Scenarios we tested

- **Present day** — representing the current situation without climate change.
- **Future climate change** — factoring in predicted increases in rainfall and river flows.

Scenarios were built with detailed representation of catchment features, including existing flood defences and other critical infrastructure.

Why this matters

The model provides the evidence needed to explore possible flood management options. By understanding the extent and severity of flooding, we can focus efforts where they will have the greatest benefit.

Using a combination of the reported flood history; responses to the public questionnaire submitted in March 2025; and predicted flood outlines produced by the integrated catchment model, three flooding 'hotspots' were defined. These are shown on Figure 8 below.

Critical Storm Duration

A long duration storm can cause high volumes of water to flow through the sewer network over a long period of time and may not cause flooding due to low rainfall intensity.

Short duration storms produce the opposite—lower volumes of water but high rainfall intensity that quickly inundates drainage routes.

Between these two scenarios is the **worst case**, the scenario when taking the impact of burns and sewer network drainage capacity into account results in the greatest risk of flooding. The critical storm duration in Bridge of Earn was estimated to be **8 hours**.

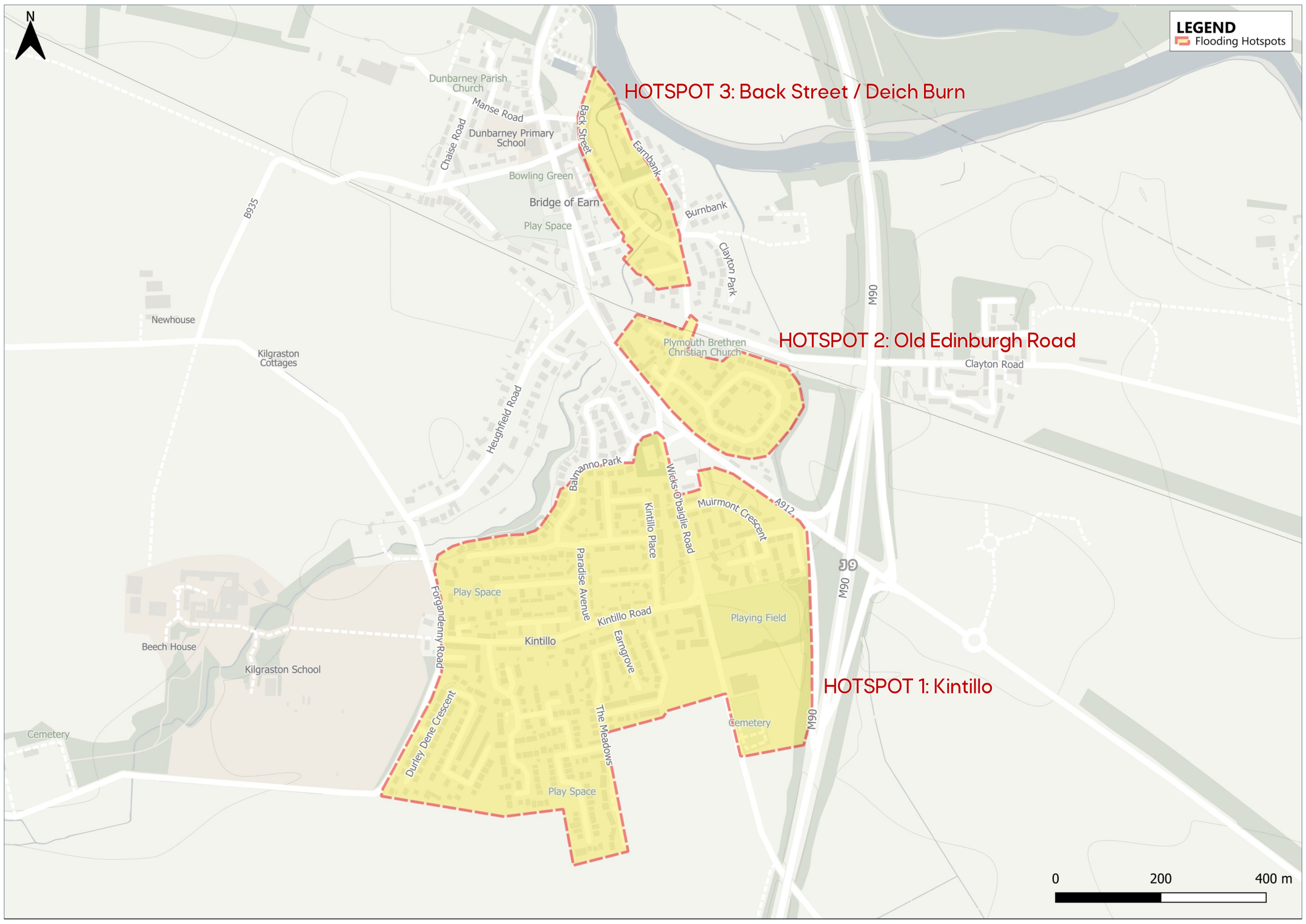

Figure 9. Flooding hotspots across Bridge of Earn

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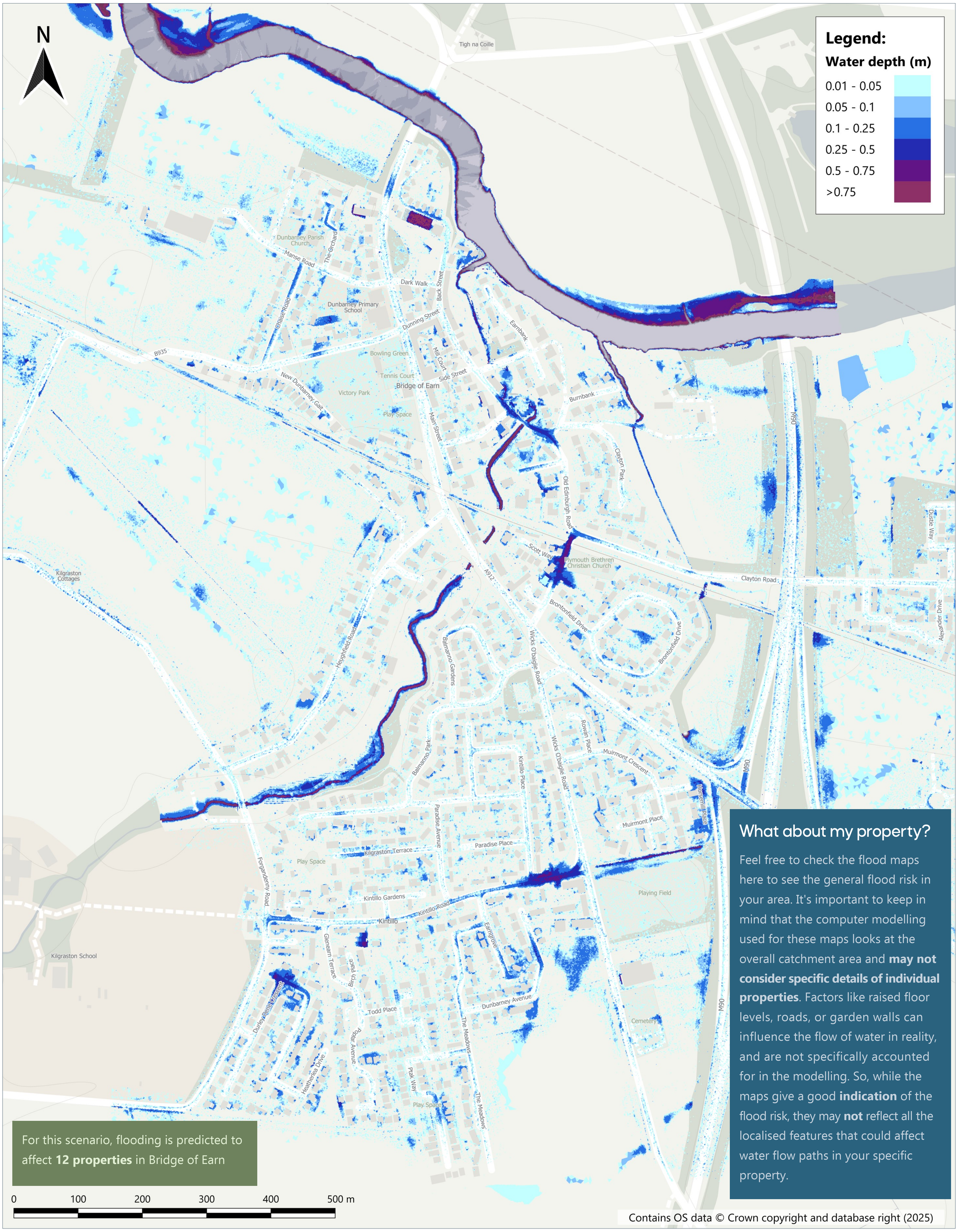
Flood map – 1 in 30-year return period 8-hour duration rainfall event



What about my property?

Feel free to check the flood maps here to see the general flood risk in your area. It's important to keep in mind that the computer modelling used for these maps looks at the overall catchment area and **may not consider specific details of individual properties**. Factors like raised floor levels, roads, or garden walls can influence the flow of water in reality, and are not specifically accounted for in the modelling. So, while the maps give a good **indication** of the flood risk, they may **not** reflect all the localised features that could affect water flow paths in your specific property.

Figure 10. Flood map 1:30-year, 8-hour duration storm

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Flood map – 1 in 200-year return period 8-hour duration rainfall event

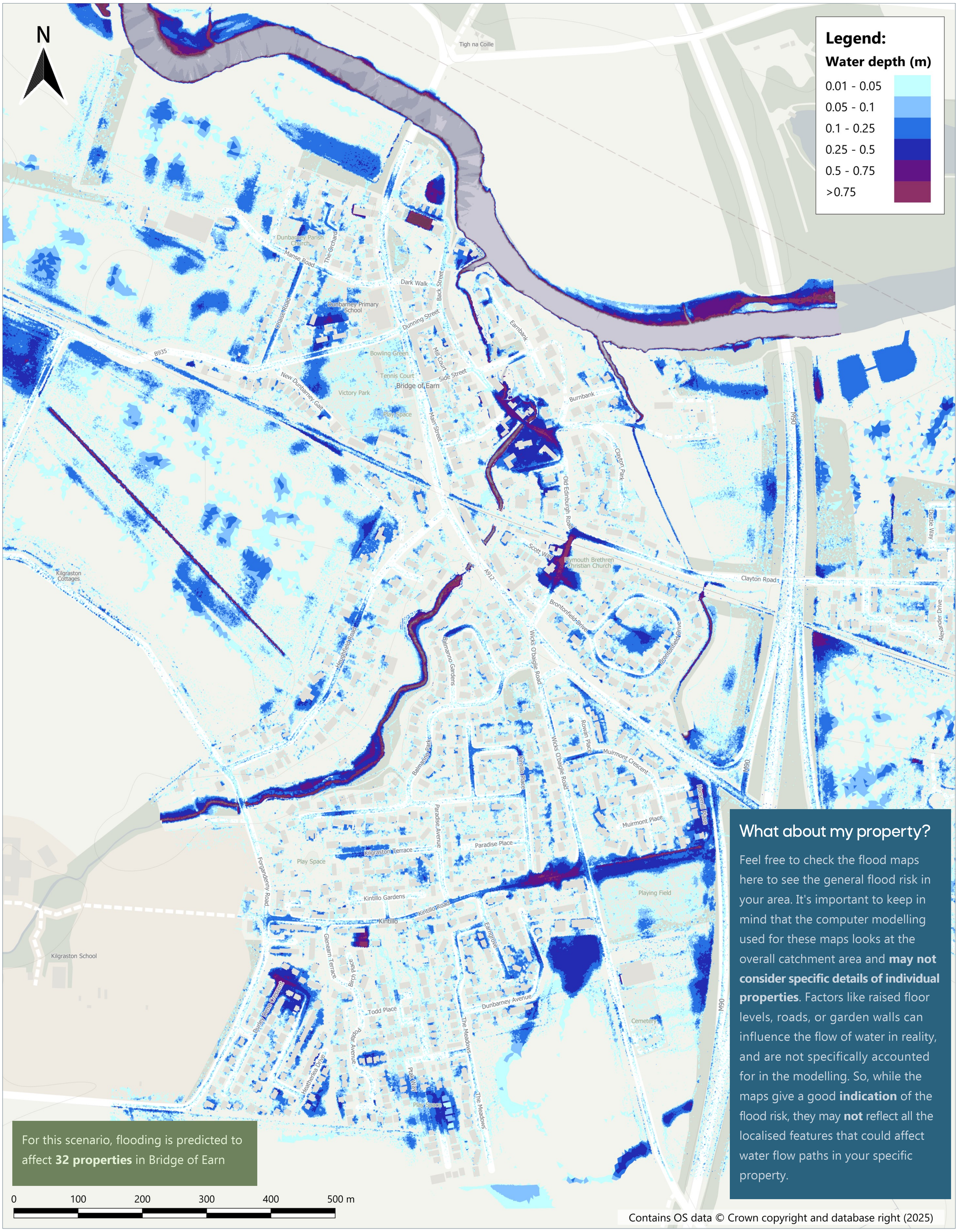

Figure 11. Flood map 1:200-year, 8-hour duration storm

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4. Flood risk management

To develop options for managing and, if possible, reducing flood risk in Bridge of Earn, we followed a series of steps.

1. Available information and a hydraulic model were used to identify the flooding issues within the catchment. These findings serve as a **baseline** for evaluating options to manage flood risk.

2. A **long-list** of measures was considered that could be taken to reduce or manage the flood risk. This was screened to remove measures that were clearly unfeasible, leaving an initial short list of potential actions.

3. We conducted a high-level scoring exercise to evaluate the options and produce a final **short-list** of those that are most feasible. This helped us eliminate measures that were not practical or viable for the situation.

4. We conducted a detailed **appraisal** of the final short-listed options using the hydraulic model and **multi-criteria assessment**. This involved evaluating their performance under different scenarios, considering their implementation requirements, compatibility with other policies and plans, and their potential to achieve the objectives of the SWFS.

5. Based on the results of the appraisal, we selected **recommended options**. Factors such as effectiveness, affordability, environmental and social impacts were considered during the selection process.

Multi-criteria assessment

Options are evaluated against a range of criteria to determine their suitability, including **technical**, **environmental**, **social** and **economic** feasibility.

In managing flood risk Perth & Kinross Council is required to have regard to the economic impact of its actions. For an option to be considered viable, the costs must not exceed the benefits, i.e. the **benefit-cost ratio** (BCR) must be greater than 1.

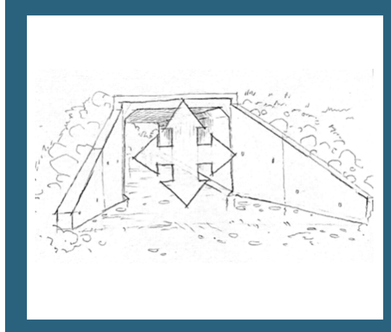
BCR is a core requirement in appraisal frameworks, in line with HM Treasury's Green Book, and is essential for securing Flood Protection Scheme funding through the Scottish Government. Local Authorities must demonstrate **Value for Money** through BCR, and demonstrate **strategic alignment and wider benefits** through a MCA.

What was considered in the long-list?

A range of different actions were considered when producing the long-list. Actions can be classified under the following the categories:

◀ Direct Defences

This group of measures includes construction of flood walls and embankments.



◀ Conveyance Improvements

Including channel modifications and culvert up-grades to increase flow capacity.

◀ Upstream Storage

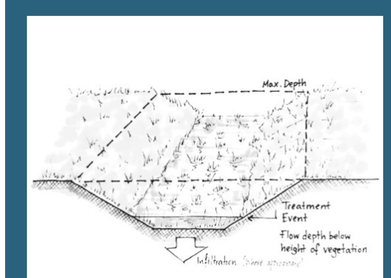
Measures to create new or upsize existing stor-age were considered.

◀ Natural Flood Management (NFM)

NFM techniques work with natural processes to manage flood risk, and work on the principle of slowing the flow down in the upper catchment.

◀ River Restoration

Within this group are included actions such as wetland creation, floodplain recovery or re-meandering.



◀ SuDS elements

Sustainable Drainage Systems (SuDS) are ele-ments with innovative design to collect, store and treat overland flows. These aim to imitate the natural drainage processes. Examples are: Ponds, swales, green roofs or rain gardens.

◀ Non-Structural Measures

These consist of policies, regulations and prac-tices that aim to reduce the exposure and vul-nerability of communities to flooding.

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5. Short list of options

This is summary table of the shortlisted options considered in the SWFS:

Option	Benefit-Cost Ratio (BCR)	Multi-criteria assessment Score	Rank (MCA Score)
Option 1 — Overland flow into Deich Burn	0.7	Fail	-
Option 2 — SuDS at playing field (Kintillo)	0.3	Fail	-
Option 3 — Pipe upsizing (Kintillo)	0.8	Fail	-
Option 4 — SuDS and new sewer line (Kintillo)	0.4	Fail	-
Option 5 — SuDS at Brontonfield Drive	0.6	Fail	-
Option 6 — SuDS at Old Edinburgh Road	**7.3**	**65%**	**3**
Option 7 — Flood relief conduit to Deich Burn	**2.3**	**61%**	**6**
Option 8 — Speed hump on Clayton Road	**17.3**	**62%**	**5**
Option 9 — Upstream storage at Forgandenny Road	**3.6**	**66%**	**2**
Option 10 — Flood relief channel to Yellow Burn	**2.4**	**54%**	**7**
Option 11 — Amend existing flood defences & add upstream storage	**5**	**69%**	**1**
Option 12 — Deculverting of Deich Burn at Back Street	0.4	Fail	-
Option 13 — New surface water pipeline on Back Street	**3.8**	**64%**	**4**
Option 14 — Streetscaping, drainage and speed hump at Holiday Park	0.5	Fail	-

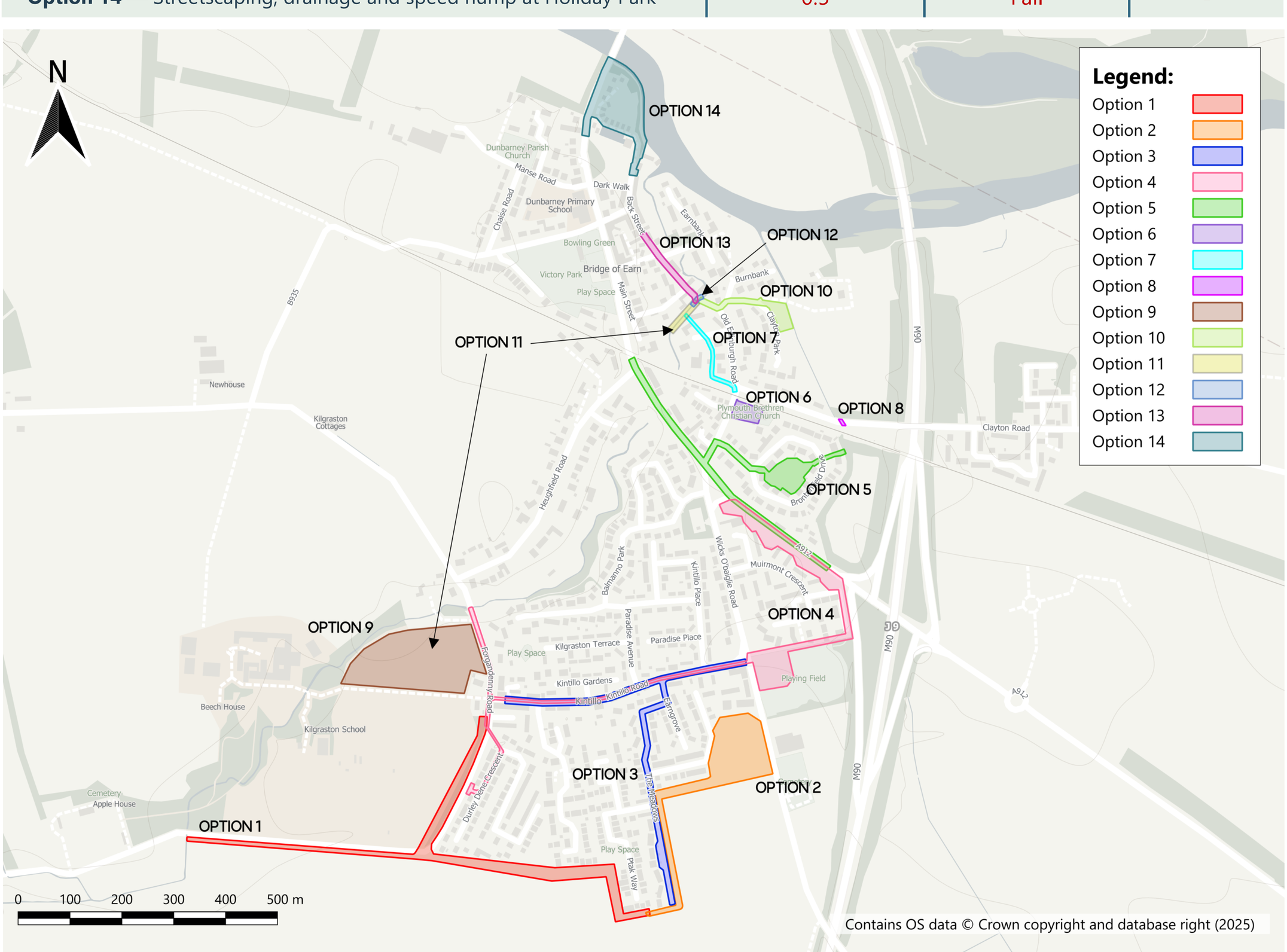

Figure 12. Considered options

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OPTION 11. Amend existing flood defences & add storage

MCA Rank #1
MCA Score: 69%
BCR: 5

This option utilises the land west of Forgandenny Road as a temporary storage area during high-flow events in the Deich Burn, providing flow attenuation and reducing downstream flood risk. Additionally, it includes adaptations of the existing flood walls at Back Street to further lower flood risk in the area.

Figure 13. Deich burn at Back Street

Figure 14. Option 11 sketch

OPTION 9. Upstream storage at Forgandenny Road

MCA Rank #2
MCA Score: 66%
BCR: 3.6

The option involves using the land west of Forgandenny Road as a temporary storage area during high-flow events in the Deich Burn, providing flow attenuation and thereby reducing flood risk down-stream.

Figure 15. Land west of Forgandenny Road

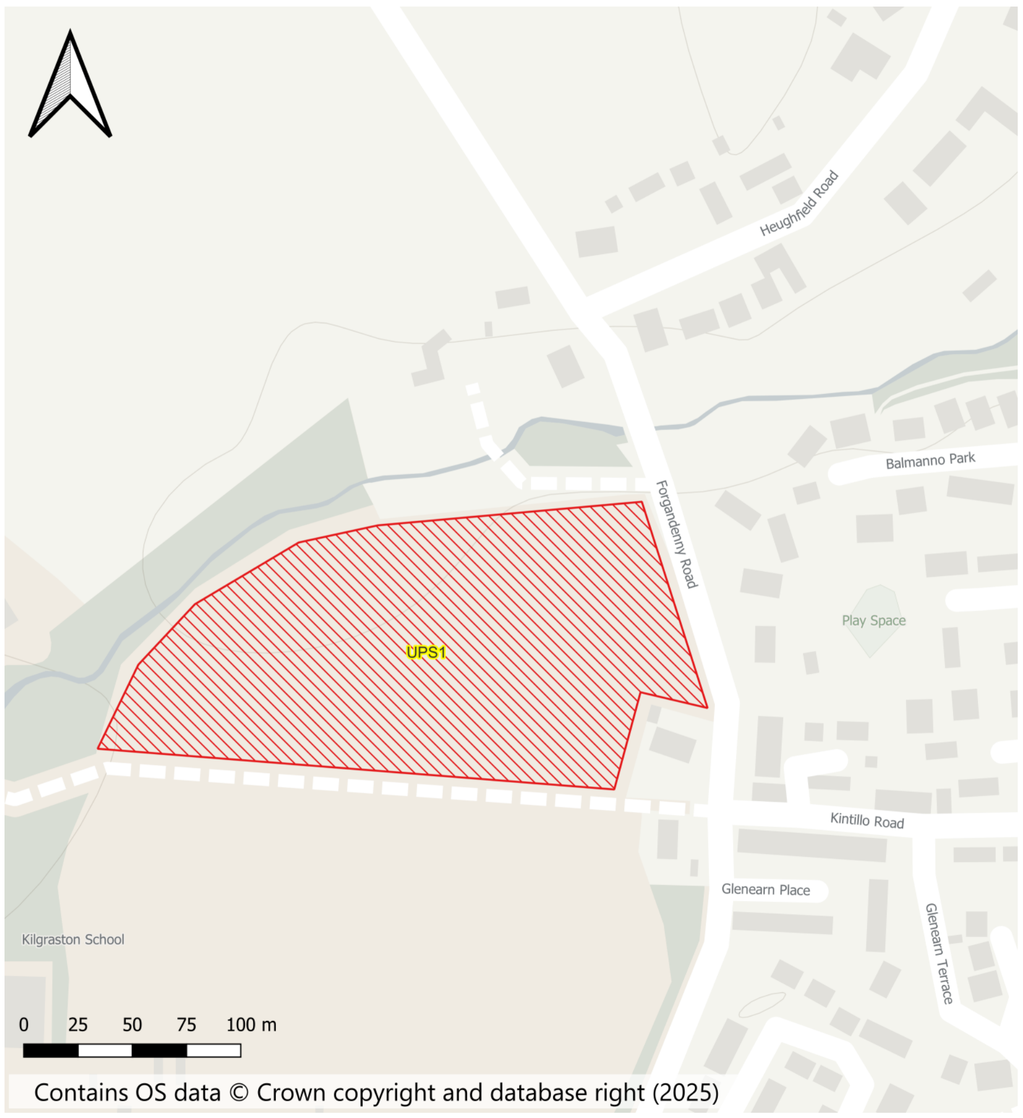

Figure 16. Option 9 sketch

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OPTION 6. SuDS at Old Edinburgh Road

MCA Rank #3
MCA Score: 65%
BCR: 7.3

The preferred option includes the construction of a SuDS basin to provide storage for the predicted flood water volume accumulating on Old Edinburgh Road during extreme rainfall events, reducing the number of properties at flood risk in the area.

Figure 17. Old Edinburgh Road

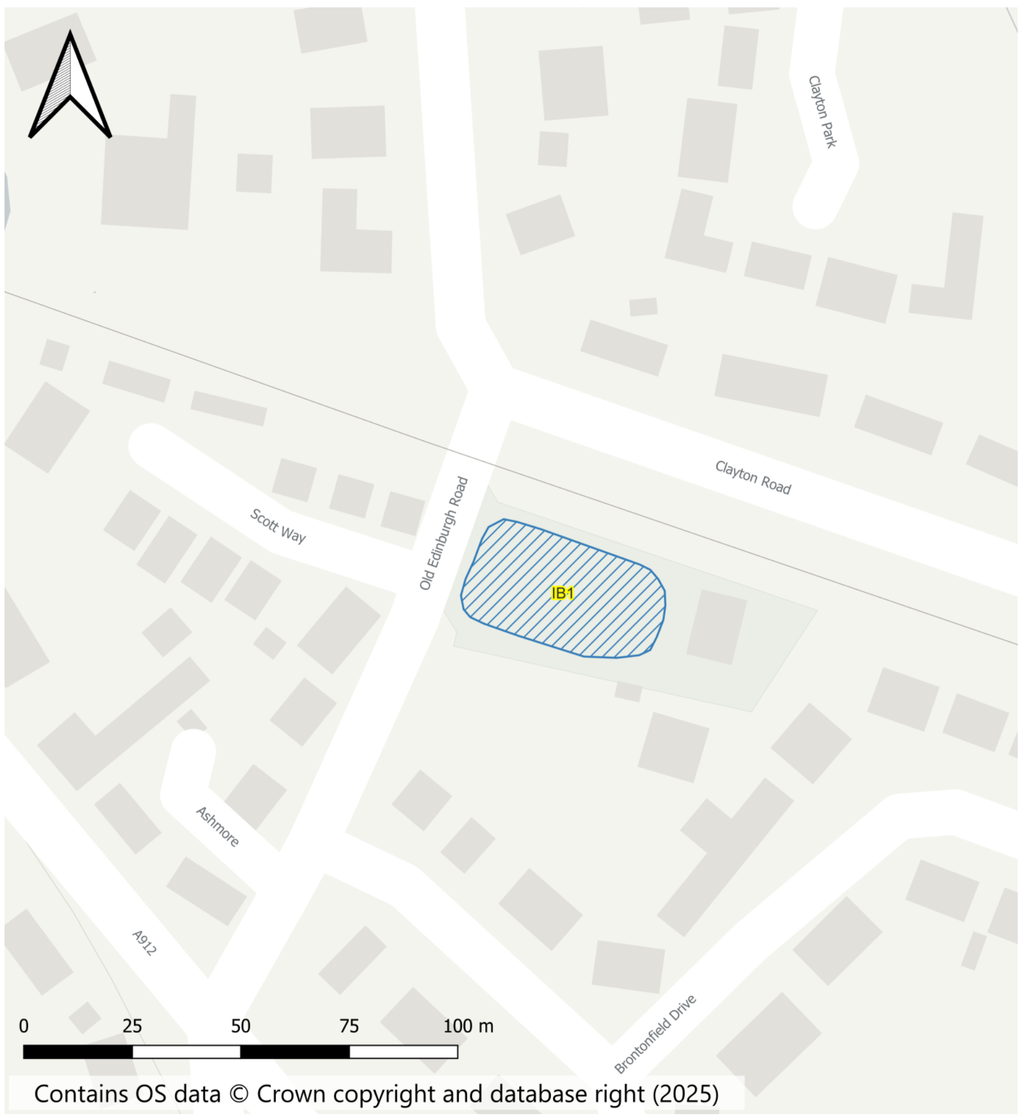

Figure 18. Option 6 sketch

OPTION 13. New surface water pipeline on Back Street

MCA Rank #4
MCA Score: 64%
BCR: 3.8

The preferred option includes the construction of a new surface water pipeline along Back Street discharging into Deich Burn to reduce the surface water flood risk in this area.

Figure 19. Back street

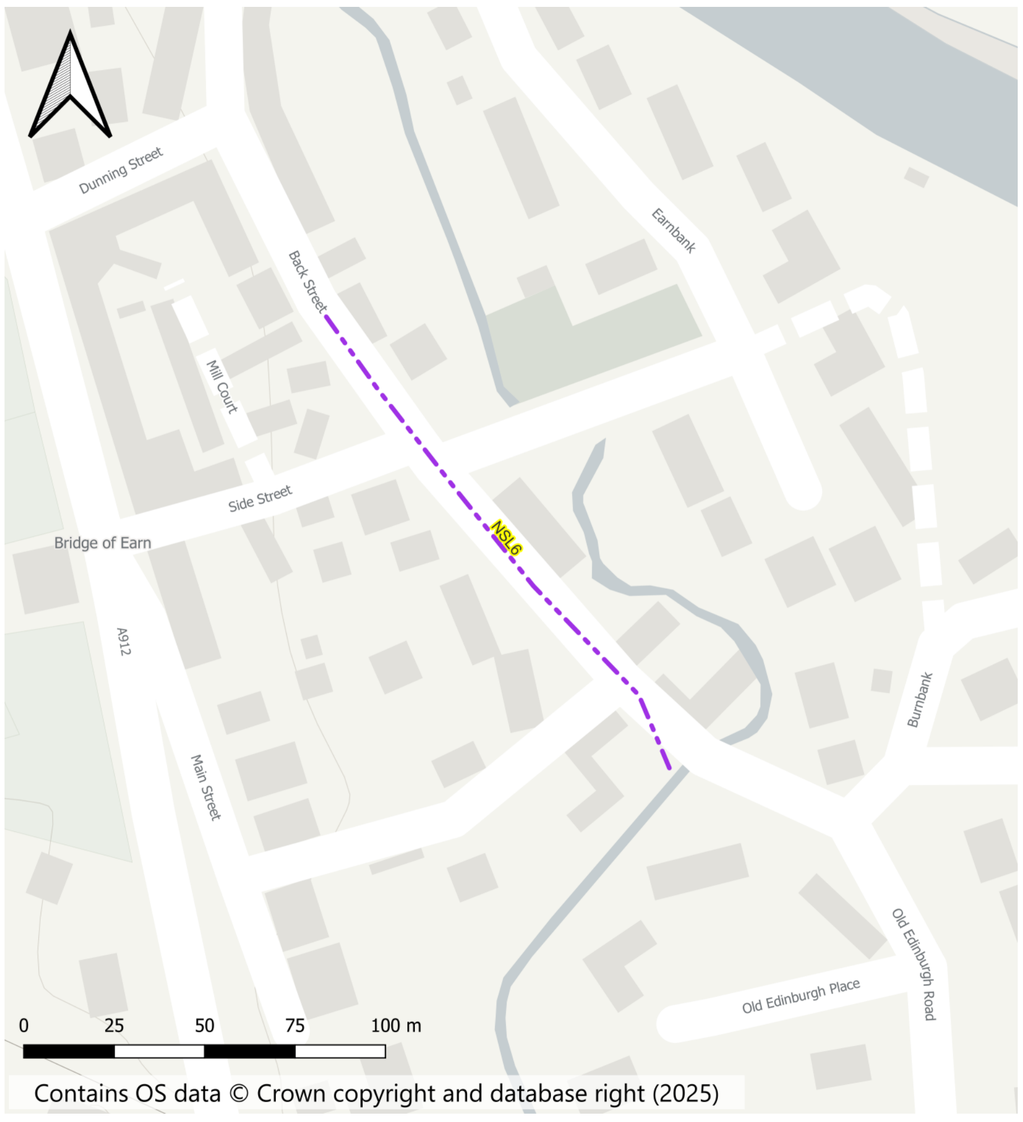

Figure 20. Option 13 sketch

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OPTION 8. Speed hump on Clayton Road

MCA Rank #5
MCA Score: 62%
BCR: 17.3

This option involves the implementation of a speed hump across Clayton Road adjacent to the Yellow Burn crossing. The implementation of this feature would redirect overland flows on the road to the watercourse, avoiding water accumulation on Old Edinburgh Road and, therefore, reducing the risk of flooding in this area.

Figure 21. Clayton Road

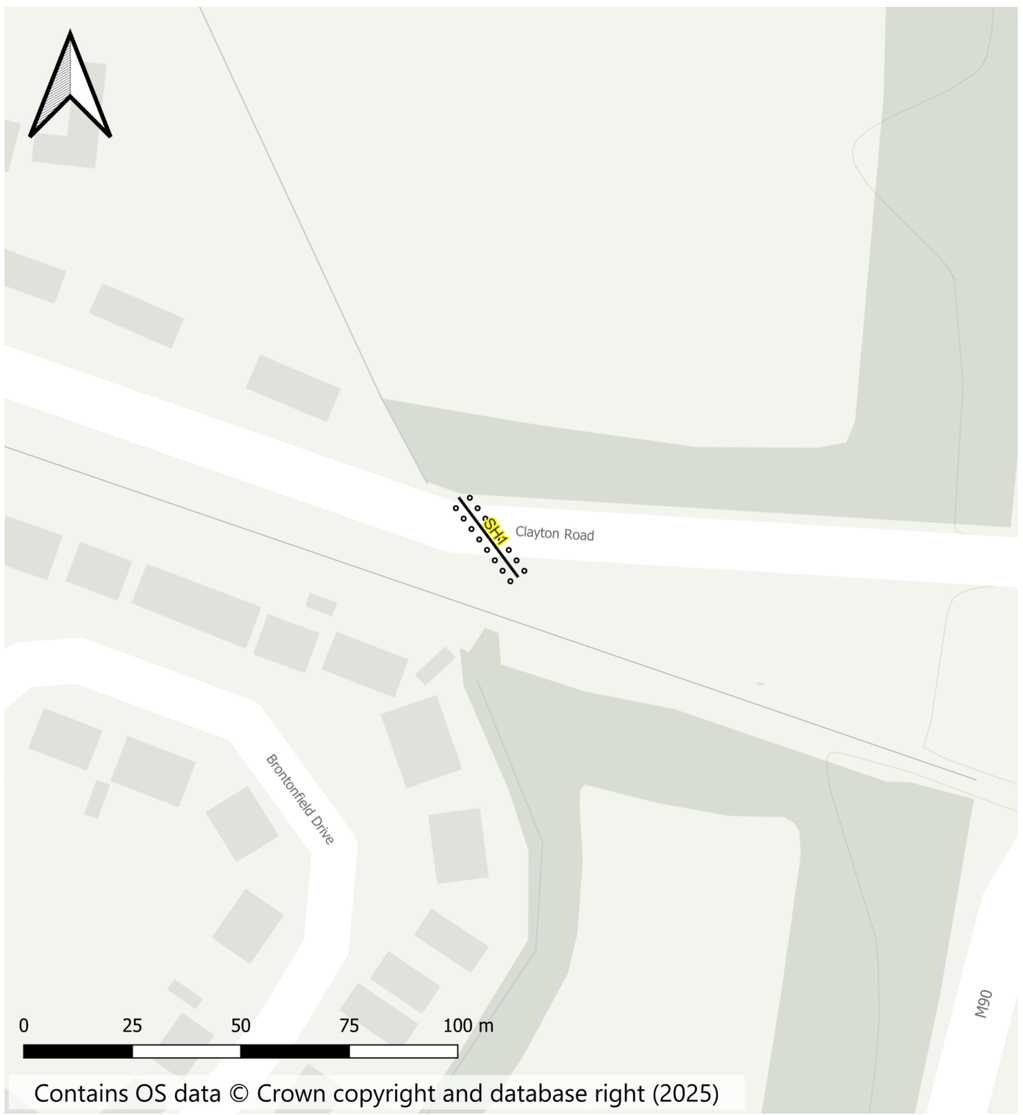

Figure 22. Option 8 sketch

OPTION 7. Flood relief conduit to Deich Burn

MCA Rank #6
MCA Score: 61%
BCR: 2.3

The preferred option includes the construction of a pipeline for the conveyance of flood water predicted to accumulate on Old Edinburgh Road. The channel would redirect water at this location northwest into the Deich Burn, reducing the number of properties at flood risk in the area.

Figure 23. Old Edinburgh Road

Figure 24. Option 7 sketch

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OPTION 10. Flood relief channel to Yellow Burn

MCA Rank #7
MCA Score: 54%
BCR: 2.4

This option involves constructing a channel or conduit to convey floodwater ponding at Back Street westwards into a SuDS storage basin at Clayton Park, where flows are attenuated before being discharged into the Yellow Burn.

Figure 25. Clayton Park

Figure 26. Option 10 sketch

6. Options summary

Option	Option 11	Option 9	Option 6	Option 13	Option 8	Option 7	Option 10
Capital cost	£149,180	£149,180	£70,964	£83,671	£19,200	£184,275	£107,856
Total estimated **cost** across a 100-year lifespan	£329,688	£329,688	£156,829	£184,912	£42,432	£407,248	£410,842
Estimated **flood damages avoided** across a 100-year lifespan	£1,633,925	£1,188,245	£1,142,977	£695,979	£733,493	£941,816	£971,101
Benefit-cost ratio	**5.0**	**3.6**	**7.3**	**3.8**	**17.3**	**2.3**	**2.4**
Multi-criteria assessment score	69%	66%	65%	64%	62%	61%	54%

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7. Summary of the study findings & recommendations

The Bridge of Earn SWFS has given us a much clearer understanding of the flood risks within the catchment. To achieve this, we collected and reviewed extensive data, carried out surveys, and developed a detailed integrated hydraulic model to improve the accuracy and reliability of the flood predictions. Now we have a clearer picture to make informed decisions to reduce the flood risk at Bridge of Earn.

We built a combined 1D-2D hydraulic model to assess the study area. This model incorporates the watercourses, sewer network and overland flood flows, enabling us to understand how these systems interact. It also allowed us to estimate flood damages and evaluate the economic impacts of different mitigation options over a 100-year period.

From the 14 shortlisted options, seven provide cost-effective flood mitigation and are recommended for implementation:

- **Option 11** involves the amendment of the flood wall at Black Street and the implementation of upstream storage at Forgandenny Road (BCR = 5).
- **Option 9** involves the implementation of upstream storage at Forgandenny Road (BCR = 3.6).
- **Option 6** involves the construction of SuDS basin at Old Edinburgh Road (BCR = 7.3).
- **Option 13** involves the construction of a new sewer line on Back Street (BCR = 3.8).
- **Option 8** involves the implementation of a speed hump on Clayton Road (BCR = 17.3).
- **Option 7** involves the construction of a flood relief channel from Old Edinburgh Road to Deich Road (BCR = 2.3).
- **Option 10** involves the construction of a flood relief channel from Back Street to Yellow Burn (BCR = 2.4).

8. Feedback & next steps

A **community drop-in session** will be held at:

Dunbarney Church Strathearn Hall,
Manse Road, Bridge of Earn
PH2 9DY

on the following dates:

DAY 1:
Wednesday 10th December 2025
from 2pm to 8pm

DAY 2:
Tuesday 13th January 2026
from 2pm to 8pm

Council officers and the design consultants will be present to provide an opportunity for residents to learn more about the study outcomes and ask any questions.

It is also anticipated that the following partner agencies will be present during the drop-in sessions:

Scottish Water — to answer any queries on the sewer network.

SEPA — to provide advice on Floodline and the Scottish Flood Forecast.

Scottish Flood Forum — to provide advice on property flood resilience products.

Contact details

For further information on the Bridge of Earn SWFS please contact:

Flooding Team
Pullar House
35 Kinnoull Street, Perth
PH1 5GD
United Kingdom
Tel: **01738 475000**
Email: **flood@pkc.gov.uk**

Any comments or questions?

Please complete our feedback form; or visit the PKC Consultation Hub page for this project at:

https://consult.pkc.gov.uk/communities/bridgeofearnswfsevents

Please ensure that all comment forms or online submissions are returned to PKC by **23rd January 2026**.

Responses to any questions raised will be provided to the community by PKC and Binnies in a '**Question & Answer**' report. The flood study will then be then finalised, taking into account the information received during the community consultation, and we will report the outcome to the next available meeting of the Council's Climate Change and Sustainability Committee.

Thank you!

We would like to thank you for your attendance and comments today. Community involvement is a key part of flood risk management and your views are appreciated