BRISTOL CITY COUNCIL

Bristol Avon Flood Strategy

Outline Business Case

Bristol City Council

Bristol Avon Flood Strategy – Outline Business Case

Recommendation

A Strategy for flood risk management is needed to better protect Bristol and neighbouring communities from the increasing flood risk posed by the River Avon from high river flows and tidal surges. The preferred long-term adaptive approach is to create new flood defences or raise the level of existing flood defences in phases along lengths of the River Avon from Swineford, through Bristol and downstream to Sea Mils and Shirehampton.

The Strategy will deliver an estimated £2.3bn in benefits to the UK economy by reducing flood risk over the next one hundred years. These benefits include £593m benefits to people (OM1b) and 414 properties at flood risk today are moved to a lower risk band by the end of the strategy life (OM2a). A further 188 properties at flood risk in future climate conditions are moved to a lower risk band by the end of the strategy life (OM2b). The benefit to the local economy could be over £7.0bn.

The scheme capital costs are estimated at £255m present value for the initial construction starting in 2029. The whole life costs of the scheme are estimated at £293m present value, which includes an additional £10.9m present value for the future works in the 2060s, and maintenance costs of £27.1m. The benefit cost ratio for this scheme (against GiA eligible benefits) is 7.8.

This scheme is assessed in the Defra Partnership Funding (PF) Calculator to be eligible for £197.7m FCRM Grant in Aid funding towards up-front costs. However, we will not be spending any FCRM Grant in Aid until after Full Business Case approval. At this Outline Business Case stage we seek FSoD approval for £2m Local Levy funding towards the development of the Full Business Case. The remainder will be funded by Bristol City Council and the West of England Combined Authority. We also seek endorsement of this OBC from the Defra Investment Committee in advance of approval at Full Business Case from both Defra and HM Treasury.

Version Control

P05 – 25/06/24 for LPRG assurance following comments.
Approved by BCC Cabinet on behalf of Bristol City Council 23/01/24.

Version History

N/A

Assurance and Approval Record

RMA reference number:

EA reference number:

Date of submission to EA: 01/02/2024

Approval history:

FCERM7 F/1718/0695 £290,000

SOC F/2021/0837 £1,996,000

Assurance from Risk Management Authority

I confirm that this Outline Business Case meets our guidelines, quality assurance requirements, environmental obligations and Defra investment appraisal conditions. All internal approvals, including member approval, have been completed. I apply to the Environment Agency for approval to claim local levy in the sum of £2,000,000 (Grant Claim Value).

Name of RMA Project Executive: Alex Hearn

[For administrative use only]

Approval from Risk Management Authority Council

Version approved: P04

Date: 23/01/2024

Endorsement from Environment Agency Area Flood and Coastal Risk Manager

I confirm that the Outline Business Case is ready for assurance.

Name of Area Flood and Coastal Risk Manager: Ron Curtis

Date: 01/02/2024

[For administrative use only]

Environment Agency Assurance and Technical Approval

I recommend that the application is granted technical approval. The record of assurance is appended to the business case.

Name of AFCRM or Lead Assurance Reviewer:

Date:

[For administrative use only]

Financial Approval

[See Section A4 of the Financial Scheme of Delegation.]

Name of Approving Officer: Ian Withers, Area Director

Date: 26/07/2024

FSoD reference: F/2425/0345

Financial Scheme of Delegation Co-ordinator

From: Withers, Ian <ian.withers@environment-agency.gov.uk>
Sent: Friday, July 26, 2024 3:44 PM
To: FSoD <FSOD@environment-agency.gov.uk>; Duffy, Philip <Philip.Duffy@environment-agency.gov.uk>
Cc: Chief Executive Office <Chief.Executive@environment-agency.gov.uk>; Morse, Paula <paula.morse@environment-agency.gov.uk>; IndependentAssuranceService <IndependentAssuranceService@environment-agency.gov.uk>; Morse, Paula <paula.morse@environment-agency.gov.uk>
Subject: RE: For Chief Executive Endorsement and Area Director Approval: Bristol Avon Flood Strategy OBC

I'm so sorry for being slow to respond to this.

I understand that my approval relates to the Local Levy element of the OBC, and I approve this investment.

Ian

Ian Withers
Area Director, Wessex

From: Duffy, Philip <Philip.Duffy@environment-agency.gov.uk>

Sent: Wednesday, July 31, 2024 4:55 PM

To: FSoD <FSOD@environment-agency.gov.uk>

Cc: Chief Executive Office <Chief.Executive@environment-agency.gov.uk>

Subject: Re: Resend: For Chief Executive Endorsement : Bristol Avon Flood Strategy OBC

Thanks Claire

Maybe one day you can come and take a look at my inbox. It is not like most inboxes.

I was content to approve this, having noted the AO assessment.

Philip

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1.0 Executive Summary

Bristol and its neighbouring communities have grown and thrived on the banks of the River Avon. However, people and property face an increasing risk of flooding. Storms can increase flows coming down the river or can force tidal water to surge up the Severn Estuary. Large parts of Bristol's centre are vulnerable to the River Avon overtopping low spots and also causing water within the harbour to flood properties. Flood risk is increasing due to climate change, causing sea levels to rise and causing storms to increase in frequency and severity.

A major flood event that currently has a 0.5% Annual Exceedance Probability (AEP) (1 in 200 annual chance) of occurring now, could become as frequent as once a year (63% AEP) by the end of the century if no strategic management of the risk is implemented.

Bristol City Council (BCC), the Environment Agency and the West of England Combined Authority (WECA) are working together to deliver a long-term plan to better protect homes, businesses and infrastructure from flooding from the River Avon. This is a unique opportunity to enhance the river for all by creating a more resilient, active and sustainable city that can meet the future needs of its residents, businesses and visitors.

This report sets out the Outline Business Case (OBC) to deliver a strategic flood risk management approach to Bristol and its neighbouring communities. The OBC has been produced in accordance with the HM Treasury Green Book and Flood and Coastal Risk Management (FCRM) Appraisal Guidance principles. This OBC covers the Bristol Avon Flood Strategy project – referred to as the Strategy throughout this document.

1.1 Strategy objectives

The key investment objectives for the Strategy have been set to reflect the importance of delivering robust and sustainable flood risk management infrastructure for the strategy area, whilst acknowledging the importance of the area for employment purposes and future redevelopment opportunities. They are as follows:

- To support safe living, working and travelling in and around central Bristol by ensuring flood threat is reduced and measures address residual risks.
- To facilitate the sustainable growth of Bristol and the West of England by supporting opportunities for employment and residential land, and infrastructure.
- To maintain natural, historic, visual and built environments within the waterfront corridor and where possible deliver enhanced recreational, heritage and wildlife spaces.
- To ensure navigation of river and harbour, and marine activities continue.
- To ensure the strategy is technically feasible and deliverable.

These have been used to evaluate the flood risk management strategic approaches and to support the appraisal process. In addition, the following objectives have been developed in relation to wider opportunities, following the identification of a preferred way forward:

- To enhance walking and cycling links to enable greater access to opportunities, work and housing.
- To bring existing communities closer together, as well as providing the opportunity to unlock new development land and attract residents, businesses and visitors.
- To protect and enhance recreational, heritage and wildlife spaces, to create healthier and more resilient communities, particularly those with higher inequality or limited access to green space and contribute to ambitions for the Avon Corridor as a key green infrastructure resource.
- To seek opportunities to provide improved harbour operational arrangements where feasible and consistent with wider project objectives.

1.2 Strategic case

Tidal and fluvial flooding from the River Avon represent an increasingly significant risk to Bristol and its neighbouring communities with the potential for severe consequences. The city is at risk from both tidal surges and high river flows. Climate change is increasing sea levels and peak river flows meaning that widespread flooding of central Bristol is likely to become a relatively frequent occurrence.

Bristol has a history of flooding. More than twenty minor tidal events in the last decade have flooded properties and/or roads around the river including at Sea Mills, the Portway, Cumberland Basin, Avon Crescent, Coronation Road, Cattle Market Road and at St Philip's. The highest of these was in March 2020.

Flooding currently poses a threat to lives, properties, wellbeing and the long-term economic prosperity of the city and wider region. A severe flood today would result in lasting widespread impact from hazardous flood water, damage to property, damage and disruption to infrastructure and loss of cultural heritage.

Bristol's Floating Harbour forms a fundamental part of the city's current River Avon flood defences. The harbour's capacity is limited and the tidal flood gates are increasingly vulnerable to operational failure, overtopping and outflanking by flood water.

Futureproofing the city and neighbouring communities – Without investment, Bristol and neighbouring communities are at increasing risk of widespread flooding. Around 1,000 homes and businesses near the city centre and around 400 properties in neighbouring communities are at risk of being flooded in either a severe river or tidal flood today from the River Avon. Tidal flooding would be relatively rapid. Predictions show flood waters inundating a wide area to significant depths, creating an environment hazardous to life. Without action, by the end of the century almost 3,100 existing properties could be at risk in severe floods (Table 1).

Figure 1 - Visualisation of flood risk predictions looking east – Hotwells and Junction Lock in foreground, SS Great Britain and Spike Island in background

Figure 2 - Visualisation of flood risk predictions looking east – Temple Meads in foreground, St Philip's Marsh and Netham in background

Year	Location	Residential properties	Non-residential properties	Total
2030	Central Bristol	616	426	1,418
	Downstream	170	26	
	Upstream to A4174	117	63	
2130	Central Bristol	1,483	1,062	3,086
	Downstream	323	31	
	Upstream to A4174	117	70	

Table 1 - Properties at risk of flooding in 0.5% AEP tidal or 1% AEP fluvial events in the Do-Minimum status quo baseline (Avoids double counting and is not properties claimed in the Partnership Funding Calculator)

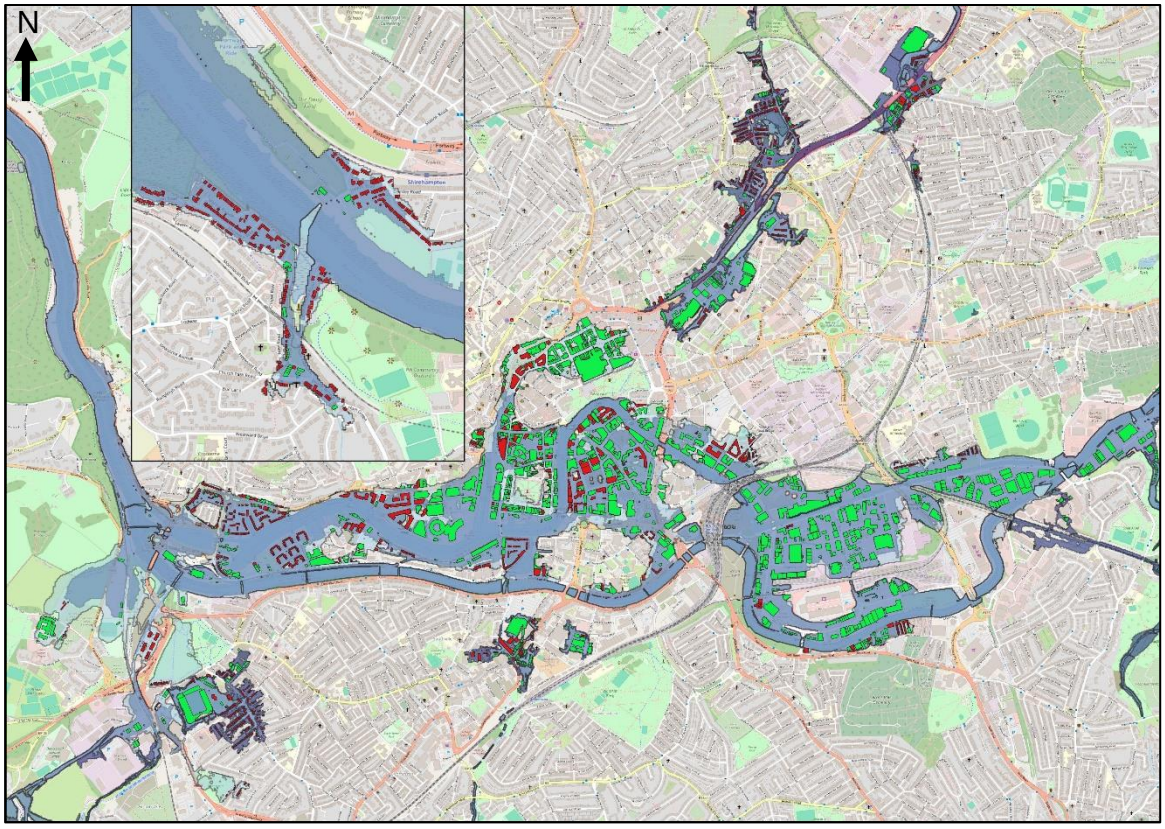

Figure 3 - Residential (red) and non-residential (green) properties within the 2130 0.5% AEP tidal (pale blue) and 1% AEP fluvial (dark blue) flood extents. Inset: Pill & Shirehampton

Without investment, Bristol and neighbouring communities are at an increasing risk of widespread flooding. Without the Strategy, the operation of the harbour for navigation will also be severely impacted due to increasing inundation of operational areas. The Harbour Authority has endorsed the Strategy.

Enabling a greener, more active city – Creating and improving flood defences presents an opportunity to improve walking and cycling routes along the River Avon. Links could be created with other parts of the city, better connecting people with housing, work and recreation. Improved active travel links are planned to be integrated into the defences. In areas where more space is available, defences could take the form of a green space that provides additional wildlife and recreation benefits every day. Access to the riverside could be improved, whilst areas with historic features, such as retaining walls, could be restored and maintained to prolong their life.

Unlocking Bristol's potential - Currently, without a Flood Risk Management Strategy that has reasonable certainty of delivery, new development must individually deliver flood risk mitigation to ensure the development is safe for its lifetime (100 years for residential uses) without increasing flood risk elsewhere and benefits from safe, dry access during a "design flood". In some locations this is extremely challenging to achieve, meaning development is unlikely to comply with national planning policy and may be refused on this basis. Hence, regeneration in the area is stagnating. The proposed approach has learnt lessons from other cities divided by rivers who have successfully seized similar opportunities including Derby, Leeds and Sheffield.

The Strategy also recognises the potential synergies with the emerging masterplans at Western Harbour and Bristol Temple Quarter. There is significant scope for integrating the redevelopment of these areas with proposed flood defences, rather than constructing standalone defences for the Strategy and for development. This has the potential to reduce the overall cost of the Strategy to BCC, whilst also allowing development to come forward and bringing wider benefits such as active travel to the city.

A Strategy with a reasonable certainty of delivery will reduce the constraint of flood risk and open opportunities for regeneration and new development, contributing to the economic success of the city. By defending areas currently at risk of flooding, the proposed defences will also unlock wider benefits to the city through supporting growth and regeneration such as the jobs, homes and public spaces that will ensure Bristol is a resilient city where people and business can thrive.

A planning position statement published in July 2022 set out the adopted and emerging planning policy position for managing flood risk in Bristol. This confirmed that "*The Strategy is also the council's preferred approach to enabling new development in areas at risk of flooding from the river Avon.* The draft Bristol Local Plan (due for adoption in 2025) sets out the development objectives for Bristol, and includes a policy specifically in relation to the proposals set out in this OBC. Policy FR2 – Bristol Avon Flood Strategy states that "*Flood risk from the river Avon will be addressed on a strategic basis consistent with the Bristol Avon Flood Strategy."*

1.3 Economic case

The preferred long-term adaptive approach is to create new flood defences or raise the level of existing flood defences in phases along lengths of the River Avon riverbanks to better protect people and property from the increasing risk of fluvial and tidal flooding.

The Strategy will deliver an estimated **£2.3bn in benefits to the UK economy by reducing flood risk** over the next one hundred years (Outcome measure (OM)1a benefits). These benefits include £593m benefits to people (OM1b) and 414 properties at flood risk today are moved to a lower risk band by the end of the strategy life (OM2a). A further 188 properties at flood risk in future climate conditions are moved to a lower risk band by the end of the strategy life (OM2b). **The benefit to the local economy could be over £7.0bn.** Even this estimate does not account for the potential value to the wider West of England of avoiding blight and frequent flooding to the central transport hub, and commercial and cultural heart of the region.

The operation of the existing infrastructure around the Floating Harbour reduces tidal flood risk. However, this will become less effective in future due to climate change, and there is an increasing risk that this will not be able to be operated during large flood events.

A comprehensive appraisal process of strategic approaches has been carried out to determine the preferred way forward to manage flood risk over the next one hundred years. Different flood defence interventions that might be effective were identified. Combinations of these interventions were used to create a long list of adaptive approach options. This was reduced to a shortlist from which the preferred approach of phased raised defences was selected as the most feasible option for reducing the flood risk to Bristol and its neighbouring communities.

As outlined in the SOC, a downstream tidal barrier closing when tidal surges are forecast would be significantly more expensive than the proposed approach. A tidal barrage that permanently dams the river would be even more costly and have significant negative impacts on habitats, landscape, fish passage and navigation of the river. Both a barrage and barrier were found to increase upstream flood risk as the River Avon does not have sufficient space to store river flows trapped when the structures are closed.

The SOC also considered measures such as flood storage areas, working with nature or land management capture. This concluded that while these measures store water, slow and somewhat reduce the peak river flows from upstream tributaries, smaller streams or rivers that flow into the River Avon, these techniques will not reduce tidal flood risk from the estuary. However, SOC consultation demonstrated a high level of support for such measures and the wider benefits. BCC will continue work with neighbouring authorities, the Environment Agency and other organisations to exploit opportunities as they arise to help reduce peak flows from upstream and bring wider ecological benefits to the area. Further work will be done at FBC.

The option selection process also identified an adaptive (rather than precautionary) approach had significant advantages in terms of economic efficiency and environmental impact. Defences will be built in phases:

- In the 2020s and 2030s, raised defences in locations along the Avon from Swineford upstream, through Bristol city centre and as far downstream as Shirehampton and Pill.
- In the 2060s, where necessary these defences will be raised, as well as additional defences being constructed as extensions to defences already built.

Subsequently, additional analysis was undertaken to determine the required and optimum Standard of Protection (SoP) for the defences in each phase and for the spatial extent of the Strategy.

In total, around 15km of raised defences are required to be constructed, in addition to a limited number of property flood resilience measures. These range in geographic area from Swineford upstream to Pill and Shirehampton downstream. The raised defences generally take the form of walls and embankments, as well as utilising existing defences where possible. New lock gates are proposed at Entrance Lock, and a new flood gate at Netham. A number of smaller flood gates are required, although the strategy looks to utilise 'passive' defences where possible. It is expected that for areas that overlap with areas of growth and regeneration (particularly Bristol Temple Quarter and Western Harbour), defences will be integrated into development.

The preferred scheme on economic grounds in accordance with the FCRM Appraisal Guidance Decision Rule is a scheme that addresses the requirements of the National Planning Policy Framework (NPPF), with a standard of protection (SoP) of 1 in 100-year annual chance for fluvial events and 1 in 200-year annual chance for tidal events. The scheme would be constructed in the late 2020s and 2030s with an allowance for climate change to 2069, and defences uplifted in the 2060s to have a climate change allowance to 2130. This scheme is assessed in the Defra Partnership Funding (PF) Calculator to be eligible for £197.7m FCRM Grant in Aid (GiA) funding towards up-front costs.

This scheme is also BCC's preference, and is therefore the preferred way forward.

The scheme capital costs are estimated at £255m present value for the initial construction starting in 2029.

The whole life costs of the scheme are estimated at £293m present value, which includes an additional £10.9m present value for the future works in the 2060s, and maintenance costs of £27.1m. The benefit cost ratio for this scheme (against GiA eligible benefits) is 7.8 – with details of the alternatives shown in Table 2.

Including benefits to the local economy, this BCR is approximately 30, demonstrating a compelling case for the Strategy to move forward.

	Do nothing	Do minimum	1.33% AEP SoP	1% AEP SoP	NPPF Local choice	0.5% AEP SoP
Damages (£m)	2532	2285	277	270	253	252
Benefits (£m)	0	247	2255	2262	2279	2280
Whole Life Costs (£m)	0	19	286	288	293	295
Benefit Cost Ratio		13.0	7.9	7.9	7.8	7.7
IBCR to previous option	-	13.0	7.5	6.5	3.0	0.5

Table 2 - Present Value damages, benefits and whole life costs of baseline and do-something options of Standard of Protection (SoP) considered by economic appraisal.

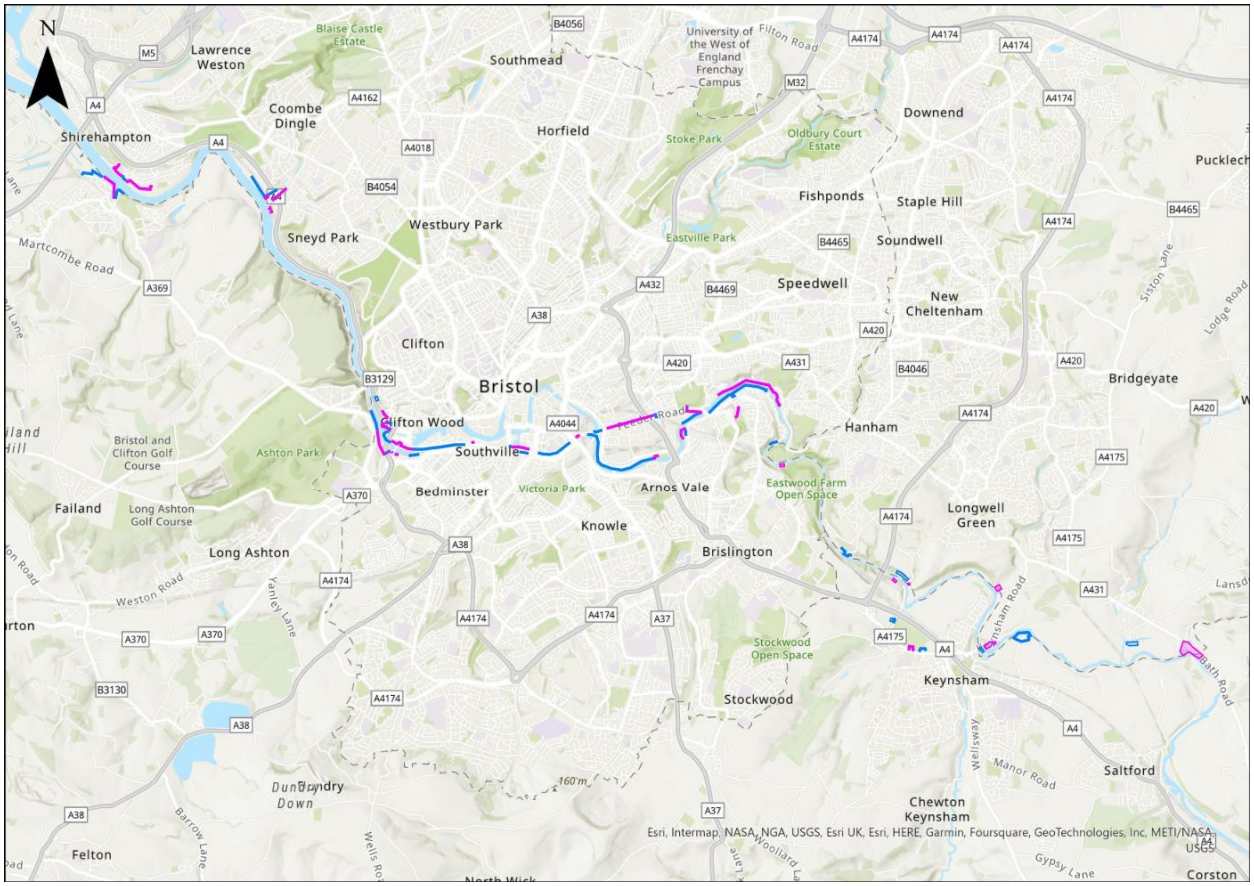

Figure 4 - Extent of Defences. Separate colours denote a change in defence type

A full Environmental Impact Assessment (EIA) will be required as part of the consenting approach for delivery of the Strategy. A Preliminary Draft EIA Scoping Report has been written for the OBC stage, building on the Strategic Environmental Assessment carried out to support the SOC. The purpose of this has been to both inform the scope of the Full Business Case (FBC) and to prepare for the formal submission of the EIA Scoping Report to the determining authority. This will be undertaken at FBC.

The report sets out the need for the Strategy and the site context; the policy context surrounding it; a high-level approach to the EIA methodology and outlines those topics considered to have the potential for significant effects. The key environmental topics were identified as Cultural Heritage, Biodiversity, Ground conditions and Contaminated land; Townscape and Visual impact and Water environment and Flood risk. Statutory stakeholder working group sessions were held quarterly with representatives from the EA, BCC, Natural England, Historic England and others. These sessions were used to discuss these key environmental topics, seeking feedback to inform the report.

To support the report, additional studies have been carried out including:

- Preliminary Ecological Appraisal
- Outline Heritage Desk-based assessment
- Habitats Regulation Assessment

- Preliminary Water Environment Regulations assessment

A Biodiversity Net Gain (BNG) assessment has also been carried out. The Strategy will deliver a minimum of 10% BNG, with an aspiration to deliver 20%.

The carbon impact of the Strategy has also been assessed. An estimated 55,000 tonnes of CO_{2e} of emissions are estimated across the strategy's 100-year life, with multiple areas for reduction identified for development. The carbon impacts avoided from flooding that the strategy is predicted to prevent is over 1,366,000t CO_{2e}, making the strategy carbon negative overall.

1.4 Commercial case

BCC will lead the delivery of the Strategy in recognition of the potential impact and opportunity for the city, and the Strategy's interface with BCC's harbour, highways, planning, lead local flood authority, coastal protection, civil protection and major landowner roles. The Environment Agency and BCC have a Memorandum of Agreement and an initial collaborative agreement in place. The Environment Agency intends to delegate statutory powers for flood risk management works to Main Rivers to BCC, as necessary, achieved through further legal agreements.

Procurement for the Strategy will follow the design – bid – build procurement route. FBC stage will be consultant led with Early Supplier Engagement, and include the detailed design, associated surveys and investigations; with supporting specialist advice and expertise provided through ESE.

Multiple FBCs are proposed to maximise the significant opportunity to coordinate with areas of growth and regeneration. Phasing will be in line with masterplan and business case development. The three FBCs proposed are:

- FBC1 - Defences outside areas of growth and regeneration
- FBC2 - Western Harbour Reach
- FBC3 - St Philips March Reach

A procurement strategy for the construction phase will be developed at FBC stage, in line with BCC procurement rules, submitted as part of the Transport and Works Act Order 1992 (TWAO) application.

During FBC stage, BCC will be subject to development planning applications. In support, the Strategy will be embedded into relevant planning policies, providing guidance on residual risk mitigation measures to be addressed in individual planning applications.

Integrating defences into development will be encouraged through the publication of the Local Plan, setting out expectations of how development should integrate flood defences into proposals.

Figure 5 demonstrates a credible route to delivery, following a full TWAO consenting process, strategically aligned with areas of growth and regeneration (G&R). Further updates to this timeline will be required at FBC stage in response to G&R programmes.

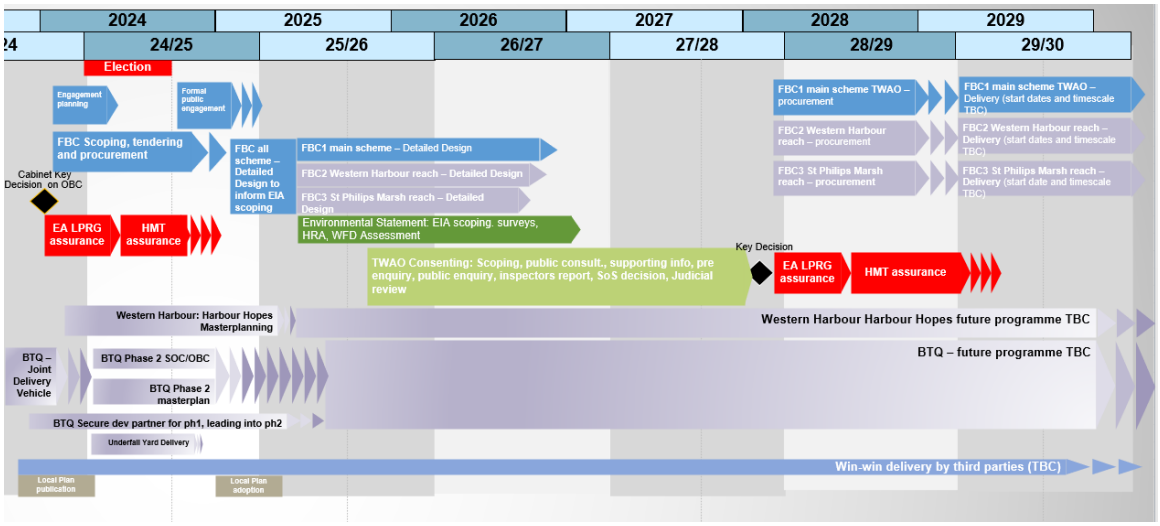

Figure 5 - Indicative strategy timeline showing the delivery of multiple FBCs, TWAO consent and construction over the 2020s, leading into 2030s.

1.5 Financial case

In cash terms, the total phase 1 scheme costs (not including SOC or OBC costs incurred, but including FBC development) are £335.1m (or £298.8m in present value terms). Funding has been allocated from various sources, including:

- FCRM GiA, which is estimated via the partnership funding calculator at £197.7m in pv terms, which equates to £229.2m in cash terms.
- The WECA Economic Development Fund has a programme allocation of £5m in 2023 and £5m in 2032 (today's prices).
- BCC reserves of £10m identified (today's prices).
- CIL allocated by BCC totalling £20.4m (today's prices).
- Local Levy funding of £2.2m (today's prices) towards FBC costs.

Note that we recognise that the FCRM GiA eligibility presented is based on the benefits of delivering both phase one and two, and that as a local authority we cannot provide an absolute guarantee that the future (circa 2070) investment will be made, despite the council being committed to do so. However, the benefits of delivering phase one alone returns a minimum FCRM benefit cost ratio of 6:1, which provides strong justification for the adaptive, phased approach presented as the preferred option.

Making reasonable assumptions about the profiling of those funding sources gives a total allocated amount of £271.8m in cash terms (£238.2m in pv terms). That leaves an additional funding requirement of £63.3m in cash terms (£60.6m in pv terms). The current cost and funding position is summarised below. This is presented in present value and cash terms for comparison across the rest of the OBC.

Summary Table	Present Value (£m)	Cash Cost (£m)
	50 %ile risk, inflated and discounted to 2028	*95 %ile risk, inflated to outturn year, undiscounted*
Project capital costs, including inflation, risk and optimism bias	255.5	320.1
Identified funding (excl local levy)	250.7	269.6
Additional funding requirement (excl FBC)	**4.8**	**50.5**
Project capital costs plus FBC costs	270.5	335.1
Identified funding (incl local levy)	252.9	271.8
Additional funding requirement (incl FBC)	**17.6**	**63.3**

Table 3 - Summary of cost and funding position

This translates into partnership funding scores as set out below.

Source of Funding	%
Raw Partnership Funding score	70
Adjusted Partnership Funding score	86

Table 4 - Partnership funding scores

A wide range of other funding sources has been explored to maximise local contributions to the Strategy. Further work is planned to determine the quantum of each option, however, analysis completed to date has identified sufficient funding to achieve an adjusted partnership funding score of up to 120%. Only a small proportion of the identified funding opportunities needs to be secured to achieve a score of 100%.

This funding assessment is based on considerable work that has been undertaken by BCC in close consultation with the Environment Agency and other partners to develop a funding strategy for the project, covering both Phase 1 and 2. The overarching approach has followed the 'beneficiary pays' principle i.e. the approach should distinguish between:

- National contributions towards the 'public good' elements of the programme.
- City-wide and/or broader regional contributions, to reflect the role that Bristol plays in the West of England economy.
- Specific contributions from those who are directly subject to flood risk, where appropriate and feasible.

There is a compelling case for other sources of funding for the Strategy. Opportunities for contributions in the form of cash or 'in kind' contributions such as associated works delivered by BCC or developers will be sought. The economic analysis identifies significant potential benefits (over £7.0bn) to the local economy, in terms of supporting development proposals, protection against

business disruption, the tourism economy, and transport infrastructure improvements. Further funding options are identified in section 5.4.3, along with an indicative funding solution.

With a clear plan for managing the risk of River Avon flooding, citizens and businesses will have confidence that Bristol is a city to invest in, helping in turn to fund defences for the city and ensuring flood defences are integrated into new developments.

FCRM GiA cannot be used for maintenance and operational costs. One of the conditions for receiving FCRM GiA is that the authority applying for grant must find the funding for ongoing operation and maintenance. In general, the Strategy is dependent on the continued serviceability of some of the existing New Cut and harbour structures. In practice, a significant part of the projected maintenance and operational costs for the Strategy are derived from the need to continue Floating Harbour operations and these costs would have been incurred anyway.

1.6 Management case

Delivery of the Strategy will be led by BCC, supported by the Environment Agency and is underpinned by legal agreements. Future stages of the Strategy including detailed design and construction will be overseen by a multi-agency Project Board. The Project Board will comprise senior management representation from BCC, the Environment Agency and suppliers, and will be supported by a project team led by a dedicated Project Manager. The Strategy will be reviewed periodically over its lifetime, at least every six years or as the evidence base is significantly updated.

The Strategy will be delivered using powers under the Flood and Water Management Act or Water Resources Act. BCC is the landowner for the majority of the Strategy however in St Philip's Marsh, east of Temple Meads and in neighbouring communities there will be third-party interfaces.

In October 2020, public consultation commenced to inform BCC's decision-making prior to adopting the Strategy. The consultation raised awareness of the need for the Strategy and sought views on the leading strategic approach. At FBC stage, BCC will seek wider consultation in line with the TWAO consenting route, and work with neighbouring authorities to consult communities affected by the proposals outside of Bristol. On completion and following BCC cabinet approval, the full business case will be submitted to the Environment Agency's Large Project Review Group (LPRG) for assurance and onto Defra and HM Treasury (HMT) for further assurance and approval.

The strategy has been divided into two phases. This management case focuses on the first phase of construction works planned from 2029 onwards. However BCC and the Environment Agency are equally committed to delivery of the second 2060s phase with the legal agreement underpinned by a funding strategy and the emerging Local Plan to ensure confidence in delivery of this adaptive approach. The Strategy will be reviewed periodically over its lifetime, at least every six years or as the evidence base is significantly updated.

1.7 Project statistics for EA assurance

Approval Value of Project £338.3m Assurance Value of Project (next stage – FBC Development) £15m

Project Summary (£m)	Economic appraisal	Whole life cost	Project cost (approval)
	(Pv costs, 50th %ile risk, no inflation)	(Cash cost, 95%ile risk, + inflation)	(Cash cost, 95 %ile risk, + inflation, no future costs)
Project development costs			
a) to SOC	*Sunk Costs*	1.3	1.3
b) SOC to OBC	*Sunk Costs*	1.9	1.9
c) OBC to FBC	*Sunk Costs*	15.0	15.0
Post approval project costs	165.8	186.6	186.6
Inflation		16.0	16.0
Risk	8.0	18.3	18.3
Optimism bias (49%)	81.2	99.2	99.2
Initial project costs	**255.0**	**338.3**	**338.3**
Future costs:			
Capital	7.3	31.6	
Revenue	20.8	84.1	
Future risks (assumed 30% of maintenance, 49% on capital works)	9.8	40.7	
Total project costs	**293.0**	**494.7**	**338.3**

Table 5 - Summary of project costs for preferred option

Flood risk type: Fluvial & Tidal

Numbers of households at flood and/or erosion risk

- Households at very significant risk now –138
- Households at significant risk now - 1
- Households at intermediate risk now – 263
- Households at moderate risk now – 66
- Households at very significant risk in 2130 - 0

- Households at significant risk in 2130 – 0
- Households at intermediate risk in 2130 – 35
- Households at moderate risk in 2130 – 23

Critical Infrastructure at risk now and in 2130

- Bristol Temple Meads station
- Road and rail infrastructure in Bristol
- Floating harbour infrastructure

Over the 100-year appraisal period a total of 111 electrical substations are at risk in the Do-Nothing scenario.

National Grid facilities at Avonbank off Feeder Road include engineering offices, administrative offices, and repair facilities, as well as a 20MW biofuel generation site for addressing peak demand.

Several educational properties are at risk over the 100-year appraisal period for the Do-Nothing scenario.

- St. Philips Marsh nursery school
- St. Mary Redcliffe & Temple C of E school
- Redcliffe Childrens Centre and maintained Nursery School
- Becket Hall Day Nursery

Emergency service centres at risk over the 100-year appraisal period for the Do Nothing scenario:

- Avon Fire & Rescue Service (Hartcliffe Way & Temple back)
- Bristol Ambulance Emergency Medical Services and fleet repair (off Feeder Road)
- Bristol Ambulance Emergency Medical Services (Albert Crescent)
- Kenneth Steele House Police Station (off Feeder Road)

Healthcare facilities at risk within the appraisal area in the Do-Nothing scenario:

- Bristol Child and Adolescent Mental Health Services, Redcliffe
- Bristol Central Health Clinic
- Queens Park Clinic, Queens Square
- Public Health England Offices, 2 Rivergate
- Nuffield Health, Canynge St

Economic cost and benefit of selected option

- Present Value Benefit - £2,279m
- Present Value Cost - £293m
- Net Present Value - £1,986m
- Benefit to Cost Ratio – 7.8
- Incremental Benefit to Cost Ratio – 3.0
- Whole Life Cash Cost - £494.7m

Affordability of selected option

- Raw Partnership Funding score is 71%
- Adjusted Partnership Funding score is 86% from confirmed sources. Analysis completed to date has identified sufficient funding to achieve an adjusted partnership funding score of up to 120%.
- Funding from Environment Agency (Grant in Aid) is £197.7m
- Funding from the Regional Flood and Coastal Committee is £2m

Risk

- The total contingency amount is £117.5m (cash terms – including optimism bias and 95th percentile risk allowance)

Top three residual risks are:

- Delay or challenge to delivery of Strategy
- Securing remaining required funding
- Landowner / occupier agreements

Permissions and consents

- Transport and Works Act Order
- All consents & permissions to be secured post OBC assurance.

Outcomes

- OM2a – 414
- OM2b - 188

Activity	Date
Strategic Outline Case – Submitted to LPRG	November 2020
Strategic Outline Case – Approval	January 2021
Outline Business Case development	January 2022-December 2023
BCC cabinet OBC approval	January 2024
Outline Business Case – Submit to LPRG	February 2024
Outline Business Case – LPRG, Defra and HMT assurance	November 2024
Procure consultant for FBC	March 2024 – December 2024
Environmental Statement preparation	2025-2027
Public consultation for TWAO	2026-2027
TWAO preparation and determination	2026-2028
FBC – Detailed Design & Consents	2025-2029
Construction Start – Phase 1	2029
Construction End – Phase 1	2036

Table 6 - Schedule of critical milestone dates

2.0 Strategic Case

2.1 Introduction

Bristol and its neighbouring communities have grown and thrived on the banks of the River Avon, creating one of the largest economic centres in the South West.

Built on a background of trade, commerce and infrastructure, Bristol has grown into a city recognised internationally with a sustainable, innovative and culturally diverse community. The city's success brings with it challenges such as inequality, increased cost of living and congestion.

As with any city located close to rivers and the sea, Bristol has experienced many flood events in its past. Today its people and property face an ongoing flood threat which due to climate change will significantly worsen in future without intervention. In addition, it is becoming increasing difficult to enable development to proceed within the city centre under the current circumstances, stagnating the city's ability to thrive.

A strategy for flood risk management is needed to better protect Bristol and neighbouring communities from the increasing flood risk posed by the River Avon from high river flows and tidal surges. A major flood event which currently has a 0.5% annual chance of occurring now, could occur as frequently as once a year (63% AEP) by the end of the century if no strategic management of the risk is implemented.

The Strategy is ambitious and will rely on funding from a range of sources. With a clear plan, flood defences can be integrated with high-quality public spaces in future developments, positively regenerating areas around the River Avon, whilst giving businesses the confidence to invest in Bristol, unlocking the funding needed to realise these ambitions.

2.1.1 The Bristol Avon flood strategy background

The Bristol Avon Flood Strategy sets out a strategic long-term plan for managing flood risk from the River Avon to Bristol and its neighbouring communities.

The Strategy has been developed by Bristol City Council (BCC), with support from the Environment Agency, the West of England Combined Authority (WECA) and consultants Arup. BCC lead in recognition of the potential impact and opportunity for the city, and the Strategy's interface with BCC's harbour, highway, planning, lead local flooding, coastal protection, civil protection and major landowner roles. The Environment Agency will play an essential role given their statutory lead role for Main River and coastal flood risk management. WECA is also a key project partner, recognising the transformative nature of the Strategy and the opportunities for multiple regional benefits including active travel, green infrastructure and regeneration, and how this aligns with WECA's ambitions.

This report is presented in the format of an Outline Business Case (OBC). The report is intended to inform BCC's and Environment Agency's decision makers and will be formally submitted to the Environment Agency to support advancing the delivery of the first phase of the Strategy.

2.1.2 Flood risk

The Strategy has been developed because effective strategic flood risk management is essential for the long-term sustainability of Bristol and the health and wellbeing of its citizens, as well as neighbouring communities. Flooding poses a threat to lives and property, and to the long-term economic prosperity and viability of the city.

Bristol is positioned near the mouth of the River Avon as it connects with the Severn Estuary, with the highest tidal range in Europe. It is therefore subjected to flood risk caused by extreme tidal events (from the sea) and extreme fluvial events (from the inland waterways) and probabilistic combinations of both types of events occurring at the same time.

The predominant flood risk and potential for the most severe damage to much of the city centre is from high tides combining with storm surges. This forces water up the river, overtopping many low spots around the harbour and causing the Floating Harbour to flood properties. Some overtopping is shown at Albert Road in the 63% AEP tidal event in 2030, the first 'out of bank' flooding predicted to occur. However, the River Avon is also fed by a large upstream catchment causing a significant fluvial flood risk.

Over 1,000 homes and businesses near the city centre and around 400 properties in neighbouring communities are currently at risk of being flooded in either a severe river or tidal flood from the River Avon, severing the region's transport network (see 2.5.1), causing grid lock to the city centre, and putting the operation of the existing flood risk management systems at risk.

2.1.3 Influence of climate change

Since 1900, UK sea levels have risen by more than 16cm. Studies of records at Avonmouth found between 1993 to 2007 sea levels on average increased 0.2cm every year. As a consequence of climate change, the observed increasing sea levels and peak river flows are predicted to continue and accelerate. Without action, by the end of this century over 3,100 existing properties could be at risk in the event of a severe tidal flood. Figure 6 shows the areas that would be flooded by a 50% annual chance flood in 2069 and 2130 should no action be taken (the 'Do Nothing' scenario). The 2130 flood outline is the equivalent of a 0.5% AEP event today.

Flood risk is currently a significant constraint on development opportunities in central Bristol. Without a strategic intervention, the predicted impact of climate change would exacerbate the impact of flood risk, causing deep and hazardous flooding and further constrain the scale and form of development in the central area.

Flood risk in the study area will increase unless appropriate action is taken. BCC operates the infrastructure in the Floating Harbour which forms a fundamental part of the flood defences of the City. However, this is increasingly vulnerable to tidal overtopping.

The climate change allowances used in this business case are discussed in section 3.5.1, and the residual risks discussed in section 3.10.

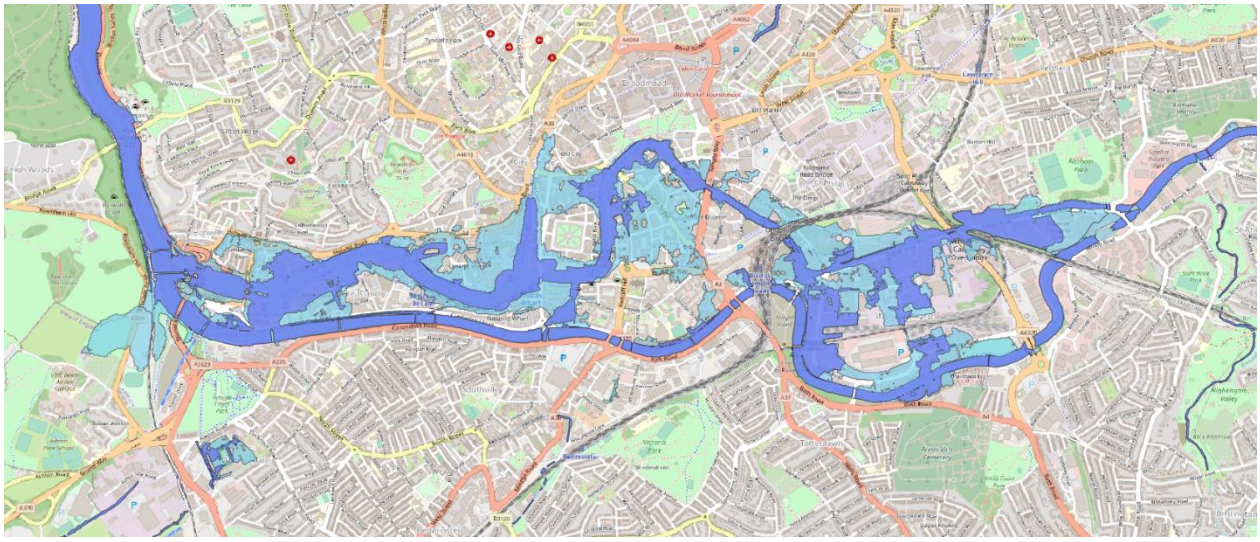

Figure 6 - Do Nothing 50% annual chance tidal flood outline, 2069 (dark blue) and 2130 (light blue) (background mapping © OpenStreetMap).

2.1.4 Strategy development

In 2017 an early study focusing on the threat from tidal surges was produced. The River Avon Tidal Flood Risk Management Strategy (the "2017 Study")[1] was developed by BCC with consultants AECOM following the Environment Agency's strategic appraisal approach whereby the technical, economic, environmental and social merits of a range of strategic options were assessed. The 2017 Study set out a preferred option which involved delivering flood defences at low spots along the River Avon delivered in phases. Engagement was limited to statutory consultees informing the emerging technical studies. The 2017 Study is referred to throughout this document.

In 2018 Arup were appointed to work with BCC to develop the 2017 Study. The work reviewed and built on the evidence base and ensured that the strategic approach also manages fluvial flood risk and delivers wider benefits to public spaces.

The revised Strategy added detail in considering:

- combined fluvial and tidal flood risk.
- future areas of growth and regeneration around the harbour and NPPF requirements.
- opportunities to unlock wider benefits of the Strategy.
- measures to prevent adverse impacts of the preferred option.
- a revised phasing plan.
- updated costing and economics.
- updated funding strategy.

[1] AECOM, "River Avon Tidal Flood Risk Management Strategy - Strategy Technical Report," 2017.

- the environmental impact of these options, in addition to the work done as part of the 2017 Study.
- a plan for stakeholder engagement.

The Strategy was developed and presented as a Strategic Outline Case (SOC) following a public consultation[2]. This was presented to the Environment Agency's Large Project Review Group (LPRG) and assured in January 2021 prior to Environment Agency Director endorsement. BCC Cabinet approved the Strategy in March 2021. In October 2022, BCC Cabinet approved[3] the Environment Agency-BCC initial collaboration agreement, planning position statement and the emerging funding strategy.

This OBC builds on the SOC and will be presented to BCC Cabinet for approval, followed by the Environment Agency's LPRG for assurance and onward approval. It will be agreed as to whether it also needs to go to Defra and HMT at this stage.

2.1.5 Historic flood events

Bristol has a long history of flooding, as suggested by numerous place names throughout the city centre, such as Temple Meads and St Philip's Marsh. The extent of tidal dominance in the New Cut channel changes depending on tide conditions. Under extreme conditions the tide can extend far upstream of Netham Weir.

Bristol has been lucky in recent years and has avoided severe flooding. However, there have been more than twenty minor tidal floods in the last decade. Properties and roads around the river have been flooded including at Pill, Sea Mills, the Portway, Cumberland Basin, Avon Crescent, Coronation Road and Cattle Market Road.

A 1.6m tidal surge in December 1981 caused levels to reach 8.8mOD and flood many properties at Pill, Shirehampton, Avon Crescent and across St Philip's. Subsequently flood defences were constructed by the Environment Agency at Pill, Shirehampton and St Philip's. Despite this defence, there was still localised flooding of St Philip's in 2014 and 2020.

There have been many recent near misses. Levels reached 8.8mOD in February 1990 and 8.7mOD in January 2014 when flooding closed key roads including the A4 Portway, Cattle Market Road and Cumberland Road. Good weather in 2014 reduced forecast surge levels by 0.8m and the proactive use of a temporary barrier protected properties at Avon Crescent.

[2] Bristol City Council, Bristol Avon Flood Strategy consultation, October 2022 Available at: https://www.ask.bristol.gov.uk/bristol-avon-flood-strategy-consultation

[3] Bristol City Council, Key Decision Paper," [Online]. Available:https://democracy.bristol.gov.uk/ieDecisionDetails.aspx?AIId=27802

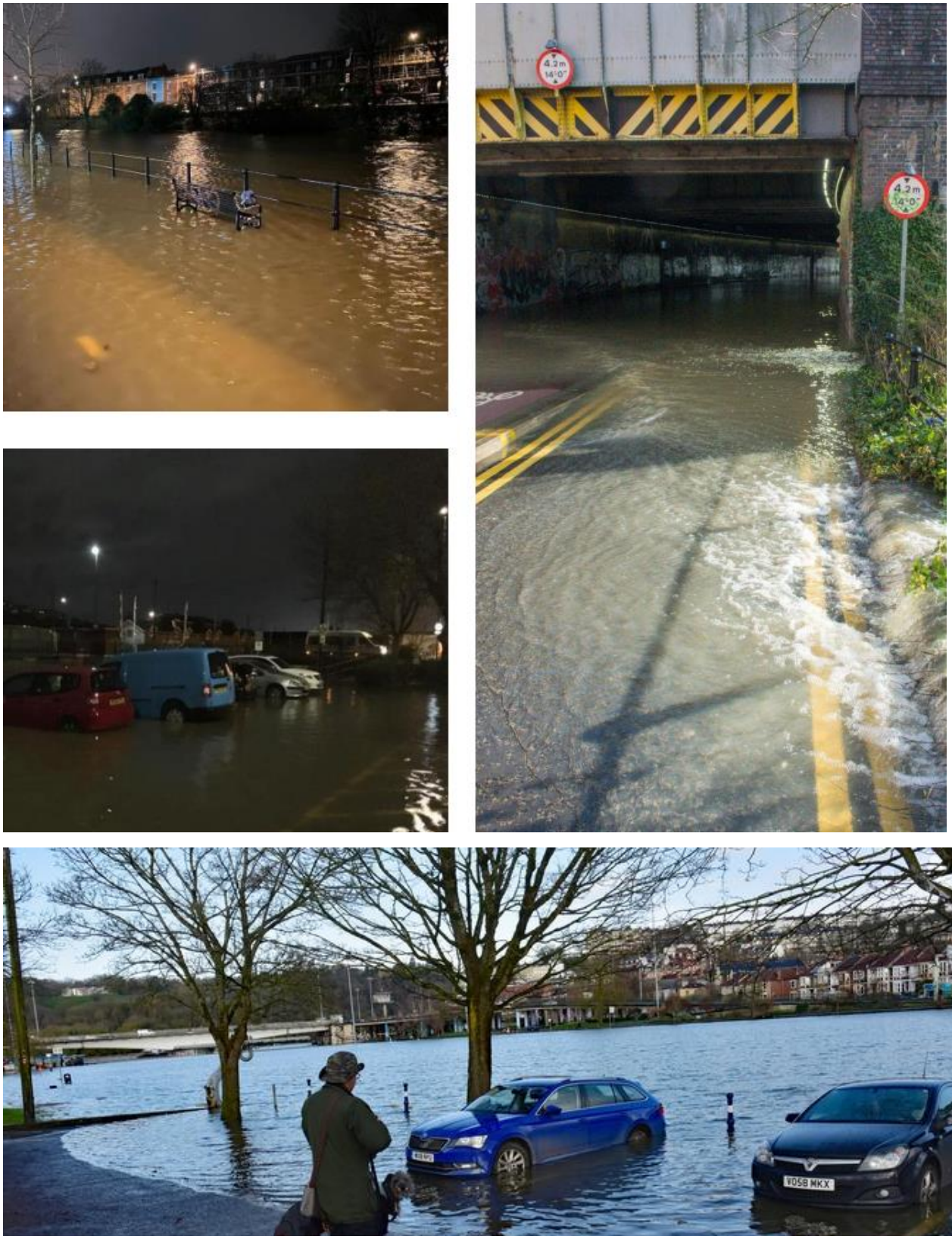

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Figure 7 - March 2020 tidal surge caused localised overtopping around the Harbour and River Avon

In March 2020, Bristol experienced the highest tidal event (of 8.81m AOD) since records began. This led to significant flood depths under the Clifton Suspension Bridge, at Junction Lock and at Cattle Market Road (see Figure 7). Flooding occurred for up to 15 hours[4]. Astronomical high tides combined with a 1.0m storm surge caused by a low-pressure system and south-westerly winds. Flood gates were closed at Pill and Shirehampton. At Sea Mills property flood defences were successful in protecting all but one property. Roads were inundated throughout the city, with disruption amplified due to precautionary closures for safety. The following morning, levels were again high at 8.67mOD. It was also difficult to access the harbour assets for maintenance and proactive intervention as the harbourside itself was flooded. The event could have been significantly worse if it had coincided with the worst of the storm surges seen just a few weeks earlier. The hydraulic model developed as part of this OBC was successfully validated against the March 2020 event.

Downstream, Pill and Shirehampton experienced widespread flooding with three major tidal flooding episodes between 1981 and 1990 affecting roads and properties to depths of 0.6m, prior to construction of raised defences. The riverside communities here have a long history of fluvial flooding.

Upstream, high tides frequently overtop Netham weir. The tidal limit stretches up to Hanham Weir in a 50% fluvial event with a Mean High Water Spring tide. However, a 0.5% AEP tidal event paired with a 50% AEP fluvial event impacts almost to Saltford Weir because the tide prevents fluvial flows from discharging. This area is also subject to frequent fluvial flooding. Some properties on the River Avon between Bristol and Bath flooded in 2000, 2014 and 2023.

2.1.6 Extent of Strategy Influence

Outside of Bristol, the Strategy extends into North Somerset at Pill and Ashton; South Gloucestershire at Hanham Mills; and Bath and North East Somerset (B&NES) at Keynsham and Swineford, potentially interfacing with emerging ambitions for growth and regeneration at North Keynsham.

2.2 Strategic Context

2.2.1 United Nations Sustainable Development Goals (United Nations, 2015)

Several of the UN's sustainable development goals are relevant to the development of the Strategy, as described below.

- Goal 3 – good health and well-being. The Strategy is required to protect Bristol's residents from the detrimental effects of flooding to physical and mental health, as well as promoting improved health by improving opportunities for active travel.
- Goal 4 – quality education. The Strategy is required to protect schools in Bristol which are at risk of being closed or damaged by flood events.

[4] Bristol City Council, "Flood Investigation for the March 2020 Tidal Flood Events," 2020.

- Goal 8 – decent work and economic growth. The Strategy is required to help to promote economic growth throughout Bristol and its neighbouring communities.
- Goal 9 – industry, innovation and infrastructure. The Strategy is required to ensure Bristol is resilient and has high quality infrastructure.
- Goal 11 – sustainable cities and communities. The Strategy will look to safeguard cultural heritage, reduce the number of people affected by disasters (in this case flooding) and provide access to safe, inclusive and accessible public spaces.
- Goal 13 – climate action. The Strategy will strengthen the city's resilience and adaptive capacity to climate-related hazards and integrate climate change requirements.
- Goal 14 – life below water. The Strategy is required to protect the ecosystems and habitats within Bristol and the River Avon.

2.2.2 Flood and Coastal Risk Management (FCRM)

The National FCRM Strategy for England[5] has been split into three high level core ambitions concerning future risk and investment need.

- Climate resilient places: working with partners to bolster resilience to flooding and coastal change across the nation, both now and in the face of climate change.
- Today's growth and infrastructure resilient to tomorrow's climate: making the right investment and planning decisions to secure sustainable growth and environmental improvements, as well as resilient infrastructure.
- A nation ready to respond and adapt to flooding and coastal change.

The primary Strategy Objectives agreed by BCC's Project Board are directly aligned with the National FCRM strategy ambitions.

The Strategy sits on the second tier of flood risk management hierarchy, below the Severn Estuary Shoreline Management Plan (SMP) which was completed in 2010 and the Local Flood Risk Management Strategy (LFRMS) and Flood Risk Management Plan (FRMP) for Bristol.

These plans and strategies identify flood risk management policies to deliver sustainable flood risk management for the long term. The SMP is a high level non-statutory planning document which presents a long-term policy framework to reduce the risks associated with coastal processes. Within the SMP, the Strategy area has a designated 'hold the line' management policy.

In the LFRMS and FRMP the recommended policy for Bristol is to take further action to reduce flood risk to ensure that the SoP through Bristol is improved where required. The Wessex Regional Flood and Coastal Committee Strategy

[5] Environment Agency, "National Flood and Coastal Erosion Risk Management Strategy for England", [online] Available: https://www.gov.uk/government/publications/national-flood-and-coastal-erosion-risk-management-strategy-for-england--2

identifies Bristol as a priority at-risk community. Managing flood risk is also a priority in Bristol City's Resilience Strategy initiative.

In addition to these plans and strategies, a number of studies have investigated flood risk in Bristol in more detail. In 2010 BCC commissioned the Bristol Central Area Flood Risk Assessment (CAFRA) to develop an understanding of flood risk on tidally influenced watercourses within the Bristol City boundary. A significant aspect of this study involved the building of a numerical hydrodynamic model and its use for option testing. Updates to the CAFRA study were made in 2014, 2015, 2017 and 2019.

In 2013, a first phase Feasibility study was undertaken to appraise strategic options to manage the flood risk in central Bristol. Given the changing flood risk profile over the next century an adaptive approach that progressively improves the flood risk management by building on the outcomes of previous interventions was advocated by the study.

In addition to the above, a draft of the Severn Estuary Flood Risk Management Strategy was produced in 2013[6]. This defines a 100-year plan of investment for flood defences for the coast between Gloucester to Lavernock Point near Cardiff, and from Gloucester to Hinkley Point in Somerset. The Strategy does not yet have formal approval from the Department for Environment, Food and Rural Affairs (Defra) or the Welsh government and is considered a working draft.

2.2.3 Climate Resilience

The Climate Change Act 2008 commits the UK Government to reduce carbon emissions to net zero by 2050.

BCC declared a Climate Emergency in 2018, recognising the risk of climate change to the city. In 2020 BCC published the Bristol One City Climate Strategy[7] setting out a strategy for a carbon neutral, climate resilient Bristol by 2030. The wider opportunities of flood risk mitigation are recognised within the Strategy, such as integrating green infrastructure solutions into a city centre flood management strategy and developing wildlife and nature corridors (green and blue) to create a network through Bristol that connects to surrounding areas.

Launched in January 2019, the One City Plan describes where BCC want to be by 2050, and how city partners will work together to create a fair, healthy, and sustainable city. Drawing from feedback, input and consultations throughout the year, the City Office produced the second iteration of the One City Plan. Relevant goals include:

- Improve Bristol's infrastructure to protect against flash flooding in high-density areas (by 2026)

[6] Severn Estuary Coastal Group, "Flood Risk Management Strategy" [online]. Available: https://severnestuarycoastalgroup.org.uk/severnestuaryfrms/

[7] Bristol City Council, "One City Climate Strategy" [online]. Available: https://www.bristolonecity.com/wp-content/uploads/2020/02/one-city-climate-strategy.pdf

- Sustainable urban drainage will span the city and reduce likelihood of localised flooding during wet weather (by 2043)
- The city is fully resilient and able to respond to rising water levels and localised flood risks (by 2048)

In February 2020 BCC declared an ecological emergency. In response it published the One City Ecological Emergency Strategy in September 2020. One of the actions emerging from the strategy is to "*embed biodiversity planning and Nature Based Solutions within Local Flood Risk Management Strategy work*[8]". Natural Flood Management (NFM) and nature based solutions are discussed further in this OBC in 3.9.3.

The Environment Agency have committed[9] to becoming a net zero organisation by 2030. The construction of FCRM capital projects forms a major source of carbon emissions and early consideration of carbon is required to identify solutions that efficiently minimise whole life carbon impacts. By contrast, the function of FCRM capital projects is to reduce carbon emissions by preventing damage to property and other assets with embodied carbon.

2.2.4 Planning and Development Policy

The NPPF sets out the Government's planning policies for England. Those policies require that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future) – the sequential approach. Where development is necessary in such areas, it is expected to be made safe for its lifetime, considering the predicted impacts of climate change without increasing flood risk elsewhere. Strategic policies for flood risk are expected to take account of advice from the Environment Agency.

The draft Bristol Local Plan[10] (due for adoption in 2025) sets out the development objectives for Bristol. The local plan includes BCC's approach to minimising the risk and impact of flooding in the context of new development. Its spatial strategy is based on a sequential approach whereby priority is given to development of sites with the lowest risk of flooding in the area.

The Local Plan also includes a policy specifically in relation to the proposals set out in this OBC. Policy FR2 – Bristol Avon Flood Strategy states that "*Flood risk from the river Avon will be addressed on a strategic basis consistent with the Bristol Avon Flood Strategy*". It provides the policy basis for securing developer

[8] Bristol City Council, "One City Ecological Emergency Strategy" [online]. Available: https://www.bristolonecity.com/wp-content/uploads/2020/09/One-City-Ecological-Emergency-Strategy-28.09.20.pdf

[9] Environment Agency, "Environment Agency sets net zero emissions aim" [online]. Available: https://www.gov.uk/government/news/environment-agency-sets-net-zero-emissions-aim

[10] Bristol City Council, "Local Plan review" [online]. Available https://www.bristol.gov.uk/residents/planning-and-building-regulations/planning-policy-and-guidance/local-plan/local-plan-review

contributions to the strategy, ensuring that "*Development in an area that benefits from a reduction in flood risk by the future delivery of the Bristol Avon Flood Strategy will be expected to… Facilitate the delivery of future flood defences and an enhanced multi-purpose greenway along the river Avon frontage including through financial contributions where appropriate*". At the time of writing and in advance of Local Plan adoption, several contributions are already in negotiation.

The policy goes further with development located within or adjacent to areas that are essential for the delivery of future flood defences which will be "*expected to accommodate space for and/or deliver flood protection infrastructure required as part of the development of the area including an enhanced greenway"* to the higher (phase 2) defence level. *Development proposals will not be permitted if they prejudice the implementation of the Bristol Avon Flood Strategy.* This policy safeguards the land footprint required for the delivery of both phases of the adaptive Strategy.

As part of the draft Local Plan, it is expected that large numbers of new homes and other forms of development will be delivered in central Bristol within the plan period, with scope for significantly greater numbers where the delivery of flood risk management infrastructure can unlock more potential. Potential is focussed particularly in proposed areas of growth and regeneration at Western Harbour, Bristol Temple Quarter and St Philip's Marsh which all include areas at risk of flooding.

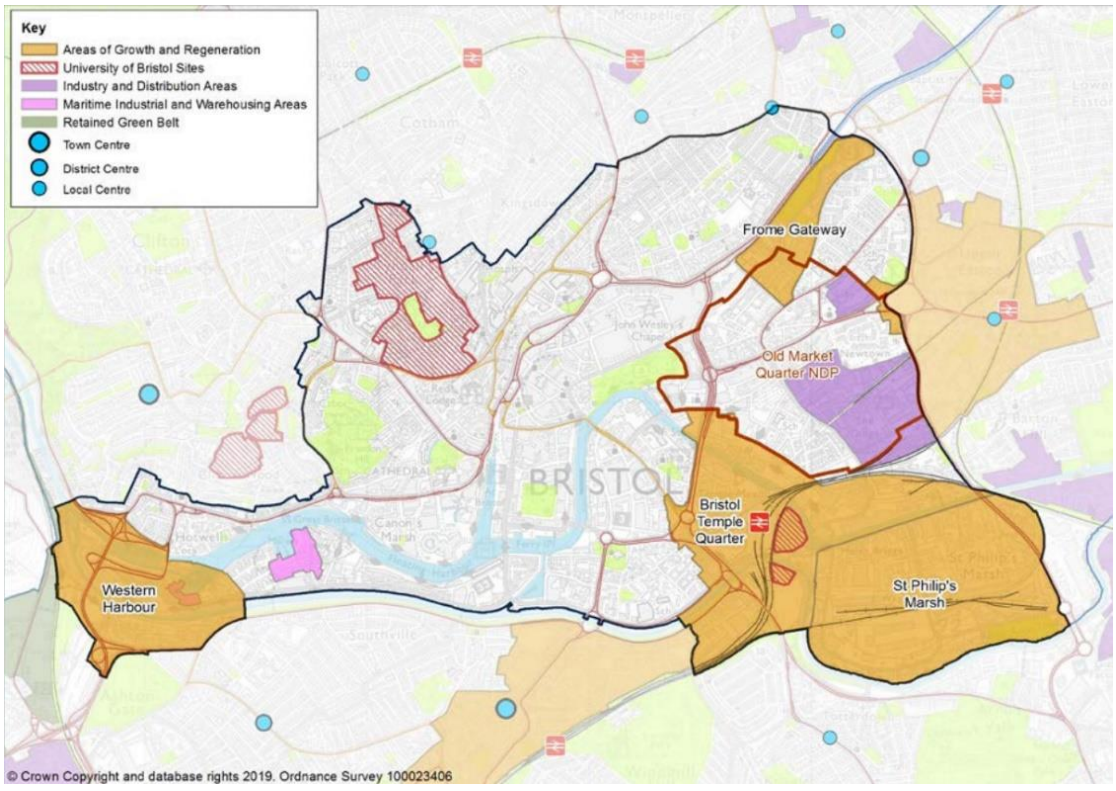


Figure 8 - Areas of growth and regeneration identified in the Local Plan Review[11]

A planning position statement[12] published in July 2022 set out the adopted and emerging planning policy position for managing flood risk in Bristol. This confirmed that "*The Strategy is also the council's preferred approach to enabling new development in areas at risk of flooding from the river Avon. However, [BCC] recognises that new development proposed in areas at risk of flooding cannot delay applications given the urgent need for new homes in the city. The current position is that new development proposed in areas at risk of flooding cannot rely on defences being built through the Strategy. However, confidence that the Strategy will be delivered is increasing, and appropriate weight will be given to the Strategy at the time of determining individual applications."* Since this was published the Environment Agency and BCC have agreed a further joint position statement that sets out how developers can rely on the future defences, but will a contribution towards their delivery is expected. This has not yet been published but will complement the Local Plan policies.

The emerging Local Plan contains a policy whereby new development can rely on both phase 1 and phase 2 of this Strategy being constructed to make it safe from flooding. Where development sits within or adjacent to the footprint of proposed defences, the council's requirement is that defences will be integrated within development proposals to the higher (phase 2) defence level.

This also overcomes the conflict between development needing to comply with NPPF (with a 100-year SoP) and phase 1 of this Strategy (outside of development areas) being constructed to a 2069 SoP, and it demonstrates the need to deliver both phases of the Strategy. The value of an adaptive approach and commitment to phase 2 is discussed further in the management case, see section 6.2.2.

2.2.5 Local Cycling and Walking Infrastructure Plan

The spatial extent of the Strategy interfaces with the WECA regional strategic transport programme, which includes the A4 Bath-Bristol and MetroWest Portishead to Bristol suburban rail corridor enhancements.

In June 2020, WECA produced a Local Cycling and Walking Infrastructure Plan[13] 2020-2036 as part of their wider plans and ambitions for creating and improving active travel, and their vision to *"Connect people and places for a vibrant, inclusive and carbon neutral West of England"*. The plan includes key walking

[11] Bristol City Council, "Local Plan review" [online]. Available https://www.bristol.gov.uk/residents/planning-and-building-regulations/planning-policy-and-guidance/local-plan/local-plan-review

[12] Bristol City Council, "Development in areas of flood risk. Planning position statement" [online]. Available: https://www.bristol.gov.uk/files/documents/5158-development-in-areas-of-flood-risk-planning-position-statement/file

[13] TravelWest, "Local Cycling and Walking Plan," [Online]. Available: https://travelwest.info/projects/local-cycling-and-walking-infrastructure-plan

routes and zones, as well as proposed improvements, for several areas impacted by the Strategy including Bedminster, Southville and Shirehampton.

2.2.6 Joint Green Infrastructure Strategy (JGIS)

The West of England Joint Green Infrastructure Strategy 2020-2030[14] aims to secure investment in Green Infrastructure planning and provision. The rich and diverse natural environment of the West of England is integral to the region's health and economic prosperity. Well planned, managed and functioning Green Infrastructure is crucial for people, places and nature and is a key component in addressing environmental impacts including climate change and biodiversity loss. The JGIS strategy establishes the approach for identifying and coordinating future partnership projects and funding bids for key shared green infrastructure assets such as the River Avon.

2.3 Environment and other considerations

The Strategy area is a mixture of developed urban environment and open space, as well as some agricultural land. There are a number of environmental designations within and adjacent to the study site. For maps of the environmental designations within and adjacent to the study site refer to the Preliminary Draft EIA Scoping Report (Appendix I). The following sections offer a description of the main environmental considerations.

2.3.1 Ecology

Consideration has been given to the potential impacts of the development on ecological receptors. During OBC stage, guidance and advice was provided at optioneering by an experienced ecologist, and opportunity identification was undertaken during design development to minimise potential impacts. The primary intention as part of iterative design development was to align legislation and policy requirement as part of evolving proposals.

Sensitive designated sites were identified within or adjacent to the study site:

- Avon Gorge Site of Special Scientific Interest (SSSI), Horseshoe Bend SSSI, Ashton Court SSSI, Bickley Wood SSSI, Cleeve Wood, Hanham SSSI and Ham Green SSSI.
- Avon Gorge Special Area of Conservation (SAC).
- The Severn Estuary, situated close to Pill and Shirehampton, is designated as a SSSI, SAC, Ramsar and Special Protection Area (SPA).
- North Somerset and Mendip Bat SAC.
- Bath and Bradford-on-Avon Bats SAC.
- Leigh Woods National Nature Reserve (NNR).

[14] West of England Combined Authority , "West of England Joint Green Infrastructure Strategy 2020-2030," [Online]. Available: https://www.westofengland-ca.gov.uk/west-of-england-joint-green-infrastructure-strategy

- The River Avon, which forms a Site of Nature Conservation Interest throughout the city and links Important Open Spaces.
- Lamplighters Marsh Local Nature Reserve (LNR), Avon New Cut LNR, Eastwood Farm LNR, Avon Valley Woodland LNR, Troopers Hill LNR, St George's Flower Bank LNR, Stockwood Open Space LNR, Royate Hill LNR and Callington Road LNR.

A Preliminary Ecological Appraisal (PEA) was undertaken to inform key constraints, design development and consents. Designated sites, habitats such as Habitats of Principal Importance and ancient woodlands, and protected species were identified, and will be used to inform the scope of FBC. Potential for bats, badgers, beavers, hazel dormice, otter, water vole, white clawed cray fish, breeding and wintering birds, reptiles, great crested newts, invertebrates, and fish were identified, therefore further surveys are required to confirm presence prior to the submission of an Environmental Statement. Required surveys are detailed in the PEA (Appendix I) and suggested timescales are included in the project schedule (Appendix G).

2.3.2 Heritage

The Floating Harbour, the New Cut, the Feeder canal and associated structures form, as an ensemble, the primary heritage asset of the city[15]. The globally significant innovations in engineering required to allow the docks to operate and flourish, through the management of the Avon's extreme tidal range by the creation of the Floating Harbour, fundamentally altered the physical, commercial and social landscape of the city. While there are many individual heritage assets that form part of the Avon, Floating Harbour, New Cut and Feeder Canal, they form one overarching historic landscape, combining both natural and engineered features. Upstream and downstream of the city, the historic landscape is less urban, but still combines many historic and natural features, including harbours, river crossings and inter-war housing estates.

A large number of individual heritage assets are also present along the river, including the scheduled Roman settlement of *Abonae* at Sea Mills and the scheduled Underfall Yard. There are numerous listed buildings, including the Grade I listed Temple Meads Station, Temple Meads Old Station, the Avon Bridge and the Clifton Suspension Bridge and the Grade II* listed swing bridges and entrance locks at the Cumberland Basin. Areas of historic built heritage are designated within 12 conservation areas, while Ashton Court is a Grade II* registered park and garden. There are also a large number of non-designated heritage assets and areas of archaeological potential.

The historic nature of the docks means that many of the designated and non-designated heritage assets are integral to the existing flood defences along the River Avon and the Floating Harbour and have the potential to be impacted by the strategy, although the scale will depend on the design of the flood defences.

The character of the reaches along the river varies significantly. From the wide-open estuarine environment at Pill and Shirehampton, to the iconic setting of the

[15] Bristol City Council, 2015. *Our Inherited City: Bristol Heritage Framework. 2015-2018*, Bristol: Bristol City Council.

River Avon gorge, the urban historic townscape of the New Cut, the original river course upstream of Temple Meads with both urban and natural settings, and then to wooded river valley at Conham. The scale of the impact is dependent on the setting of the area and the form and scale of any flood defence.

The River Avon at Entrance Lock and Cumberland Road falls within the City Docks Conservation Area. It is rich in both long-range panoramic views, long views to specific features, landmarks and distinctive skylines, as well as short-range contained views and glimpses. The Cumberland Basin area offers high quality views out of the character area including the iconic view of the Avon Gorge and Clifton Suspension Bridge.

The Cumberland Road and Bathurst Basin areas are more enclosed, offering local views across the New Cut and longer views along the river corridor to bridge crossings. From Bedminster in the South, when the trees are not in leaf, views from the slightly elevated Coronation Road are across the New Cut to Spike Island, with the distinctive skyline of Clifton, Clifton Wood and Brandon Hill above.

2.3.3 Townscape

Consideration has been given to the potential impacts of the development on townscape and visual receptors. During OBC stage, specialist landscape guidance and advice was provided at optioneering and design development to minimise potential impacts and highlight opportunities for enhancement. The primary intention as part of iterative design development was to align with existing local character and embed public space enhancement as part of evolving proposals.

Receptors sensitive to changes in townscape and visual were identified as part of the preparation of the Preliminary Draft EIA Scoping Report to inform the scope of FBC. These included sensitive landscape character areas such as Avonmouth floodplain, Avon Gorge, Entrance Lock to the west of the development and Wooded Avon Valley, Keynsham floodplain to the east, and sensitive views towards the development such as from public rights of way.

2.3.4 Water

By nature of the Strategy, the development of flood defences in and around Bristol has the potential to affect the water environment and is intended to manage flood risk for the years to come. A large number of surface water features and ground water features have been identified to provide context to the Strategy, including Water Framework Directive (WFD) classified and non-WFD classified surface water and groundwater features, drinking water safeguarding zones and aquifers.

Consideration has been given to the potential impacts on the waterbodies and protected sites and compliance with the Water Environment Regulations (WER). Potential impacts were screened into the assessment given the potential in-river works and the potential for changes in flood flows to impact upon the hydromorphology of the River Avon. A scoping assessment to identify WER quality elements at risk from the project was undertaken including the need for further assessment. Opportunities for enhancement have also been identified as

part of the assessment including benefits to water quality through biodiversity benefits through provision of riparian planting and bankside improvements which can also contribute to erosion protection and reduce the input of sediment.

Further detail of the water features and flood risk are summarised in the Preliminary Draft EIA Scoping Report (Appendix I).

2.3.5 Ground conditions and contaminated land

Bristol City and surrounding areas have been subject to ground raising and subsequent residential, industrial and commercial land-use development since the 1800s. Poor fill engineering and extensive historical industrial use mean the area is likely to contain a variety of contaminants. During OBC, desk study investigations were undertaken to identify the geological, land contamination, agricultural land, and mineral resources baseline, and the potential for unexploded ordnance.

Further detail of the ground conditions and contaminated land are summarised in the Preliminary Draft EIA Scoping Report and desk studies (Appendix I)

2.4 Consenting

The Strategy extents comprise areas in both the marine and terrestrial jurisdictions. The marine area is defined as the area below the Mean High Water Springs (MHWS), and the terrestrial area is defined as the area above the Mean Low Water Springs (MLWS). The regulatory body for the marine area is the Marine Management Organisation (MMO) and for the terrestrial area are the respective Local Planning Authorities (LPAs).

A review of existing harbour legislation and provisions contained within them has identified that BCC does not, in its capacity as statutory harbour authority (SHA), already have statutory authorisations for all the proposed works situated below MHWS in its area of jurisdiction. The existing powers that BCC hold only relate to a proportion of the proposed works. Similarly, with works also proposed below MHWS outside the Council's area of jurisdiction as SHA, statutory authorisation may also, in principle, be required for those works as well.

Three potential consenting routes were considered:

1. Application for planning permission under the Town and Country Planning Act 1990 (TCPA) and application for Listed Building Consent under the Planning (Listed Building and Conservation Areas) Act;

2. An Order made under the Transport and Works Act 1992; and

3. An application for Development Consent under the Planning Act 2008.

A Development Consent Order (DCO) was discounted due to the associated costs and timescales associated with it. Due to the nature of works below or impacting on the area below MHWS, a TCPA route alone would not be sufficient to provide the necessary powers to construct and operate the scheme.

Therefore, to obtain the necessary statutory authorisation for works below or impacting on the area below MHWS (during construction for example), a

Transport and Works Act Order (TWAO) would provide the necessary statutory authorisation to construct and operate the strategy.

A TWAO is a statutory instrument made under the Transport and Works Act 1992 (TWA 1992) to the Secretary of State (SoS) to authorise guided transport schemes and certain other types of infrastructure. Section 3 of the TWA 1992 includes provisions relating to 'Orders as to inland waterways, etc.' It is considered that the provisions of Section 3(1)(b)(i) '(b) the carrying out of works which— (i) interfere with rights of navigation in waters within or adjacent to England and Wales, up to the seaward limits of the territorial sea' would apply to the consenting option in relation to flood defences.

Furthermore, given the scale of the proposals covering multiple Local Authority areas, consent could be applied for under the TWA 1992 to the SoS and the TWAO application could cover the whole Strategy area within Bristol, North Somerset, and Bath and North East Somerset (BANES), or such areas as required.

Further benefits of the TWAO include:

- powers to construct, alter, maintain and operate (or transfer the operation of) a transport system or inland waterway.
- powers to carry out and use works that interfere with navigation rights.
- compulsory powers to buy land and take temporary possession.
- the right to use land on short-term arrangements or long-term provisions (for example, for access or for a work site).
- amendments to, or exclusion of, other legislation.
- the closure or alteration of roads and footpaths.
- provision of temporary alternative routes.
- safeguards for public service providers and others.
- transfers of undertakings.

powers for making bylaws or introducing penalty fares.

2.5 Need for intervention

The 'Do Minimum' scenario for the Strategy represents a continuation of the status quo, assuming existing activities are continued and the current defences are kept in place, but not raised. The do minimum scenario is described in more detail in 3.5.1, as it also takes into account the fact that the infrastructure must be operated successfully, which is in itself susceptible to potentially hazardous flooding.

Numerical modelling has shown that around 1,050 homes and businesses near the city centre and 400 properties in neighbouring communities are at risk of being flooded in either a severe river or tidal flood today from the River Avon in the Strategy area and sever the region's transport network. Tidal flooding would be relatively rapid. Predictions show flood waters inundating a wide area to

significant depths, creating an environment hazardous to life. Without action, by the end of the century almost 3,100 existing properties could be at risk in severe floods.

The main areas of River Avon flood risk in central Bristol are located on the north bank of the New Cut and the Floating Harbour. On the south bank of the New Cut the flood risk is more localised and often multi-sourced, for example, from tide locking of fluvial watercourses. Flood maps showing the flood risk to Bristol in a ‘do nothing’ or ‘do minimum’ (the status quo) are included in Appendix D.

Year	Location	Residential properties	Non-residential properties	Total
2030	Central Bristol	616	426	1,418
	Downstream	170	26	
	Upstream to A4174	117	63	
2130	Central Bristol	1483	1062	3086
	Downstream	323	31	
	Upstream to A4174	117	70	

Table 7 - Properties at risk of flooding in 0.5% AEP tidal or 1% AEP fluvial events in the Do-Minimum status quo baseline (Avoids double counting. Not properties claimed in the Partnership Funding Calculator)

The main areas of River Avon flood risk in central Bristol are located on the north bank of the New Cut and the Floating Harbour. On the south bank of the New Cut the flood risk is more localised and often multi-sourced, for example, from tide locking of fluvial watercourses. Flood maps showing the flood risk to Bristol in a ‘do nothing’ or ‘do minimum’ (the status quo) are included in Appendix D.

Figure 9 - View looking East - Temple Meads in foreground, St Philip's Marsh and Netham in background.

Figure 10 - View looking east - Hotwells and Cumberland Basin in foreground. SS Great Britain and Spike Island in background.

The impact of frequent and / or widespread flooding to Bristol would be felt across the West of England due to the city's importance for employment, transport, recreation, tourism and economic growth. Key heritage and tourist attractions are also at risk, such as the SS Great Britain (located in the Floating Harbour), the Mshed and We the Curious museums. Frequent flooding would lead to blight to the cultural and economic centre of Bristol, with long term impact for the wider city and region.

2.5.1 Transport severing

Bristol is a South West hub for links between South East (Bath, Swindon, Reading, London), the Midlands (Gloucester, Cheltenham, Birmingham), Wales (Cardiff, Newport) and the South West (Bridgwater, Exeter, Devon and Cornwall). Many people work in, visit or travel through the centre of Bristol every day, so people across the city and the region will be affected. Although it should be noted that the coronavirus pandemic may have had a long-term effect on transport and how people use cities, the centre of Bristol will remain vital. Bristol's transport network is vulnerable to flooding; ranging from the Portway and riverside arterial routes to Bristol Temple Meads railway station underpass becoming impassable, as happened during the March 2020 flood mentioned in 2.1.5.

Bristol Temple Meads station is a key transport hub for the wider south-west region, and investment in the station is seen as a key component of economic growth for the region. Significant investment is being made around the station in the form of Bristol Temple Quarter – see section 2.14.1, and to the station itself to increase its capacity. Yet, flood mapping from this project shows that by 2130, all major roads around the station will subject to flooding more than once a year on average.

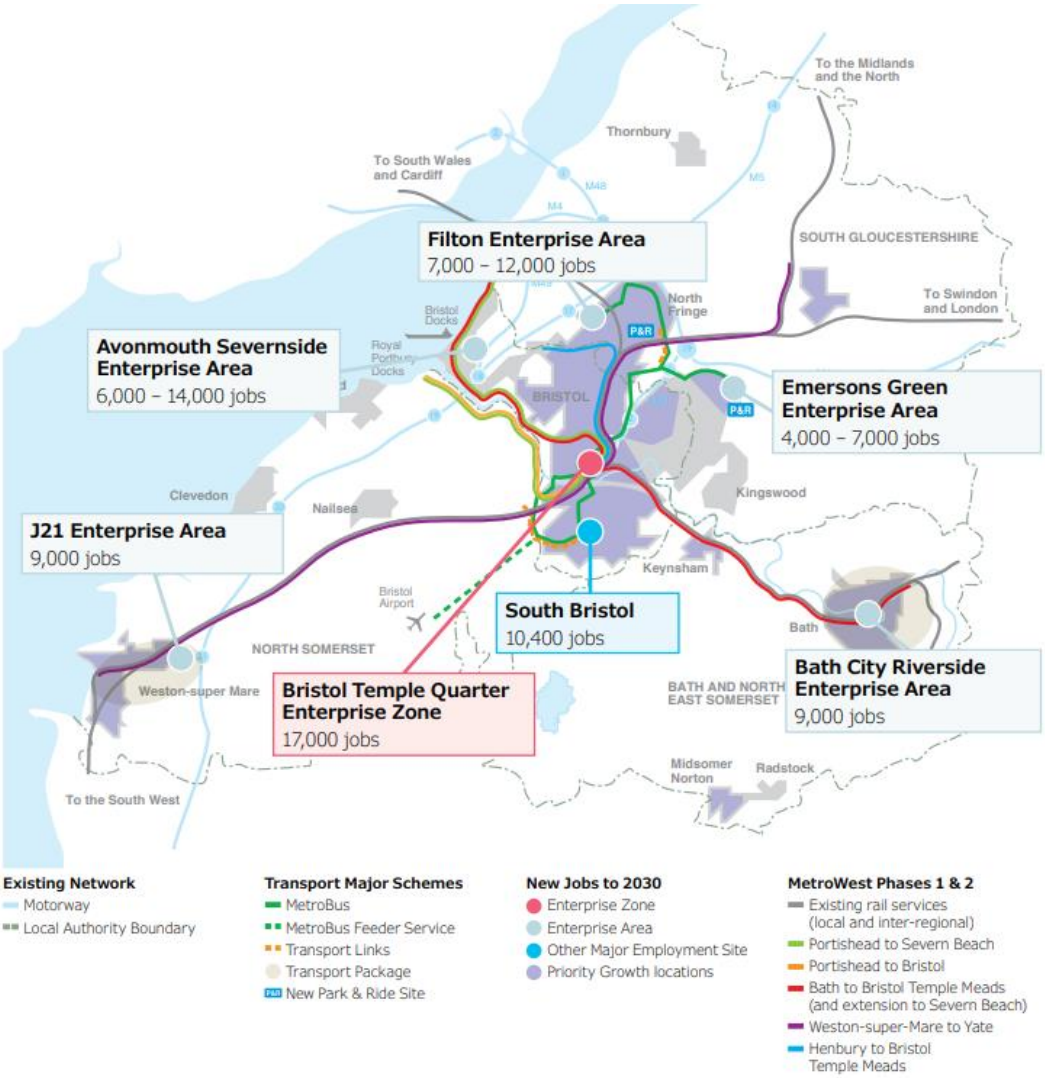


Figure 11 - Bristol Temple Meads and Bristol City Centre are key transport hubs for the South West and beyond. (Extract from the West of England Strategic Economic plan 2015-30)

2.5.2 Social consequence

Flooding can also have large social consequences for communities and individuals. Parts of Redcliffe and Barton Hill fall within the 10% most deprived neighbourhoods in England. In some cases, flooding can lead to poverty in low income households. It can make life more precarious for the vulnerable and elderly and have psychological impacts. There are also short- and long-term health impacts associated with flooding. For instance, drowning, injuries and

hypothermia could all occur during or immediately after a flood event, whereas long term issues such as chronic disease, disability, poor mental health, as well as stress and anxiety related illnesses may be a legacy from a severe flood event.

The benefits of reducing the flood risk in Bristol are therefore wide ranging, with economic, social, health, infrastructure, recreation and tourism benefits.

2.6 Supporting development

Developments in central Bristol which are at risk of flooding must be consistent with the 'sequential approach' and comply with the 'exception test'. That means they should deliver sustainable development benefits which outweigh the flood risk and will be safe for their lifetimes without increasing flood risk elsewhere. Previously, without a Flood Risk Management Strategy that had reasonable certainty of delivery, new development has been required to individually deliver flood risk mitigation to ensure the development is safe for its lifetime (100 years for residential uses), without increasing flood risk elsewhere, and provide safe, dry access during a "design flood". In some locations this has been impractical to achieve meaning development has been unable to comply with planning policy and in some instanced refused on this basis.

With the OBC adopted by BCC and endorsed by the Environment Agency as providing increased certainty of delivery, it will further enable opportunities for regeneration and new development that aligns with the Strategy to contribute to the economic success of the city.

The draft Local Plan policy FR2: Bristol Avon Flood Strategy, sets out how new development can rely on the future delivery of the strategic flood defences ahead of their construction, but in return will be expected to contribute financially to the delivery of the scheme, and / or provide a length of the defences consistent with the overall Strategy within the development proposals, see section 2.2.4. The proposed approach has learnt lessons from other cities, divided by rivers, but have successfully seized similar opportunities including Derby, Leeds and Sheffield.

2.7 Other sources of flooding

Whilst River Avon flooding is the key source of risk being addressed by the Strategy there is also a significant localised flood risk from the River Frome and other tributaries outside the scope of the Strategy. For example at Ashton, the flood risk from Colliter's Brook is the result of a combination of tide locking, stormwater discharge and land drainage issues.

Other sources of flooding, such as surface water, sewer and groundwater flooding, are outside of the scope of the Strategy and have not been considered in detail. These aspects will need to be adequately appraised and any adverse impacts prevented through suitable mitigation in the design and delivery of required schemes.

Wessex Water (WW), the sewerage undertaker for Bristol, has identified operational performance concerns with several combined sewer overflows into the River Avon, where tidal ingress can occur at times of extreme high tide.

There are reports of drainage surcharging at times of tidal surge. WW plan studies by 2026 to review and improve or rationalise these arrangements where necessary and this may involve pumped arrangements and enhanced non-return valves to maintain flood protection against increasing tidal levels.

The likelihood of a GiA application(s) for other sources of flooding in the Strategy location is low. Nonetheless, a strategic approach has been applied by avoiding claiming benefits within surface water flooding hotspots highlighted by the SWMP, and by avoiding double counting of benefits on the Frome and at Pill.

2.8 Strategic objectives

The key investment objectives for the Strategy have been set to reflect the importance of delivering robust and sustainable flood risk management infrastructure for the strategy area, whilst acknowledging the importance of the area for employment purposes and future redevelopment opportunities.

- To support safe living, working and travelling in and around central Bristol by ensuring flood threat is reduced and measures address residual risks.
- To facilitate the sustainable growth of Bristol and the West of England by supporting opportunities for employment and residential land, and infrastructure.
- To maintain natural, historic, visual and built environments within the waterfront corridor and where possible deliver enhanced recreational, heritage and wildlife spaces.
- To ensure navigation of river and harbour, and marine activities continue.
- To ensure the Strategy is technically feasible and deliverable.

In addition, objectives have been developed in relation to placemaking opportunities, following the identification of a preferred way forward. The placemaking opportunities report produced as part of the SOC expanded on these in relation to the four character areas identified in Figure 12.

- To enhance walking and cycling links to enable greater access to opportunities, work and housing.
- To bring existing communities closer together, as well as providing the opportunity to unlock new development land and attract residents, businesses and visitors.
- To protect and enhance recreational, heritage and wildlife spaces, to create healthier and more resilient communities, particularly those with higher inequality or limited access to green space and contribute to ambitions for the Avon Corridor as a key green infrastructure resource.
- To seek opportunities to provide improved harbour operational arrangements where feasible and consistent with wider project objectives.

Figure 12 - Character Areas identified in the SOC Placemaking Report

2.9 Current arrangements

Numerical model simulations show that River Avon flooding occurs in two ways; by directly flooding properties adjacent to low points in the New Cut defences, and by indirectly flooding properties adjacent to the Floating Harbour after flood water has entered the harbour, filled to capacity and then spilled into adjacent areas.

2.9.1 Bristol's Floating Harbour

Bristol's historic Floating Harbour was constructed to overcome the challenge of the second highest tidal range in the world. Opened in 1809, the river was diverted, and lock gates were installed so that the water level in the harbour remains constant, regardless of the level of the tide. In the 1870s, changes were made to Cumberland Basin and the harbour's water and silt level regulation.

Now, two pairs of BCC-owned lock gates west of Cumberland Basin and a pair of lock gates at Junction Lock maintain water levels at 6.2mOD and enable navigation during mid-tide. During high tide these navigation lock gates have no ability to hold back high river levels because they are mitred in the opposite direction, and so are opened to avoid damage due to reverse loading.

Fluvial flow enters the harbour from the River Avon via the Feeder Canal at Netham Lock diverted by Netham Dam, and also from the River Frome which passes through the centre of Bristol and enters from the north at Broad Quay and Castle Park. Flows discharge from the harbour via four culverts at Underfall Yard sluice, located close to Junction Lock. The schematic in Figure 13 shows the range of connected assets associated with controlling the Harbour, and their approximate locations, from which it can be seen that it is a relatively complex system.

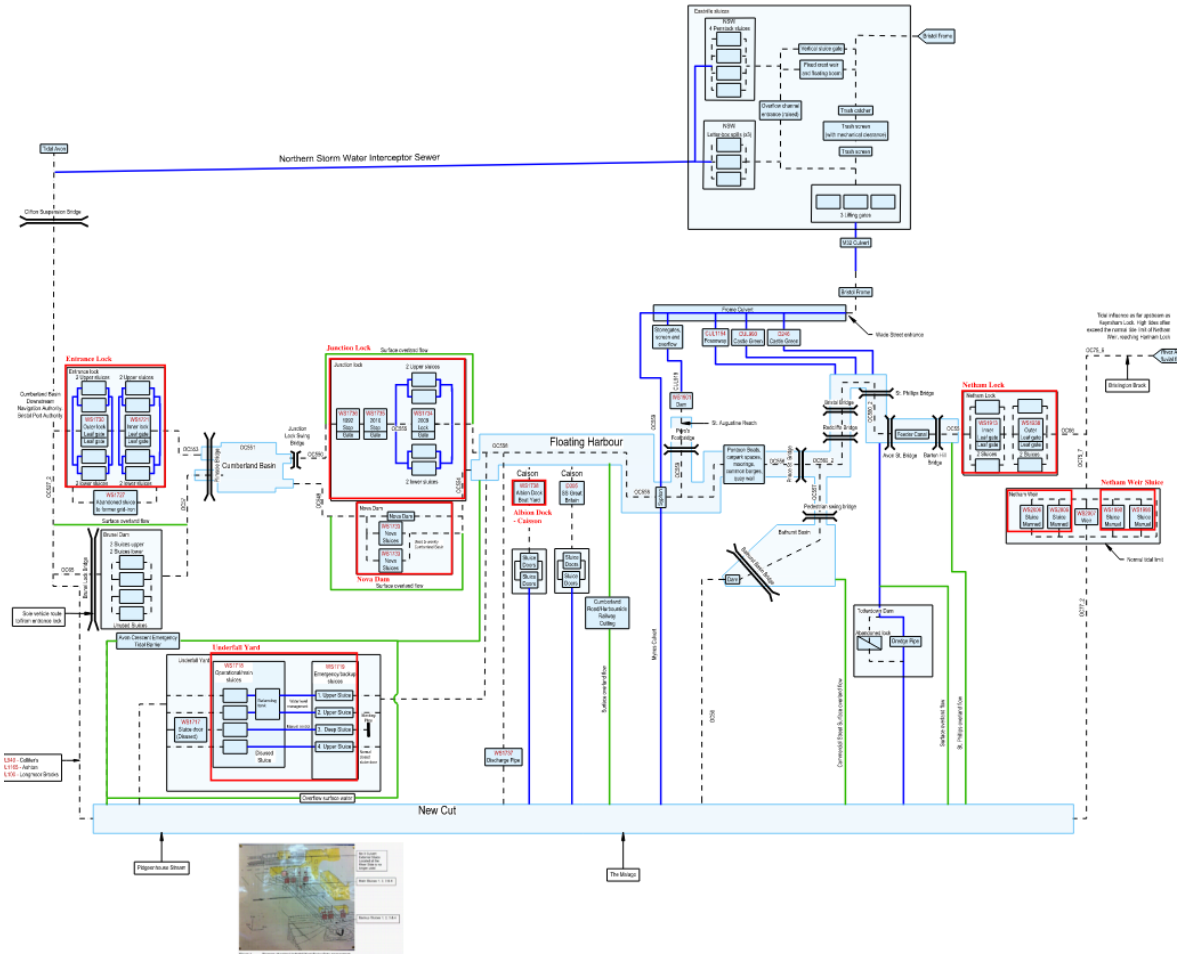


Figure 13 - Asset schematic showing the numerous interconnected control structures around the Harbour.

Figure 14 - Netham Lock

At Junction Lock and Netham Lock the quayside levels adjacent to the stop gates are lower than the crest level of the gates, and if water levels exceed 8.2mOD, river water can overflow into the harbour. Other low points in the defences adjacent to the harbour also serve as entry points, such as Bathurst Basin Dam at 8.3mOD.

Figure 15 - Water shown overtopping the Junction Lock stop gates into the Floating Harbour

2.9.2 Bristol's Floating Harbour operation

The harbour infrastructure and operating procedures aim to reduce the chance and consequences of overtopping into the Floating Harbour to reduce flood risk to large parts of the central Bristol. Two pairs of flood stop gates are deployed by BCC at Junction Lock (the downstream entry point to the harbour) to restrict water from flowing from the River Avon channel into Cumberland Basin and then into the harbour. The stop gates are operated and maintained by BCC under a Memorandum of Understanding with the Environment Agency who pay for their operation. The Junction Lock stop gates are operated around 200 times every year but are otherwise left open. The manual lock gates at Netham (upstream entry point to the harbour) were refurbished in 2011, and restrict water entering at this location.

BCC works in partnership with the Environment Agency and Met Office to monitor river levels and rainfall and respond accordingly. In addition to the above, water levels in the Floating Harbour are typically lowered by 0.05m prior to a flood event to increase the storage capacity of the harbour. The maximum the harbour level can be reduced by is 0.5m.

The procedures to manage flood risk in central Bristol are reliant on effective and timely flood forecasting. The Environment Agency flood forecasting enables preparation, however, Bristol's 12m tidal range makes tidal forecasts challenging. Significant variations in predictions occurred during the lead up to peak tidal surge events in 1981, 1990, 2014 and 2020. Water levels are gauged by the Environment Agency upstream of Netham Weir and at Avonmouth, and by BCC at Bedminster Bridge.

The harbour's capacity is limited. The harbour's control infrastructure operation is extremely vulnerable to flooding and some key assets are approaching the end of their lives. As sea levels rise, the risk of operational failure increases.

An operational incident with the lock gates in 2006 almost led to the rapid draw down of harbour levels, risking the collapse of dockside walls. Despite a subsequent £11m refurbishment programme, operation remains dependent on human intervention and control infrastructure could become inoperable due to debris. Studies have highlighted the significant risk posed from boats, cars and other potential floating debris. Junction Lock hydraulic power units are resilient to flood levels up to 9.6mOD.

Flooding at three main operational locations (Junction Lock, Netham Lock and Underfall Sluices) is predicted to be hazardous. Junction Lock is typically the most hazardous location, followed by Netham. At Junction Lock the hazard rating is ‘Danger for most’ during 0.83% AEP events or above today, increasing to 5% AEP by 2030. In this situation the operation of the stop gates at Junction Lock during a flood event is likely to be unfeasible.

The following considerations highlighted by the Central Area Flood Risk Assessment (CAFRA) Harbour Resilience Study (2013) are relevant when assessing future plausibility of maintaining gate deployment and harbour operations with minimal investment:

- No recent extreme tidal event has been recorded. Tidal stop gates have only been operated during events up to a 5% annual chance.
- BCC Harbour Master has noted the Netham Lock assets are manually operated and remote from the wider harbour operation.
- The Harbour’s vulnerability increases significantly during more extreme events (especially as it relies on human intervention which may be hindered during a flood), and it will continue to increase in vulnerability as the impact of sea level rise is realised.

Figure 16 - Construction of Junction Lock, 1964 (left) and Brunel Harbour, 1929 (right)

2.9.3 Containing river levels

Along the banks of the River Avon, low points include Cumberland Road, Commercial Road, Clarence Road and Cattle Market Road. Raised defences in the city include the recently constructed MetroBus flood wall along a length of

Cumberland Road and a combination of embankments and defacto defences at St. Philip's. The MetroBus flood wall (

Figure **17**) is constructed to 9.2mOD (1% AEP SoP). The St Philip's riverbank is narrow and the flood defences are lower at 8.8mOD and now in a variable condition, relying on some privately-owned walls and buildings with gaps as low as 8.4mOD. Private gabion wall flood defences reduce risk to the Paintworks development in Totterdown.

Figure 17 - The MetroBus flood wall on Cumberland Road

2.9.4 Outside the city centre

Pill is located downstream of central Bristol, on the south bank of the River Avon. The frontage is defended to 9.3mOD by a sea wall constructed in the 1990s and a series of manually operated flood gates. Shirehampton is located opposite Pill, on the north bank of the River Avon, and includes a mixture of defences also built in the 1990s to 9.35mOD and a set of manually operated raised flood gates. Several properties rely on standalone flood defences at Watch House Road. The flood gates at Pill and Shirehampton are operated by the Environment Agency and rely on effective and timely flood forecasts. Nearby at Sea Mills, a number of low-lying properties have installed private property flood resilience measures.

Upstream of Bristol, several riverside properties between Hanham and Saltford had property flood resilience measures installed in 2016 to reduce the consequence of flooding, supported by the Environment Agency following repeated fluvial flooding. Environment Agency modelling predicted flooding to properties in proximity to Riverside Inn, Saltford (20% AEP), Swineford (1.33% AEP, with gardens 5% AEP), Broadmead Lane Industrial Estate (2% AEP) and Hanham/Riverside (50% AEP).

2.9.5 Tributaries

Following catastrophic fluvial flooding in July 1968 where seven people died and more than 800 properties flooded, large tunnels (Airport Road Tunnel, Malago Interceptors and the Northern Storm Water Interceptor, NSWI) have been built

that significantly reduce the fluvial flood risk to large parts of the city by diverting flood water into the River Avon from tributaries such as the River Frome and Malago.

2.9.6 Management authorities

Flood risk in Bristol is currently jointly managed by BCC and the Environment Agency. BCC is responsible for operating the water level control infrastructure in the city centre, such as the tidal stop gates at Junction Lock and Netham, and the numerous sluice and culvert systems. BCC is also responsible for the upkeep of the retaining walls on the banks of the New Cut which somewhat act as a flood defence to the areas behind. The Environment Agency is responsible for providing flood forecasting and warnings to the area which are essential for the timely operation of the water level control infrastructure of the Harbour. In addition, the Environment Agency is responsible for the closure of manually operated flood gates at Pill and Shirehampton. The Environment Agency is also responsible for opening the Eastville Sluices, which relieves the Harbour and central Bristol area in times of high flow in the River Frome.

2.10 Main benefits

The Strategy will deliver a high standard of protection against flooding for Bristol and neighbouring communities, reducing the flood risk to properties, businesses, infrastructure, heritage and commerce to 2130 and beyond. Without the Strategy, large parts of Bristol's city centre will be at potential risk of write-off or development blight. The total economic benefit to the nation is over £2.2bn when compared with the Do Nothing scenario, and over £2.0bn when compared with Do Minimum.

In addition, as outlined in 3.5.5, local financial benefits will be significant, by avoiding damage to properties and infrastructure, disruption to businesses and tourism, and unlocking sites for regeneration. These benefits are estimated at more than £7.7bn when compared with the Do Nothing scenario. Even this estimate does not account for the potential value to the wider West of England of avoiding blight and frequent flooding to the commercial and cultural heart of the region.

Whilst the key objective of this Strategy is to better protect people and property from flooding, it also brings opportunities to invest in public and wildlife spaces; improve walking and cycling links; enhance historic features and support regeneration; tackle the challenges of the climate crisis and build stronger communities (see Figure 18). The Strategy will also unlock developments in key areas around the city which are either currently at risk of flooding or will be in future. All of these will further contribute to the economic success and wellbeing of local people, businesses and visitors.

From an environmental perspective, the delivery of the Strategy provides beneficial effects to people, health, material assets, heritage features and climatic factors, as well as opportunities for environmental enhancement and biodiversity net gain (e.g. native planting, urban greening etc.). These works are crucial to the preservation of key areas of Bristol that are fundamental to the character and

make-up of the city and will better protect these areas from flood events arising from both tidal and fluvial flows.

Heading	Social	Economic	Environmental
Development: supporting economic vibrancy by providing the waterfront setting for existing and future major development sites.	New development establishes new communities and can create new destinations; increaseing activity and liveliness and natural surveillance of the public realm	Increased quality development promotes development and increases values and footfall for local businesses	Delivers a high quality, sustainable public realm that balances development, movement and nature
Landscape: creating a publicly accessible, linear greenspace; connecting healthy and well communities across the city.	As green infrastructure, landscape positively affects both mental and physical health	Landscape can provide a high quality, natural setting that increases land values and inward investment	Helps to mitigate climate change and air pollution through new tree planting
Movement: connecting people and jobs through enhanced walking and cycling links.	Active travel choices increase levels of activity and fitness, and the physical and mental health and wellbeing of the population	Providing better active transport choices helps to reduce motor vehicle usage and highway maintenance, with the associated cost benefits	Reduces motor vehicle use which will reducce air pollution and improve air quality
Heritage and Culture: protecting and conserving Bristol's harbour heritage. Supporting the visitor experience. Fostering opportunities to integrate public art.	Cultural heritage tells the story of places and communities by providing contextual identity	Stabilisation, repair and reuse of historic assets is a cost effective, sustainable approach	The repair, reuse and integration of historic assets is key to creating a quality environment, and helps to reduce the environmental impact of construction
Recreation: encouraging social and physical activity by designing in sociable places, fitness trails and resting spaces.	Fitness and play enhances and promotes healthy lifestyles and social activity	Encouraging a healthy population through recreation choices helps to reduce the costs of health care	Increased activity and liveliness in urban areas enhances a sense of ownership of the public realm
Nature: providing habitats and food for wildlife to enhance the biodiversity of the river corridor, and the movement of nature through the city.	Connection to nature has a positive affect on the mental and physical health of people	Nature based design approaches can reduce maintenance and operation costs	Reduces/ mitigates biodiversity lost through development

Figure 18 - Key benefits identified as part of a wider placemaking strategy

2.11 Main risks

A delivery risk register has been kept and updated throughout the development of the Strategy. Table 8 captures those considered the highest priority at this stage, and that could materially affect the delivery of the Strategy. Residual risks following construction of the Strategy are discussed in 3.10.

Key risk	Consequence	Response and action
Consultation risk.	Delay or challenge to delivery of Strategy.	Supportive engagement and awareness raising. Clarity of language and timing. Cross-party consensus and continue Stakeholder Working Group liaison.
Strategy assurance and approval by Environment Agency or adoption by BCC Cabinet delayed.	Delay to adoption and / or delivery of Strategy.	Programme of briefings and reporting planned. Clear governance structure agreed.
Insufficient capital funding – either insufficient budget estimates or unaddressed funding gap.	Delay to flood strategy delivery. Risk to reasonable certainty of delivery for Environment Agency consideration of strategy as part of	Funding strategy to continue to be updated throughout Strategy development. Maximise opportunity for alignment with areas of Growth and Regeneration.

	planning consultee responses.	
Landowner / occupier agreements protracted or delayed. Areas of land currently unregistered.	Programme delay and potential increase in costs for additional studies and mitigation measures.	Default strategy option minimises requirement for works on non-BCC land. Budget estimate includes compensation allowance. Embed agreements in policy.
Challenge to strategy consenting	Programme delay and potential increase in costs for additional studies and mitigation measures.	Works to prevent adverse impacts have been developed in consultation with the Environment Agency. Affected communities to be engaged, identifying 'win-win' opportunities.
Strategy contains direct impacts on heritage assets. Risk of further archaeological finds.	Potential significant increase in costs, delay or changes to proposed defences. Consent from Historic England / LPA.	Heritage baseline and assessment completed. Environmental documentation to be further updated in future stages. Engage with Historic England.
Prohibitive construction restrictions (e.g. allowable working space or level of disruption) in city centre	Potential significant increase in construction programme and costs	Engagement with ESE contractors. Cost allowance based on concurrent working areas being far enough apart to limit disruption to a single carriageway closure.
Political changes	Delays impacting assurance/approval and funding.	Cabinet approval of Strategy achieved prior to election and change from mayoral to committee with funding delegated to officers. Cross-party support for the scheme.
Ground conditions	Risk of UXO, high ground permeability and / or deeper than expected bedrock leads to increased cost of foundations	Planned Ground Investigation at FBC stage. Geotechnical feasibility studies carried out at OBC to inform design.

Table 8 - Key risks, consequences and proposed responses

2.12 Constraints

There are a large number of constraints on the Strategy, including:

- The need to minimise disruption to adjacent businesses, transport networks and the community along the Avon, its tributaries and neighbouring communities.
- The need to maintain harbour structures, operation and navigation.
- The requirement not to increase flood risk (adverse impact) due to implementation of the Strategy through permanent or temporary works.
- Funding constraints, and those associated with other works taking place in the Strategy area, are discussed in other sections of this report.
- The Strategy needs a reasonable certainty of delivery, which will require agreement with the Environment Agency.

Reasonable certainty relates to the linkage between the emerging Strategy and spatial planning and is a requirement of the regulatory role of the Environment Agency. Without reasonable certainty of delivery of strategic flood risk management infrastructure, new development is unlikely to comply with national planning policy. The NPPF requires new development to be safe in respect of flood risk, taking into account the predicted impacts of climate change without increasing flood risk elsewhere. Without a flood risk management strategy that has reasonable certainty of delivery, new development must individually meet these requirements. In some locations this is impossible to achieve due to the high flood depths, meaning that the Environment Agency as statutory consultee would be duty bound to object and development would be likely refused on this basis.

In order to overcome this issue and support the Council's aspirations for growth and the development, the Environment Agency (and Planning Inspector at any Local Plan Examination) will require reasonable certainty of delivery of a FRMS, which means that the Environment Agency need to be confident that the strategy is deliverable.

2.13 Dependencies

2.13.1 Existing riparian assets

The Strategy is dependent on retaining structures along the New Cut, the banks of the River Avon, the harbour dam structures and the harbour water control assets at Underfall Yard. In addition, navigation within the Floating Harbour requires the lock gates at Entrance Lock, Junction Lock and Netham to remain in operation throughout the duration of the Strategy.

The external dependence on these existing assets and need for continued investment in the harbour outside of the scope of the Strategy is recognised by

BCC. Works to refurbish the harbour water control assets at Underfall Yard are ongoing and subject to a complementary business case (see section 2.14.9). The cost of continuing to operate harbour assets is not fully known but BCC is committed to funding this. Following a recent comprehensive condition survey, an asset management strategy is scheduled to be completed and this will form the basis from which BCC will manage the existing assets. Regular monitoring and maintenance of the existing walls is also recommended to ensure they can retain the design flood events, as well as in the interests of public safety.

In 2018 BCC commenced preliminary inspections of existing infrastructure in and around the Harbour and New Cut. The condition of riparian retaining walls is poor in places and deteriorating. Recent riparian wall collapses include Clarence Road (2014) and Cumberland Road (1981 and 2020, see below). An asset condition survey carried out in 2019 highlighted that some were in 'serious' or 'critical' condition – most notably on Cumberland Road and also around the Paintworks, which are likely to require remediation prior to flood defences being constructed. Arup carried out a review of the harbour assets in serious or critical condition that are relevant to the Strategy (see section 6.4.1).

2.13.2 Cumberland Road stabilisation works

In January 2020, a 113m length of riparian wall on Cumberland Rd collapsed (see Figure 19). The area had been subject to long-term monitoring due from progressive movement of the road and parallel Chocolate Path. The collapse itself was a sudden failure related to oscillating groundwater levels driven by the tidal cycle, exacerbated by a lack of groundwater drainage.

The failure led to immediate closure of the highway, heritage railway, footpath and cycle path, with significant disruption at a local and regional level. Although the highway was partially reopened, all routes were not reopened until completion of the works in September 2023 at a cost of ~£11m. The cost of emergency works was higher than if a similar solution had been carried out as part of planned works as significant extra piling works were required to enable a working platform for the main repair works. Other areas along the Cumberland Road are currently being identified as subject to similar levels of degradation.

The new structure supports Cumberland Road, Bristol Harbour Railway and the Chocolate Path and comprises a contiguous bored pile wall and pile group tied together by a single concrete slab. Crucially the structure has been designed to allow the future raising of the Cumberland Road parapet flood wall from the existing 9.2mOD to 10.5mOD to accommodate this Strategy's response to sea level rise.

Figure 19 - Photo showing collapse of the riparian wall on Cumberland Road in 2019

2.13.3 Partnership funding

The Strategy is dependent on the provision of partnership funding in addition to FCRM Grant in Aid . In order to progress an application for GiA it will also be necessary for the OBC for the first phase works to be approved by the Large Projects Review Group (LPRG). No FCRM Grant in Aid will be requested for phase 2.

2.14 Interfaces with other projects

Emerging proposals and projects likely to influence the Strategy, and vice versa, are summarised below.

2.14.1 Bristol Temple Quarter (BTQ) Growth and Regeneration Programme Area

Working in Partnership

The BTQ regeneration programme is a partnership between BCC, WECA, Homes England and Network Rail. In June 2022, £94.7m was awarded to kickstart BTQ Phase 1 focused on areas immediately around Bristol Temple Meads station. Improvements will include new Northern and Southern Gateways to the station, and the completion of a new Eastern entrance by September 2026 giving direct access to the University of Bristol's Enterprise Campus, Temple Island and future developments nearby. The investment will unlock the delivery of 2,500 new homes by 2032 and support 2,200 jobs.

BCC's Cabinet has now approved the council entering into a Joint Delivery Vehicle (JDV), including pooling its land with the other project partners and for the JDV once set up in February 2024, to begin the procurement of a

development partner to deliver much needed new homes, jobs and public spaces.

Key to the regeneration of BTQ is the University of Bristol's new Enterprise Campus. Set to open in September 2026, the £500m investment will bring thousands of new jobs and more inclusive routes to education to Bristol, stimulating wider investment at BTQ and fostering innovative knowledge-led employment.

Quality Placemaking

BTQ Phase 2 includes 57 hectares of land across St Philip's Marsh. In May 2023, BCC's Cabinet endorsed a Development Framework[16] following extensive public consultation. The framework sets the vision for change in the area. 87% of respondents to the consultation agreed or strongly agreed with the five principles that will guide change in the area.

The partnership has now appointed masterplanners to help develop proposals for the transformation of BTQ to build on the high-level principles for change in the Temple Quarter Development Framework. Alongside the masterplanning team, the partnership has also appointed consultants to help define the sort of place Temple Quarter should become. This placemaking commission will ensure the area becomes somewhere people want to live, work and spend time, while reflecting the best that the city-region has to offer.

BTQ and the Flood Strategy

The masterplan will include an infrastructure and delivery strategy to build on the early flood strategy work in respect of identifying opportunity to activate the river frontage with public realm spaces that can also function as flood defences when needed. This will lead to exploration of a widened river frontage with a high-quality placemaking approach. This will support the overall flood resilience strategy but equally enable consideration of the regeneration area holistically.

Although the Bristol Avon Flood Strategy has identified a solution for costing purposes that could be delivered within the narrow river corridor, this would not be an optimal solution when considered against the wider opportunities arising from such a major infrastructure enhancement. It would provide few of the wider opportunities identified in the BTQ masterplan and would not maximise the wider benefit to the city. The city's clear ambition is therefore to blend the needs of the flood defences with emerging development proposals, to provide enhanced and more integrated solutions along the river frontage.

The BTQ workstreams will include an infrastructure and delivery strategy that is expected to be consistent with the broader ambition as set out in the Development Framework and supportive of an integrated approach with a wider river frontage. They will also include extensive stakeholder engagement and

[16] Bristol Council, 2023 Available at: https://www.bristol.gov.uk/business/planning-and-building-regulations-for-business/planning-for-business/planning-in-bristol-temple-quarter

public consultation, leading in due course to a strategy which is anticipated to be given formal status in the Development Plan (in the form of a Supplementary Planning Document or SPD) alongside a delivery plan for comprehensive regeneration. This will underpin the Bristol Local Plan Review which includes policy proposing comprehensive regeneration and delivery of the widened river frontage including flood defences. The Plan is currently out to formal statutory consultation (Reg 19) from November 2023 to January 2024.

A Coordinated Approach to Design and Delivery

By working together through shared governance (BAFS – via BCC/Environment Agency Flood Board) and BTQ (Shadow JDV Board and Strategic Board) the two programmes are demonstrating a positive and mutually supportive approach through co-ordinating a number of complex workstreams. Terms of Reference are in place, project managers and consultants appointed, PMO support on board and an agreed joint programme.

During 2024, BAFS will aim to secure OBC approvals and FBC scoping and procurement ready to commence FBC in late 2024. During this time, BTQ will have:

1. Established the Joint Delivery Vehicle in February 2024;

2. Commenced BTQ Phase 2 Strategic Case, with an aim to complete by end 2024 and have entered BTQ OBC stage;

3. Completed the BTQ Phase 1 and 2 Masterplan.

In addition, the JDV will be well on the way to securing a development partner (by early 2025), bringing private sector expertise to the design and delivery of BTQ Phase 1 and then BTQ Phase 2 (St Philips Marsh).

2.14.2 Western Harbour Growth and Regeneration Area

The Western Harbour[17] was also included in the Bristol Local Plan Review 2018 as an area of growth and regeneration, consulted on in 2019. Proposals are at a very early scoping stages and a masterplan for the area has yet to be developed. Progress to date has included a Transport Feasibility Study and significant engagement to develop a vision for Western Harbour which was since endorsed by BCC in July 2022. The Council has recently secured funding to develop a masterplan and infrastructure delivery plan for the area and are in the process of commissioning this work which will focus on the area that is mainly within BCC ownership. In addition, there are a number of development sites that fall outside of the council's ownership are likely to come forward in due course.

There is significant scope for integrating the redevelopment of this area with proposed flood defences which can be explored at future stages. Delivery is constrained and regeneration is anticipated to be phased over the long term.

[17] Bristol City Council, "Western Harbour," [Online]. Available: https://www.bristol.gov.uk/planning-and-building-regulations/western-harbour

2.14.3 Pill

The Environment Agency is investigating the case for works to sustain or improve the Standard of Protection within the Pill area, focusing on the Markham Brook tributary. Likely works include upgrades to a culvert, trash screen and pumping station on Markham Brook; and implementation of NFM options upstream is also being considered. Studies and engagement are ongoing as part of the OBC programmed for approval in May 2024, leading in to FBC stage and subject to funding, construction starting in summer 2025. As works are required at Pill as part of the Strategy, this interface will be managed to ensure the schemes are compatible, and that benefits are not claimed twice.

Figure 20 – Existing flood defences in operation at Pill

2.14.4 Lower River Frome

The River Frome discharges into the Floating Harbour, with the River Avon and harbour levels causing a backwater effect, increasing river levels and flood risk to properties in the lower River Frome area. The area is significantly constrained by flood risk, driven by limited pass-forward culvert capacity and considerations of necessarily precautionary NSWI Tunnel failure scenarios.

BCC is working in partnership with the local community to guide and shape the long-term transformation of the land either side of the lower River Frome in St Jude's and has produced a Regeneration Framework[18] to create a long-term vision and strategy for change in this area of proposed regeneration, which is called Frome Gateway.

The Environment Agency has started developing a business case to better define the case for asset repairs to sustain defences in the lower River Frome, including the NSWI Eastville sluices. The OBC is anticipated to be completed in 2025. In parallel, the Environment Agency is to complete a Bristol Frome Catchment Investment Strategy to identify the case for short-, medium- and long-term

[18] BCC Frome Gateway Regeneration [Online]. Available: https://fromegateway.co.uk/

interventions to reduce flood risk and deliver wider benefits with partners BCC and South Gloucestershire Council. BCC and the Environment Agency will ensure that both schemes are compatible and benefits will not be 'double-counted'. The benefits identified for the BAFS on the River Frome assume that the existing assets are in a good condition, leaving the benefits available for the deteriorating condition of the assets to be claimed by the River Frome refurbishment project (Eastville to city centre).

2.14.5 Local cycling and walking infrastructure plan

The WECA Local Cycling and Walking Infrastructure Plan[19] includes proposed improvements to walking and cycling in the Strategy area. The Strategy may interface with emerging proposals for cycle path enhancements of St Philip's Marsh River Avon, Feeder Road and St Anne's, and Bedminster Bridges improvements.

2.14.6 North Keynsham

North Keynsham was identified as a strategic development location in the West of England Joint Spatial Plan (JSP). The JSP was halted at examination and the Plan was withdrawn in January 2020. Within the context of the subsequently withdrawn JSP, Bath and North East Somerset (B&NES) Council undertook work on their Local Plan 2016-2036, including an Issues and Options consultation. A 2017 initial strategic planning framework undertaken to inform the Local Plan 2016-2036 assessed and identified the development potential of this location (circa 1,400 new homes with supporting mixed land uses over the 150ha site)[20]. The site slopes to the River Avon and a riverside park was proposed for areas within the functional floodplain. As the JSP was withdrawn in 2020 work also ceased on the Local Plan 2016-2036. B&NES Council is now undertaking work to inform its current Local Plan Review, which will cover the 2022-2042 period. This work includes further technical assessments of the area that will help to determine whether the North Keynsham area will be put forward as a locational option for development.

Subject to North Keynsham being put forward as an Option in the B&NES Local Plan there is scope for integrating proposed works to prevent adverse impacts with development proposals which can be explored at FBC. Synergies will be pursued such as sharing of enhanced hydraulic modelling. Any regeneration is anticipated to be phased over several decades.

2.14.7 Review of Bristol Harbour

Bristol Harbour is classified as a Statutory Harbour Authority. To ensure that it is operating to modern standards, BCC has carried out an independent Harbour Operational Review which will enable the Harbour Authority to be governed and managed sustainably for the benefit of the whole city in line with national best

[19] TravelWest, "Local Cycling and Walking Infrastructure Plan," [Online]. Available: https://travelwest.info/projects/local-cycling-and-walking-infrastructure-plan

[20] Bath & North East Somerset Council, "North Keynsham Strategic Planning Framework", [Online]. Available: https://www.bathnes.gov.uk/sites/default/files/sitedocuments/Planning-and-Building-Control/Planning-Policy/LP20162036/lp_201636_io_north_keynsham_strategic_planning_framework.pdf

practice and guidance. In July 2023 the decision[21] was taken to approve the creation of ring-fenced accounts for the sustainable management and operation of the Harbour and to prepare and submit a new Harbour Revision Order (HRO), with approval anticipated by late 2025. The new HRO will amend and make harbour legislation fit for purpose, and the Strategy's preferred option delivery will need to comply.

The Harbour Authority endorses the strategy preferred option In principle, recognising the significant operational risk to the harbour posed by the Do-Nothing or Do-Minimum scenarios. Engagement with the Authority has supported refinement of the preferred option since SOC at key operational interfaces. This has included replacing pedestrian flood gates with ramps and mitigating the impact of siting new flood gates at Entrance Lock through continued day to day operation of existing Junction Lock flood gates. This will ensure the Cumberland Basin remains in use as a holding area for vessels during tides that exceed the harbour floating level. During FBC, the surveys and design will revisit opportunities to decommission both Junction Lock flood gates through changes to Entrance Lock proposals and rationalising Netham proposals to replace the existing lock gates in favour of introducing a new set of downstream gates.

2.14.8 Wessex Water

Wessex Water is the regulated Water and Sewerage Company providing sewerage and wastewater treatment services in Bristol. They own and maintain the sewerage network which comprises a mixture of separate storm and foul, and combined sewerage, including some 32 surface water drainage and Combined Sewer Overflow outfalls within the currently defined extents of the Bristol Avon Flood Strategy defences. In addition to these, Wessex Water is also responsible for at least 51 other outfalls to the River Avon between Keynsham and Avonmouth which could be indirectly affected by the BAFS flood defence proposals.

Outfall assets generally have non-return flap valves to protect the upstream network against flooding from high river levels and tidal surge, however these cannot guarantee total isolation and it is known that saline ingress can occur during high tide conditions. Furthermore these valves cannot provide protection against flooding when heavy rainfall coincides with high tides, due to the risk of self-flooding behind a closed valve; this is particularly the case in low-lying locations such as St Phillips, where ground level is lower than the current peak river level during tidal / fluvial extremes.

The Council shared information supporting scoping feasibility studies in 2022. During 2025 to 2030, subject to the outcome of the 2024 Price Review, Wessex Water plans to conduct further detailed investigations into the condition and operation of these outfalls and to make the case for investment to improve the drainage and sewerage networks' long-term resilience to tidal surges and River Avon flood levels

[21] Bristol City Council, "Bristol City Docks - Harbour Revision Order," [Online]. Available: https://democracy.bristol.gov.uk/ieDecisionDetails.aspx?ID=1736

2.14.9 Underfall Sluice Repairs

In November 2021 BCC procured a Hazard and operational analysis (HAZOP) and dive inspection of the sluices and culverts located at Underfall Yard. The condition report provided repair and maintenance recommendations to maintain the integrity and functionality of the structures. The HAZOP assessment identified upgrades required to increase the resilience and reliability of the existing system. Failure of the sluices in a fluvial event would cause significant flooding, modelling demonstrates flooding to 112 residential properties in a 1:20 year event.

BCC received Environment Agency approval of an £1.75m OBC to undertake these works[22]. BCC aim to procure the services of a D&B Contractor to complete the design and to construct the works between May – October 2024.

The appraisal period for the Underfall Sluice Repairs avoids overlap with the Strategy appraisal period.

2.14.10 New cut erosion

BCC have identified several high priority areas along the River Avon New Cut that require urgent remediation to avoid potential collapse, leading to significant disruption and / or road closures. This includes areas of Cumberland Rd where defences are not identified as being required for this Strategy.

A project to explore potential FCRM GiA contributions towards capital costs is being carried out in early 2024. There is potential for physical interface between any proposed works and those required by this Strategy, and efficiencies in design and procurement.

2.14.11 Brislington New Bridge

Brislington New Bridge carries Feeder Road over the River Avon just downstream of where the Feeder Canal and the Avon split, upstream of Netham Weir. The bridge was constructed in 1937 and comprises twin reinforced concrete bowstring arches with a single span of 42.7m. Since 2015, various inspections have revealed defects, and maintenance works carried out. The bridge is particularly susceptible to impact loading.

Throughout 2024, an OBC is to be developed by BCC to review the strategic options for the bridge including major refurbishment and on- or offline replacement. There is significant interface with the design of the defences for the Strategy and this bridge, and potential works provide an opportunity to integrate flood defences into the bridge works. This could lead to upgrading the existing lock gates at Netham to provide flood protection, with associated cost savings.

[22] https://democracy.bristol.gov.uk/ieDecisionDetails.aspx?AIId=31168

3.0 Economic Case

3.1 Introduction

Throughout this section, ‘options’ should be considered as preferred strategic approaches or ways forward, as opposed to finalised engineering designs.

The appraisal period adopted is 100 years, based on the expected design life of any interventions. The geographic boundaries of the appraisal are set by the range of hydraulic influence of interventions at the Floating Harbour – i.e. analysis has taken account of any detriment to property caused by those works and account for any detriment mitigation, both in terms of costs and benefits.

3.2 Critical success factors

The critical success factors identified below were used to differentiate between options and formed the basis of the options assessment. The most important critical success factor is the reduction of flood risk to existing communities; however, the wider objectives and potential benefits of the strategy are acknowledged.

Critical Success Factor	Measurement Criteria
To support safe living, working and travelling in and around central Bristol by ensuring flood threat is reduced and that measures address residual risks.	• No. of people better protected against flooding over the whole life of the Strategy • No. of residential and commercial properties better protected from flooding over the whole life of the Strategy • No. of key infrastructure assets better protected from flooding • Adverse impact to other areas managed to within agreed acceptable limits
To ensure the strategy is technically feasible and has a reasonable certainty of delivery. Associated risks can be reasonably managed to ensure timely delivery. Optimise benefits and outcomes to demonstrate value for money.	• Delivery of Strategy to provide agreed scale of flood risk management • A costed option which maximises the benefit to cost ratio • Planning permission granted • Required partnership funding contributions identified and secured to achieve final PF score >100% • Key stakeholders are supportive of proposals. Communities are aware and understand project benefits and timescale

	• Health, safety and wellbeing of all involved
To facilitate the sustainable growth of Bristol and the West of England by supporting opportunities for employment and residential land, and infrastructure.	• New employment opportunities created • Sustainable development in areas benefitting from Strategy
To maintain natural, historic, visual and built environments within the waterfront corridor and where possible deliver enhanced recreational, heritage and wildlife spaces	• No net loss of key habitat and enhancement where possible • Compliance with regulations • Protection of cultural heritage assets • Placemaking opportunities realised
To ensure navigation of river and harbour, and marine activities continue.	• Number of vessel journeys affected • Continuation of existing activities • Potential enhancement of harbour operational capabilities realised

Table 9 – Critical success factors

3.3 Long list options

A long list of options was considered for managing flood risk for Bristol. The long list development and appraisal was originally undertaken in the 2017 Study, and summarised in the SOC. Given that the leading option was identified during the SOC, no further development of the longlist has taken place at OBC. This is summarised in Figure 21.

Although additional work has been carried out as part of this Strategy that has changed the costs of the raised defences options, it was noted in the sensitivity testing of the 2017 Study that even with an increase in raised defences cost *"the relative economic merits of each option would be largely unchanged".* Similarly, *"should the barrier cost reduce by 50% the barrier options still remain significantly higher than the cost of the preferred option".* Therefore, revisiting the longlist was not considered appropriate or worthwhile.

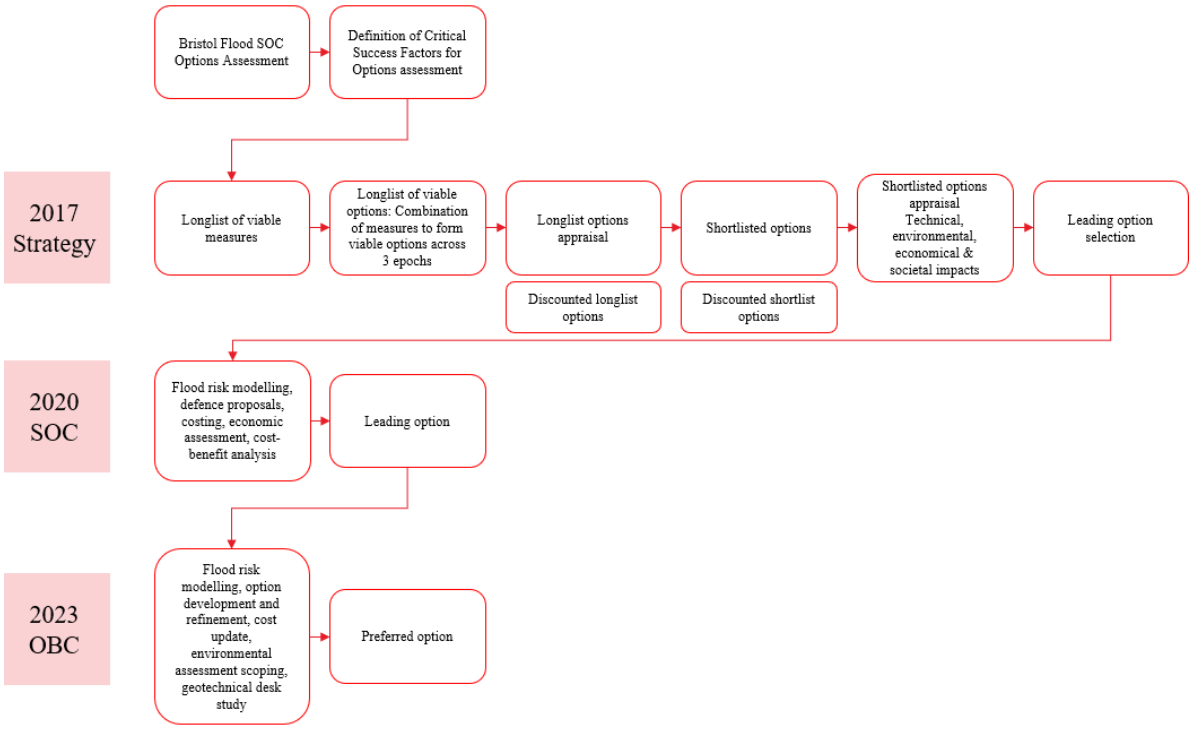


Figure 21 – Representation of the optioneering process across the 2017 Strategy, 2020 SOC and into the current OBC

A number of measures were discounted as they were not considered technically feasible.

- Source techniques to **slow the flow upstream** (such as flood storage, working with nature or land management) to capture and store water, slow and somewhat reduce the peak river flows from upstream tributaries, smaller streams or rivers that flow into the River Avon were discounted on technical grounds due to the impractically large scale of required upstream works for the 2,200km^2 upstream catchment and the fact that this approach would not reduce tidal flooding from the estuary.

  However, SOC consultation demonstrated a high level of support for such measures and the wider benefits. BCC will continue work with neighbouring authorities, the Environment Agency and other organisations to exploit opportunities as they arise to help reduce peak flows from upstream and bring wider ecological benefits to the area where possible. A study looking at potential NFM measures that reduce peak river flows has been carried out as part of this OBC and is summarised in section 3.9.3.

- Source techniques which **keep out tidal surges** include tidal barrages (permanently damming the river and controlling water levels upstream, such as the Cardiff Bay barrage) and tidal barriers (which close at times when flood tides are forecast, such as the Thames Barrier in London). A barrage would be significantly more costly than a tidal barrier and would have significant negative impacts on habitats, landscape, fish passage and navigation of the river. A barrage would increase upstream flood risk as the River Avon does

not have enough space to store river flows. Potential for wider benefits to be incorporated (e.g. synergies with a new transport link crossing the River Avon or tidal energy generation) were considered but this failed to improve the economic case. A tidal barrier was included in the long list.

- Pathway techniques to **increase the river flow conveyance capacity** (such as dredging or constructing a flood relief channel or tunnel) could potentially reduce fluvial flooding however these were discounted as they would increase tidal flood risk by allowing more water to flow up the river from the estuary and space is constrained.
- **Storing the flood water** in the Floating Harbour as it overtops low spots along the River Avon, with levels lowered at times when flooding is forecast. However, there is not enough storage space in the harbour and it would be overwhelmed during a severe flood.

Table 10 summarises the techniques taken forward to form a long list of strategic options.

Measure	Description	Commentary	Outcome
Do Nothing	A cessation of all flood risk maintenance and operations. Harbour flood gates assumed to be in open position.	No benefits delivered	Not an acceptable or viable approach. Included as a baseline against which strategic options could be compared.
Do Minimum	Maintain the 'status quo' i.e. continued maintenance of all existing defences and the existing Floating Harbour water level control structures, but no new defences and no raising of defences.	No additional benefits delivered	Not an acceptable or viable approach. Included as a baseline against which strategic options could be compared. Harbour operation increasingly prone to failure due to frequent inundation.

'Low' defences	Constructing new defences, to a chosen SoP for 2030, as an interim measure	Flood risk management up to 2030 required funds only to provide part of the defence.	Considered viable to take to the shortlist in combination with other measures.
'High' defences	Constructing defences to a chosen SoP for 2115*. Implemented by constructing a new defence or raising a low defence.	Flood risk management up to 2115*. Construction of new defences require funds in phase 1. Raising of existing defences is considered and may achieve cost savings.	Considered viable to take to the shortlist in combination with other measures.
Wide tidal barrier	Construction and operation of a tidal barrier across a 'wide' section of the River Avon downstream of Bristol at Pill and Shirehampton, approximately 500m upstream of the M5 road bridge	Flood risk management against tidal flooding. Traps fluvial flows when barrier shut and raised defence option would be required. High cost and high-risk option with negative environmental impacts.	Considered viable to take to the shortlist in combination with other measures. Potential secondary uses (generation of tidal energy and provision of transport links) found not to be viable.
Narrow tidal barrier	Construction and operation of a tidal barrier across a 'narrow' section of the River Avon downstream of	Flood risk management against tidal flooding. Traps fluvial flows when barrier shut and raised defence	Considered viable to take to the shortlist in combination with other measures.

	Bristol at Ham Green / Nibley Road, approximately 1500m upstream of the wide barrier option location.	option would be required. Relatively higher cost and higher risk option than raised defence options. Considerable negative environmental impacts.	
Local scale measures	Property resilience measures (such as flood plans, flood doors and flood resilient buildings) and temporary defences to increase the capacity of people and property to withstand the impacts of flooding and to rapidly recover after a flood.	Limited benefits. Only suitable for shallower depths of flooding.	Considered viable to take to the shortlist for suitable individual properties only. The scale, depth and speed of predicted flooding is too great to rely on these on their own. Need to be considered with other measures.

Table 10 – Summary of long list measures

*At the time of longlisting, 2115 was the strategy end date. This has since been updated to 2130.

Strategic long-list options were then formed by assigning measures to each time epoch (noting that three epochs were used during the 2017 Study, and now only two epochs are proposed). For instance, an option could comprise local scale measures followed by low and then high defences. Each long-listed option was developed sufficiently in terms of concept and spatial influence and potential form to ensure an adequate understanding of potential option impacts was achieved in order to carry out a robust appraisal with sound decision making. A long list of thirty-nine reasonable strategic options were assessed for the short list.

3.4 Shortlist options

The appraisal of the long list of options to a shortlist included a multi-criteria assessment whereby each long list option was scored against the Strategy objectives (as described in section 2.8) in equal measure. The total score of each

of the thirty-nine long listed options across the Strategy objectives was used to select the short list of options. From this assessment, the options below were discounted:

- A **wide barrier** was discounted due to having the highest capital cost, high delivery risk and estimated 20% lower GiA contributions than other options. There were also significant delivery risk and potential environmental impacts across multiple receptors. It was judged that the benefits of the wide barrier option could largely be achieved by combining alternative measures with fewer negative impacts such as the narrow barrier or high defence measures.
- **Property flood resilience (PFR)** measures were discounted as a standalone option due to the operational risks – the speed and depth of flooding makes these unsuited and thousands of individual properties would require measures to be installed in the event of a flood warning. However, PFR could still be combined with other options if appropriate.

Based on the scoring, a shortlist of seven strategic options covering both precautionary and adaptive approaches was created. A precautionary approach is where defences are built to provide flood protection to the end of the project lifetime in the short term (Epoch 1 or 2). An adaptive approach is one where lower defences are built in epoch 1 or 2, and raised in epoch 3.

The options scoring the highest from the multi-criteria assessment were adaptive approaches providing the flexibility to build defences to the level required for each epoch and thus requiring funds in phases. Precautionary approaches scored lower but were still considered viable short list options. The resulting short list was comprised of seven strategic options (denoted A-G), in addition to the Do Nothing and Do Minimum scenarios. Table 11 is a summary of the shortlisted options.

Table 11 – Shortlist of strategic options taken forward

Option	Epoch 1 (2015-2030)	Epoch 2 (2030-2065)	Epoch 3 (2065-2115)
Do nothing	No maintenance, no new defences	No maintenance, no new defences	No maintenance, no new defences
Do minimum	Existing defences maintained but no new defences, no defence raising	Existing defences maintained but no new defences, no defence raising	Existing defences maintained but no new defences, no defence raising
A	PFR measures and temporary barriers used to	Linear flood walls built to protect Bristol to a	Additional linear flood walls built to protect Bristol to a chosen standard until 2115, with

	mitigate flood risk	chosen standard until 2065	existing walls being raised or replaced as necessary
B	PFR measures and temporary barriers used to mitigate flood risk	Linear flood walls built to protect Bristol to a chosen standard to 2115.	Walls maintained, standard falls over time to chosen standard in 2115
C	PFR measures and temporary barriers used to mitigate flood risk	'Narrow' tidal flood barrier built to protect Bristol to a chosen standard or higher, for the next 100 years	Barrier maintained, standard falls over time to chosen standard or higher
D	Linear flood walls built to protect Bristol to a chosen standard for 2030.	Walls maintained, standard falls over time.	Additional linear flood walls built to protect Bristol to a chosen standard until 2115, with existing walls being raised or replaced as necessary
E	Linear flood walls built to protect Bristol to a chosen standard for 2030.	'Narrow' tidal flood barrier built to protect Bristol to a chosen standard or higher, for the next 100 years	Barrier maintained, standard falls over time to chosen standard or higher
F	Linear flood walls built to protect Bristol to a chosen standard for 2115.	Walls maintained	Walls maintained, standard falls over time to 2115
G	Do Minimum approach, existing defences maintained but no new defences	Do Minimum approach, existing defences maintained but no new defences	Linear flood walls built to protect Bristol to a chosen standard until 2115

3.4.1 Short list options assessment

The short list options appraisal consisted of a qualitative assessment of each of the shortlisted measures against the Strategy objectives and critical success factors. Each shortlisted measure was appraised on its technical viability, environmental impact and other impacts such as cost, buildability and socio-economic impact. In addition to the technical and environmental assessment undertaken in the 2017 Study, a red, amber, green (RAG) colour scheme was used to indicate the viability of each measure, included in the SOC.

A key change from the 2017 Study when the shortlisting process was carried out to the current Strategy was moving from three epochs to two. The proposed phases 1 (construction in 2020s) and 2 (2030s), were combined due to the minimal difference in water levels between 2025 and 2035, and because the vast majority of proposed defences were found to require construction in Phase 1. This is explained in more detail in a report[23] produced to support modelling for the BTQ masterplan.

By developing strategic options in accordance with these time epochs it has allowed an adaptive approach to be developed that keeps pace with climate change and potential changes in predicted sea level rise. In addition, the approach has in-built flexibility to address future uncertainty to ensure that the timing of future works is appropriate.

3.4.2 Selecting the preferred option

An economic appraisal including assessment of costs and damages and benefits was carried out on each of the seven shortlisted options.

The strategic options (Options C and E) with barrier measures, could not be economically justified (costing significantly more to construct) and the appraisal of non-economic benefits did not yield significant reasons to select them over other options. Extensive raised defences would still need to be built throughout the city centre to contain river flows trapped at times the barrier was closed, despite testing barrier locations as far downstream as possible. Therefore, these options were discarded.

The options comprising of low defence, high defence and PFR measures (Options A, B, D and F) showed economic justification for the increased investment to implement defences in epoch 1 or 2 rather than deferring to epoch 3, without any significant adverse issues so the Do minimum and deferred high defence option (Option G) was discarded.

The economic case for the low defence options (Options A and D) and the high defences options (Options B and F) were very similar. However, considering the Strategy objectives in terms of earlier investment in defences to better support wider growth and development opportunities, options involving PFR measures (Options A and B) were discarded.

[23] Arup, “Hydraulic modelling to support Bristol Temple Quarter project”, 2019

The Low defence option supporting an adaptive approach (Option D) was selected as the leading option over the high defence precautionary option (Option F) for the following reasons:

- Lower cost, and significant part of cost deferred until the 2060s.
- High defence construction deferred until the 2060s, deferring adverse visual impacts.
- A more adaptable approach, with low defences constructed in Phase 1 and ability to review the requirements of the higher defences in Phase 2 with a more accurate view of sea level rise projections.

The leading option was therefore confirmed as raised defences with an adaptive approach. Defences would be constructed in the 2020s and 2030s to provide a chosen SoP to 2065. The defences would then be raised in the 2060s to provide a chosen SoP in 2115. The SOC for this Strategy confirmed this, and introduced additional complexity in the form of:

- Updated climate change allowances
- Addressing fluvial flood risk as well as tidal
- Addressing adverse impacts of the defences
- The consideration of placemaking opportunities.

This provided further justification for the leading option, as it showed that higher defences are required earlier, and that this requires significant foundations which increase the Phase 1 costs whilst reducing the Phase 2 costs. As part of the SOC, the end of epoch 2 was moved to 2130 to reflect a 100-year appraisal period.

The identified leading option at SOC remains the OBC preferred option. The preferred option has been further developed as part of this OBC. One of the key strategic updates has been to move the appraisal period end of Phase 1 from 2065 to 2069, as this is more consistent with changes in climate change guidance, where a ‘step change’ in the increase in fluvial flows must be applied after 2069.

3.5 Economic appraisal

This assessment looks at the economic case for the scheme; the basis for selection of the preferred scheme using the FCRM Decision Rule; and the case for “local choice” of an alternate scheme that facilitates Bristol’s greater ambitions.

The assessment has undertaken analysis of FCRM GiA eligible benefits, which are attributable to the reduction of flood risk, and reflect economic impacts on the nation. These will form the basis for the assessment of the quantum of FCRM GiA that may be available to the scheme, as calculated using the Partnership Funding Calculator (PFC).

The assessment has also analysed local benefits, reflecting the financial impacts on the City of Bristol and surrounding areas of addressing flood risk. This will support the basis of bids to alternate sources of funding.

Further details of the assessment are available in the Economic Appraisal Technical Report[24], Appendix E.

3.5.1 Climate change allowances

The latest Environment Agency guidance on climate change allowances at the time of writing are:

- FCRM projects, schemes and strategies: climate change allowances, Environment Agency, May 2022. This guidance is for risk management authorities seeking GiA for FCRM projects, schemes and strategies.
- Flood risk assessments: climate change allowances, Environment Agency, May 2022. This guidance is to be used for strategic flood risk assessments and flood risk assessments (FRAs) for planning applications, and development consent orders for nationally significant infrastructure projects. This includes FCRM schemes that need planning permission.

Review of the above guidance documents showed there is no practical difference in the fluvial flow allowances between the two guidance documents.

There is a small difference in the sea level rise allowances between the two guidance documents. In all cases, the FRA Climate Change allowances were slightly higher than the FCRM allowances. Given this result, it was agreed that the sea level rise allowances specified in the FRA CC guidance as opposed to the FCRM CC guidance could be used for all modelling to be undertaken in the BAFS OBC. Further information is given in the baseline modelling report (appendix D).

This is a significant change from SOC when the latest guidance at the time showed material differences between FRA and FCRM climate change allowances. Therefore at SOC, multiple scenarios based on FCRM and FRA climate change allowances had to be costed and assessed. At this OBC stage, the preferred option of constructing defences in the 2020s to provide a SoP up until 2069, and in the 2060s to provide a SoP up to 2130 has been costed. This has been carried out for a range of standards of protection to inform the economic appraisal.

3.5.2 Detriment mitigation

A significant change has also been made regarding the purpose of the proposed defences. At SOC, the ‘main scheme’ defences were those between Netham Lock upstream and Entrance Lock downstream. These defences were set at the required SoP to protect receptors behind the defence, including freeboard for residual uncertainties. Other defences (generally those up- and downstream of

[24] Arup, “Economic Appraisal Technical Report,” 2020

the city centre) were set at the height required to prevent detriment with the phase 1 defences in place and climate change allowances applied to 2130.

During the modelling for this OBC, it was determined that the required defence height to provide flood protection in 2069 (including freeboard allowance) was at or above the level required to prevent detriment in 2130 (which does not include freeboard). It was therefore agreed with BCC and the EA that all defences downstream of (and including) St Anne's should have a consistent design basis as below:

- All Phase 1 flood defences to provide the required SoP based on 2069 epoch year and include freeboard allowance.
- All Phase 2 flood defences to provide the required SoP based on 2130 epoch year and include freeboard allowance.
- Phase 1 and Phase 2 flood defences to be sufficiently high to prevent detriment to properties based on agreed detriment criteria (given in the OBC modelling report, Appendix D).

The advantages of this approach are a clear narrative on the purpose of defences whilst a greater number of properties will be better protected for either no increase or a marginal increase in cost. During detriment mitigation modelling, some defences were locally increased to ensure compliance with the design basis.

Upstream of St Anne's, an analysis of receptors was carried out to determine where detriment mitigation measures were required, extending as far upstream as Swineford. Further information is available in the OBC modelling report (Appendix D).

3.5.3 Practical betterment

Following detriment mitigation modelling, an analysis of the required measures showed that upstream of Bristol, the flood depths in 2130 before any defences are built are predicted to be over 3m in places. Any detriment caused by the construction of defences was relatively small in comparison (between 100 and 300mm). As these areas are undefended, constructing raised defences to prevent all detriment in 2130 would result in some cases in prohibitively high defences (up to 3.5m in some areas). The majority of the affected receptors were either properties where the views of the river would be entirely blocked by a defence (significantly reducing property values and having a high likelihood of challenge) or businesses requiring waterfront access (such as marinas). It was therefore agreed in conjunction with the Environment Agency that this was likely to be unacceptable to the affected homes and businesses, so a 'practical betterment' approach could be taken with agreement from those landowners. In these instances, defences could be constructed or measures put in place to reduce the risk of flooding in more frequent (lower return-period) events, but not preventing detriment in 2130 to the design events. Details of the measures assumed for costing in this business case are provided in section 3.9.

3.5.4 Damages assessment

Economic losses from the predicted flood risk have been estimated using the Flood Hazard Research Centre's Multi Coloured Manual (MCM)[25] methodology. The avoidance of damage from flooding to residential and non-residential property fabric and contents is the principal benefit for the purposes of the economic assessment (so called 'direct' damages).

In addition, the below 'indirect' damages have also been estimated:

- Emergency Services
- Utilities damages
- Indirect commercial impacts due to flooding to businesses
- Costs of evacuation
- Vehicle damages
- Risks to Life
- Mental health
- Intangible Health Benefits
- Rail disruption
- Traffic disruption
- Erosion impacts – similar to those experienced following the recent Cumberland Road bank failure (see 2.13.2)
- Impact of rapid drawdown of the Floating Harbour
- Carbon emissions avoided
- Active travel benefits
- Environmental benefit (EHOV)
- Heritage & Cultural impact
- Recreation & Amenity impact

The shortlisted options for the economic assessment were as follows:

- Do Nothing
- Do Minimum
- Construction of flood defences

3.5.4.1 Do Nothing

Under the Do Nothing scenario, the flood gate protective structures at Netham Lock and Junction Lock are no longer powered, supported or maintained. In the

[25] Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal, 2013 Flood Hazard Research Centre

absence of proactive management of the gates, they would not be closed on time. The lock gates at Entrance Lock managed by the Harbour Master are not constructed to hold back flooding from the River Avon. All lock and flood gates are modelled as being static and open. The sluices at Underfall Yard are modelled as failing in the open position, and the Northern Storm Water Interceptor Sewer (NSWI) remains operational.

The Avon through Bristol is not subject to active maintenance. However increases to roughness or bed levels have conservatively not been assumed in the Do Nothing scenario.

3.5.4.2 Do Minimum

The Do Minimum option assumes that the lock gate and flood gate protective structures at Netham Lock and Junction Lock are maintained and refurbished over the appraisal period so that, if operated successfully, they provide a significant reduction in flood risk in flood events.

The default modelled scenario in the Do Minimum is therefore that the locks are managed in a timely fashion prior to a flood event and are managed proactively during the event so that the levels of fluvial events entering the Floating Harbour do not cause flooding by being prevented from leaving the docks.

However, the locks have had near misses during past flood events, where due to equipment failure, electrical failures, and traffic disruption impacting on staff availability, flood control systems were difficult to operate. Although this has not caused a significant issue to date, it will become more of an issue as flood risks are increasing and events are becoming more common. Notably, the need for proactive management during a flood event requires multiple operations in advance of a flood event.

In flood events greater than a present day 0.83% AEP fluvial event, or a 5% AEP tidal event, flood flows bypassing the lock gates via the quays on either side are fast and deep, achieving hazard ratings of "*dangerous to most*" or above; and it may reasonably be considered that there is a very significant chance of failure to close the gates. In the largest tidal and fluvial events, the tide has been witnessed carrying significant volumes of debris, (including vehicles), which may impair the function of the gates.

The Do Minimum economic modelling reflects this by reverting to the outputs of the Do Nothing modelling in these events.

3.5.4.3 Construction of flood defences

As explained in Section 3.4.2, the assessment of flood defences is based on an adaptive approach to raised defences. A range of SoPs have been considered in the assessment, to facilitate assessment of the Decision Rule and to allow identification of a range of options for the development of the "Local Choice" preferred option, particularly with a view to management of climate change.

3.5.4.4 Development of flood defence options

As a starting point, scenarios have been built around the concept of constructing a scheme in 2029 on a precautionary basis, the standard of which will decline

against time to meet a given standard in 2069, at which point the defence will be raised again to a higher level, the standard of which will decline against time to meet the given standard in 2130 at the end of scheme life.

For example: To provide a 1.33% AEP SoP on this basis (and considering only the tidal component for now), the scheme would need to be built to the equivalent of a ~0.2% AEP SoP scheme in 2030. Over time, this SoP would decline, reaching a 1.33% AEP SoP in 2070. At this point in time, the scheme would be raised to what would be, in 2070, the equivalent of 0.05% AEP SoP. However, over time, this too would decline to a 1.33% AEP SoP by the end of scheme life.

This example is a good illustration of why this adaptive approach is necessary. Had the scheme not been raised in 2070, the 1.33% AEP scheme would have continued to decline such that by 2130, it would have had a SoP equivalent to a 63% AEP and the property it protected would be at risk of being written off.

On the other hand, to construct on a fully precautionary basis to the 2130 1.33% AEP SoP would have meant that, when constructed, the scheme would have had a SoP equivalent to the 2030 0.011% AEP event. This would be excessive, and it is noted that the defence heights in some locations are significant: their visual and amenity impact is reduced by deferring construction to the 2130 standard. The difference between 2069 and 2130 defence heights is typically 0.70 – 0.75m.

The options considered are for a 1.33% AEP, 1% AEP and 0.5% AEP SoP, as well as a combination of 1% AEP fluvial and 0.5% AEP tidal SoPs, consistent with NPPF requirements, and identified as the ‘Local Choice’ option at SOC.

3.5.4.5 Overlaps and apportionment

Flood defence projects are being considered at Frome and Pill, which both lie within the benefit area of the Flood Strategy. However these are both refurbishment projects aiming to restore degraded assets to their current level of service. The modelling for the Flood Strategy assumes a baseline in which the assets are already restored, and as such avoids claiming benefits addressed by those projects.

Surface Water flood maps and the Surface Water Management Plan have been reviewed for overlaps with the benefit area of the Flood Strategy. Where there are overlaps, properties and benefits have not been claimed.

The analysis into impacts on the local economy covers the same area geographically as the flood damage assessment. Where proposals are being assessed for their potential to unlock future development, care has been taken to manage overlaps.

Understanding of development proposals in Bristol has been informed by BCC datasets covering disparate development initiatives, generally in a near time frame of 0-10 years, consultation of BCC planning officers, and by various masterplan documents relating to Bristol’s more strategic and longer-term Growth and Regeneration initiatives.

For properties overlapped by proposed developments, it is assumed that damages are only accrued for a 5-year period. This is because the development

of those sites will lead to replacement of the properties on those sites with NPPF compliant construction.

For properties overlapped by Bristol's more extensive masterplan ambitions, the timelines of those masterplans have been considered. Damages can still be accrued until the expected delivery timelines of those developments. Properties can still be written off if at high risk in the Do Minimum and Do Nothing scenarios.

Benefits are presented as below on the basis of a single OBC. Given the intention to progress the project with multiple FBCs (see 4.1.4), at that stage benefits will be apportioned with multiple partnership funding calculators. It has been agreed that benefits will be apportioned on the basis of total cost (rather than receptors) given the interlinked nature of the Strategy where each FBC is required to be delivered for the Strategy to be successful.

3.5.4.6 Benefits

Capped PVD damages are shown in Table 12.

	Do nothing	Do minimum	1.33% AEP SoP	1% AEP SoP	NPPF Local choice	0.5% AEP SoP
Damages (£m)	2532	2285	277	270	253	252
Benefits (£m)	0	247	2255	2262	2279	2280

Table 12 – Summary of economic benefits of options

The strategy comprises a mix of core benefit areas, around which the strategy design has been developed, and areas that are protected from detriment. For the areas that are protected from detriment, it happens to be the case that higher flood defences at the core benefit area result in higher water levels (when compared with lower flood defences) at the areas protected from detriment. Essentially, higher flood defence levels reduce the relieving mechanisms that would have applied in exceedance events.

This does not mean that those areas are at worse flood risk, but it does mean that the relationship between their residual damages and the standard of protection is inverted when compared with the core benefit areas. The overall impact on residual benefits is however a balance between the direct protection provided by the detriment flood defences, and the raised residual risk. This leads to some inconsistencies between increased standards of protection, and reduced benefits.

3.5.4.7 Costs

Net present value costs of each option have been calculated as described in 5.1.1, and are summarised in Table 13.

	Do nothing	Do minimum	1.33% AEP SoP	1% AEP SoP	0.5% AEP SoP	Local choice
Capital works, 2020s (£m)	0	14	248.6	249.8	257.3	255
Capital works, 2070s (£m)	0	0	10.6	10.6	10.9	10.9
Whole life O&M (£m)	0	5	27.1	27.1	27.1	27.1
Whole Life Costs (£m)	0	19	286.3	287.5	295.3	293

Table 13 - Summary of NPV costs for each option

3.5.4.8 Benefit cost ratios

Having calculated the benefits and costs of each option, a benefit cost ratio, and the incremental benefit cost ratio (IBCR) can be calculated as per Table 14.

	Do nothing	Do minimum	1.33% AEP SoP	1% AEP SoP	NPPF Local choice	0.5% AEP SoP
Damages (£m)	2532	2285	277	270	253	252
Benefits (£m)	0	247	2255	2262	2279	2280
Whole Life Costs (£m)	0	19	286	288	293	295
Benefit Cost Ratio		13.0	7.9	7.9	7.8	7.7

IBCR to previous option	-	13.0	7.5	6.5	3.0	0.5

Table 14 - Benefit cost ratios for each option

3.5.4.9 Application of the Decision Rule

From the Do Minimum, an IBCR>1 is required to progress to a subsequent option. The analysis indicates an IBCR of 13.

From the 1.33% SoP, an IBCR>3 is required to progress to consideration of the next option, and this is achieved up to the NPPF Local Choice (a mixture of 1% and 0.5% SoP). However the IBCR from the NPPF scheme to the 0.5% SoP scheme is less than unity.

Therefore, the preferred option on economic grounds and the option that the calculation of Grant in Aid should be based on is the "Local Choice NPPF" scheme. This is effectively the greater of the 1% fluvial and 0.5% tidal flood defence levels SoP, initially constructed to the 2069 standard and uplifted to the 2130 standard by 2070.

The GiA associated with this option is **£197.7m**, based on the payments for outcomes shown in Table 15.

OM	Deprivation	Qualifying benefits	% benefits	Payment rate	Eligible FCERM GiA	%
OM1a	overall	£1,732,990,285	74.1%	6	£103,979,417	46.1
OM1b	people related	£593,000,000	25.4%	20	£118,600,000	52.6
OM2	20% most	£593,521	0.0%	45	£267,085	0.1
	21% to 40%	£2,439,437	0.1%	30	£731,831	0.3
	60% least	£8,924,976	0.4%	20	£1,784,995	0.8
OM3	20% most	£ -	0.0%	45	£ -	0.0
	21% to 40%	£ -	0.0%	30	£ -	0.0
	60% least	£ -	0.0%	20	£ -	0.0
OM4	habitat	£ -	0.0%	20	£ -	0.0
	rivers	£ -	0.0%	20	£ -	0.0
Total		**£2,337,948,220**	**pv max. eligible GiA**		**225,363,328**	

Table 15 - Payment for outcomes from the Partnership Funding Calculator

It should be noted that GiA rules may be subject to change, and with FBC submission not expected until 2028, there is a risk of this value changing.

3.5.4.10 Local Choice

The regional ambitions for the City of Bristol, such as Western Harbour and BTQ, merit the consideration of an NPPF-compatible SoP. Such a scheme would be constructed to the greater of the 100-year fluvial, or 200-year tidal SoP, with greater allowances for climate change. This is consistent with the preferred option on economic grounds.

3.5.5 Local benefits

The FCRM GiA funding is determined based on the national economic benefits flood damages avoided. The effects on the local economy, of interest to BCC, will not necessarily be taken into account in such an assessment, and these effects are set out in this section. The unit of impact is a monetary measure of the value added by businesses to the local economy termed Gross Value Added, GVA.

The benefits assessed include:

- The “first order” losses associated with direct flood impacts on commercial property.
- GVA losses saved through reduced flood risk to existing businesses.
- GVA earned through jobs created by the unlocking of development on the floodplain.
- GVA earned through jobs created by construction of the strategy and the unlocked development.
- GVA losses saved through reduced flood risk to the tourist industry.

The calculations and methodology are set out in more detail in Appendix E, and the results are summarised in Table 16. In terms of the local economy, the strategy will help deliver significant benefits through avoided damage to businesses and infrastructure, avoided disruption to local businesses and the creation of construction jobs. The Bristol tourist industry is centred on the Floating Harbour as an aesthetic heritage site and the absence of investment in the Strategy could effectively lead to a significant portion of this industry being written off.

Even this estimate does not account for the potential value to the wider West of England of avoiding blight and frequent flooding to the commercial and cultural heart of the region.

Category	Benefit to Local Economy compared with Do Nothing (£m)
Direct benefits	
GiA compatible GVA	858
Tourism	354
GVA (construction of FAS)	23
GVA (Business Disruption avoided)	360
TOTAL Direct benefits	**1,595**
Indirect benefits (unlocked development) – general development	
GVA commercial development enabled	1,860
GVA construction	4
Indirect benefits (unlocked potential) – Temple Gate & St Phillips enabled	
Net GVA commercial development enabled	3,447
Net GVA construction	11
Net residential expenditure	1,472
Net amenity benefits	101
Net Council tax receipts	137
Net Business rate receipts	13
TOTAL Indirect benefits	**7,045**

Table 16 - Potential local benefits of the Strategy

The bulk of these benefits are associated with growth from unlocked development. It is important to recognise that identification of the potential local benefit of the scheme is not the same as claiming all these benefits for funding applications. Flood risk is not the only infrastructure issue limiting/preventing development or enabling green transport infrastructure, and the benefits identified above would need to be apportioned across a range of infrastructure investments. However, without resolving flood risk, as a it is true to say that these developments might only proceed with significant delay or cost, if at all.

The city's ambitions for growth outside of the floodplain require an effective integrated transport network linking it to the city centre, and Bristol Temple Meads rail station is the key hub of that network. However, the station, and

routes to and from the station are at risk of disruption from flooding, and the strategy proposals will form a key part of making this ambition effective.

3.6 Environmental appraisal

Prior to the OBC stage, a number of environmental studies were undertaken to assist in the development of the project's Strategy and feed into the options appraisal process at key stages. As part of this BCC chose to commission a Strategic Environmental Assessment (SEA) which was undertaken in 2017[26]. The aim of this was to identify significant positive and negative effects and ensure the surrounding environment was considered during decision making.

Following this, BCC commissioned Arup to continue the development of the Strategy which needed to consider the combination of fluvial inputs and tidal flows and their impacts on the core areas of Bristol. Arup undertook a SEA Addendum[27] which looked at changes to the Strategy as a result of the flood risk modelling undertaken on the preferred approach and provides an update to the original SEA report to review the environmental impacts to align with the amended Bristol Avon Flood Strategy.

3.6.1 Preliminary Draft EIA Scoping Report

The Strategy is considered an Annex II development under the EIA Directive: 10 (f) Inland-waterway construction not included in Annex I, canalisation and flood-relief works. As such, a full EIA will be required as part of the planning application for the Proposed Development. A Preliminary Draft EIA Scoping Report has been written for the OBC stage. The purpose of this has been to both inform the scope of the Full Business Case (FBC) and to prepare for the formal submission of the EIA Scoping Report to the determining authority. This will be undertaken in FBC.

The report sets out the need for the strategy and the site context, the policy context surrounding it, a high level approach to the EIA methodology and outlines those topics considered to have the potential for significant effects. The key environmental topics were identified as Cultural heritage, Biodiversity, Ground conditions and contaminated land, Townscape and visual impact and Water environment and flood risk. Other topics which require further studies to determine whether they would be included in the scope of the EIA were identified as Air quality, Noise and Vibration, Traffic and transportation, Climate change and greenhouse gases, Socioeconomics and Health and communities.

The consenting route for the full EIA has not yet been confirmed (see section 2.4), but will likely be submitted under the Transport and Works (Application and Objections Procedure) (England and Wales) Rules 2006 (S.I. 2006/1466)

3.6.2 Preliminary Ecological Appraisal

A Preliminary Ecological Appraisal (PEA) has been prepared for the Proposed Development as part of the OBC. This identifies any ecological opportunities

[26] AECOM, "River Avon Tidal Flood Risk Management Strategy - Strategic Environmental Assessment: Environmental Report," 2017.

[27] Arup, "River Avon Flood Risk Management Strategy - SEA Addendum," 2020.

associated with the Strategy and outlines mitigation measures required during construction. It considers ecological sites within the study areas including SACs, SPAs, a Ramsar site, SSSIs, NNRs and LNRs amongst others. UK Habitat Classification surveys were undertaken to identify habitats within the study area and their potential to support protected and notable species. The PEA also sets out further potential surveys including National Vegetation Classification, hedgerow, bat, badger, dormouse, otter, water vole, breeding and wintering birds, reptile, eDNA for great crested newts, terrestrial and aquatic invertebrates, and invasive and non-native species (INNS). Consultation with relevant stakeholders, including local Councils and Natural England, is outlined for the next stage.

3.6.3 Biodiversity Net Gain (BNG)

As part of the Environment Act 2021[28], there will be mandatory requirement for new developments to provide BNG. This will require planning applicants to demonstrate that proposals will achieve at least a 10% increase in the level of biodiversity after the development, when compared to the level of biodiversity pre-development. This mandate will come into effect in England from January 2024[29]. Given the anticipated programme for this Strategy, it is likely that BNG will be mandatory at the time of any planning submission. BCC also provide a focus and framework for securing net gain within the cities 'Green Infrastructure' policy[30], and the Ecological Emergency Action Plan / Strategy[31,32].

In compliance with legislation and policy, the Strategy will deliver a minimum of 10% BNG, with an aspiration to deliver 20% BNG. Surveys were undertaken across May and June 2022 and April and May 2023, working to the BNG Metric v3.1. All accessible areas of each site included within the Strategy were walked and existing habitats were mapped and subject to condition assessments, in accordance with the latest guidance at the time for UK Habitat Classification (version 1.0)[33]. The intertidal habitats were assessed using EUNIS habitat classification as per BNG guidance as UK Hab methodology is not suitable for these habitats. These surveys were undertaken in August 2022 and May 2023. The purposed of this initial BNG survey and assessment was to understand the scale of habitat unit loss from the proposed development, and to provide

[28] UK Government. Environment Act (2021). Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted . [Accessed online 26/10/2022]

[29] https://www.gov.uk/government/news/biodiversity-net-gain-moves-step-closer-with-timetable-set-out#:~:text=Under%20the%20updated%20timetable%20set,for%20example%20by%20creating%20new [Accessed online 24/10/2023]

[30] Bristol City Council. (2019). Bristol Local Plan Review. Draft Policies and Development Allocations. Available at: file (bristol.gov.uk) [Accessed online 10/09/2022].

[31] Bristol City Council. (2020). One City Ecological Emergency Strategy. Available at: One-City-Ecological-Emergency-Strategy-28.09.20.pdf (bristolonecity.com) [Accessed 10/09/22].

[32] Bristol City Council. (2021). Ecological Emergency Action Plan 2021-2025. Available at: Bristol Ecological Emergency Action Plan [Accessed 10/09/2022].

[33] UKHab. (2020). UK Habitat Classification System. UK Habitat definitions. Available at: https://ukhab.org/ukhab-documentation/ (Most recent update September 2020). [Accessed 20/09/22].

recommendations for avoidance of habitat loss, and general application of the mitigation hierarchy[34], through the design process. Recommendations for habitat creation and enhancement are also provided. At OBC stage, the landscaping and BNG proposals to deliver the required levels of net gain have not been designed, but an allowance for placemaking measures and environmental mitigation have been included in the costs. If compensating for losses within the development footprint is not possible, as a last resort, residual biodiversity losses should be offset by gains elsewhere. Offsets are distinguished from other forms of mitigation in that they are off the development site and require measurable conservation outcomes.

3.6.4 Habitats Regulations Assessment (HRA)

An HRA has been undertaken as part of the OBC stage and considers the impact of the construction and operational works on the following European Sites:

- Avon Gorge Woodlands SAC;
- Severn Estuary SAC, SPA and Ramsar site;
- Chew Valley Lake SPA;
- Norther Somerset and Mendip Bats SAC;
- Bath and Bradford-on-Avon Bats SAC; and
- Bristol Channel Approaches SAC.

Regulation 63 of the Conservation of Habitats and Species Regulations 2017, as amended by the Conservation of Habitats and Species (amendment) (EU Exit) Regulations 2019[35], requires a competent authority to undertake an 'Appropriate Assessment' of any plan or project (alone or in-combination with other plans and projects) which is likely to have a significant effect on the protected features of any European Site (unless the project is directly connected with the management of the site).

The pathway of effects to European Sites has been considered through design development of the proposed Strategy. An assessment is being undertaken to determine likely significant effects and will examine the potential effects, during construction and operation as a result of the proposed works.

3.6.5 Outline Heritage Desk-Based Assessment

An Outline Heritage Desk-Based Assessment (DBA) has been undertaken as part of the OBC in recognition of the significance of the historic environment which could be potentially impacted by the Proposed Development. The DBA provides a consistent baseline across the whole of the Site and has informed the design and scoping process. It will continue to inform design development and form the baseline for future impact assessment.

[34] CIEEM. (2019). Biodiversity net gain. Good practice principles for development. A practical guide. Available at: Biodiversity net gain. Good practice principles for development. A practical guide (cieem.net). [Accessed 15/10/22].

The designated assets included as part of the DBA are as follows: scheduled monuments; listed buildings; registered parks and gardens and conservation areas. Non-designated heritage assets have been identified from the lists of locally listed buildings and parks and gardens, Historic Environment Records (HER), previous assessments and walkover survey. The DBA includes details of the methodology used, based on current best practice, an overview of the historic environment baseline, an assessment of archaeological potential, an overarching statement of significance as well as individual and group statements and a complete gazetteer of all identified heritage assets.

3.6.6 Preliminary Water Environment Regulations (WER) Assessment

A WER assessment was first produced for the Strategy in 2017 and was updated in 2020 as part of the SOC. During the OBC, the WER assessment was updated again to encompass updates to WER legislation, WER status and objectives and developments in the design of the Proposed Development. The purpose of the WER assessment was: to identify relevant waterbodies which may be affected by the Strategy; set out the baseline; highlight aspects of the Proposed Development which may affect the waterbodies; identify any relevant mitigation measures which have formed part of the design; carry out a preliminary scoping assessment to identify the likely impact of the Strategy on the current status and status objectives of the waterbodies; identify any risks of non-compliance; and identify potential enhancement opportunities.

The assessment identified six surface waterbodies of which four were scoped in due to their potential to be affected: Bristol Floating Harbour, Bristol Avon, Trym and Brislington Brook. All three groundwater bodies – Bristol Triassic, Carboniferous Limestone and Portishead Mercia Mudstone – were also scoped in. The assessment concluded there was potential for minor localised adverse impacts on all the surface waterbodies scoped in as the construction of the defences with piling will reduce the aquatic habitat and potentially negatively impact the hydromorphology. This has the potential to negatively impact the ecological status of these waterbodies. The cumulative effects of multiple defence elements may also cause deterioration. There is also the potential for the piling to impact groundwater quality, levels or flows and further study is needed.

The assessment recommends that a full WER assessment is undertaken at FBC. It will evaluate the total combined length and percentage of the waterbodies affected to assess the overall impacts' significance, consider mitigation measures for adverse impacts, suggest enhancement opportunities and help to inform the development of the design.

3.7 Non-financial benefits appraisal

The objectives for the Strategy are as set out in section 2.8. The economic and flood-risk benefits have been described in previous sections, with the remaining objectives focussing on technical robustness, continuation of navigation, environmental sustainability and the facilitation of growth.

The preferred raised defences option will leave navigation requirements largely unchanged, and opportunities for enhancing capabilities (for example, greater

separation between public and operational areas) have been discussed and incorporated into the design. Further consultation is planned at FBC.

Environmental assessments are described in section 3.6.

3.7.1 Development opportunities

A key objective of the options was to facilitate the sustainable growth of Bristol and the West of England by supporting opportunities for employment and residential land, and infrastructure. In particular, this includes areas of growth and regeneration at BTQ and Western Harbour (see section 2.14).

The Local Choice option described above allows an NPPF-compatible SoP to be in place for development and therefore is likely to be more attractive to potential developers.

An adaptive approach will also allow for integration between development opportunity and the Strategy, as discussed further in section 6.2.2. Lower defences mean greater flexibility to adapt to changing development needs. The Strategy will be reviewed and updated every 6 years following completion of phase 1. This will allow for review of climate change allowances and the evolving needs of the city. . However, there will also be the flexibility to incorporate higher defences into new development as sites come forward in the short term.

3.8 Strategy Carbon Impact

BCC, supported by the Environment Agency, will work to develop solutions that efficiently minimise whole life carbon impacts. Following the carbon management hierarchy, the Strategy can make a lasting contribution through options that avoid, reduce and replace carbon. Do-something options avoid the carbon impact of the emergency response and recovery prompted by widespread flood events in the absence of investment.

At SOC stage, the whole life carbon emissions of the leading option (raised defences) were compared with the option of a narrow tidal barrier, considered to be the lowest carbon of the alternatives on the shortlist described in section 3.4.1. This found that the narrow tidal barrier option had whole life carbon emissions 46% higher than the raised defences approach. As the raised defences option has remained the preferred option, other options on the shortlist have not been reassessed for their carbon impact. However, it is considered that the carbon impact of the raised defences option is considerably lower than the alternatives.

Throughout the design development, opportunities to reduce embodied carbon have been realised, for example:

- Reducing the length of the defence at St Anne’s North by ~250m.
- Reducing the required number and lengths of piles on Cumberland Rd.
- Utilising ‘passive’ rather than ‘active’ defences such as flood gates to reduce operational carbon emissions.

The Environment Agency's ERIC carbon planning tool was used to evaluate the whole life carbon emissions of the preferred option. Details are contained in the carbon calculator and supporting technical note (Appendix J).

The emissions associated with the construction stage are 31,100 tCO_2e, operation and maintenance are emissions 10,700 tCO_2e, and residual carbon (calculated to be required after the strategy's 100-year design life) is -1,800 tCO_2e.

Given the limitations of the tool and the unknowns associated with the project design, it is suggested that a 50% contingency (similar to the optimism bias described in 5.1.4) is applied to the capital carbon value.

This gives a whole life carbon value of 55,600 tCO_2e. As would be expected, the majority of emissions are from the materials associated with construction of the defences. Opportunities for reducing emissions include:

- Refinement of the design through the detailed design, in particular whether more existing structures can be utilised
- Incorporating NFM measures (see 3.9.3), where there is an opportunity for measures to sequester around 450 tCO_2e annually.
- Inclusion of wider placemaking and habitat creation measures to sequester carbon
- Working with contractors to identify measures of reducing construction emissions from plant, construction methods and materials.

Do-something options avoid carbon impacts for example, from the emergency response and significant repair and recovery prompted by flood events in the absence of investment. The calculated figure for carbon avoided in this way is over 1,366,000tCO_2e.

3.9 Preferred option

As described in the preceding sections, the preferred way forward is to construct raised defences in the Strategy area, from Shirehampton and Pill, through central Bristol and upstream to Keynsham and Swineford. These will be constructed in two phases. The extent of the defences is shown in the drawings in Appendix C.

The preferred option specifies the construction of defences to the SoP required for 2069 starting in the 2020s. It should be noted that the hydraulic modelling report (Appendix B) suggests additional hydraulic modelling, in particular if new data or climate change guidance is available, or changes to the planned alignment of defences. It also recognises the opportunity to reduce the height of some defences, particularly where this is significant floodplain volume behind the flood defence such as at Ashton and Pill. The levels presented in this section are therefore subject to change.

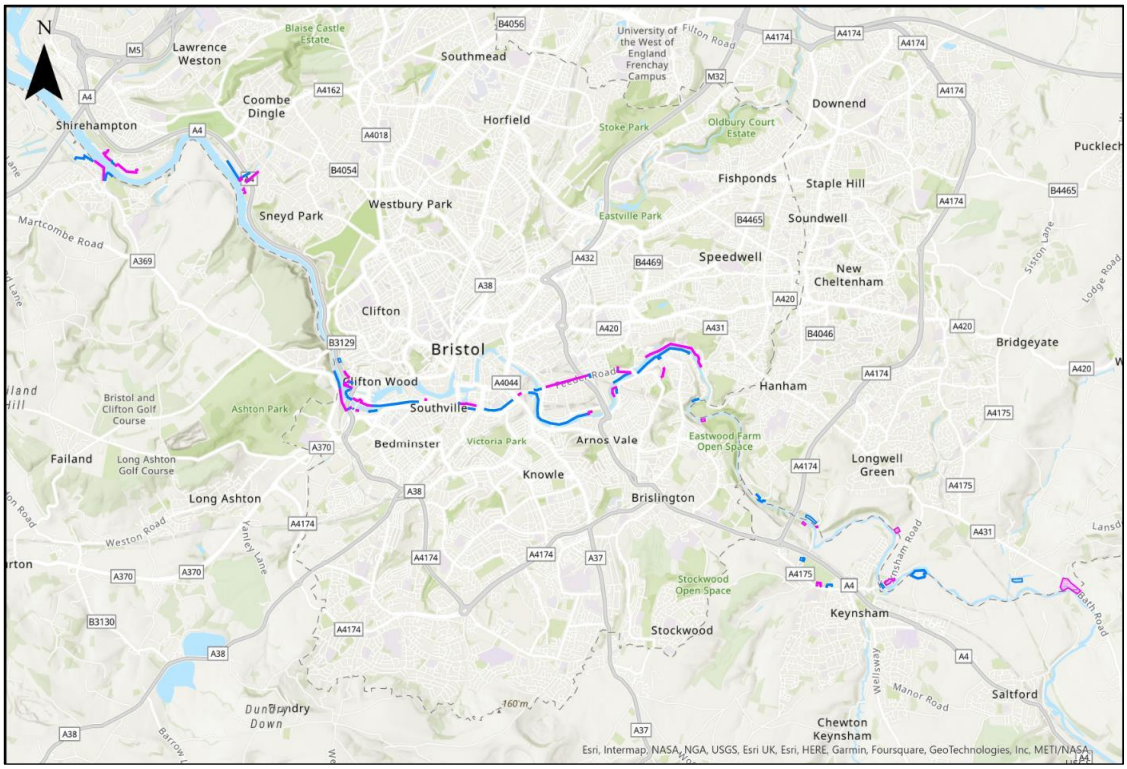


Figure 22 - Extent of Proposed Measures – different colours denote a change in defence type (for details see Table 17)

3.9.1 Engineering design

Significant optioneering work has been carried out for the Strategy. These were summarised in the SOC, where the leading option was selected as raised defences, with defences constructed in the 2020s to a chosen SoP in 2069, and then raised to provide protection in 2130.

At SOC, costs were based on a bottom-up approach, including optimism bias and an allowance for public realm enhancements. These are described in detail in the SOC and an engineering baseline report was produced in June 2022 to summarise the leading SOC option.

The design of the defences at OBC stage has been influenced by a wide range of factors and inputs, including:

- Significant hydraulic modelling has been carried out to understand the required extents and heights of defences, explained further in the baseline modelling report and OBC modelling report (Appendix D1 and D2).
- Heritage desk-based assessment (Appendix I).
- Preliminary Ecological Appraisal (PEA) Report (Appendix I).
- Geotechnical desk studies and feasibility reports (Appendix C).
- Workshops with BCC and the Environment Agency, including those with knowledge of the BTQ and Western Harbour developments.
- Workshops with BCC's harbourmaster and operations team.

- Buildability input with ESE contractor BAM Nuttall.
- Carbon study and workshops (Appendix J).
- Updated topographical surveys in some areas.
- Harbour condition surveys by BCC.
- Site visit to the Cumberland Road stabilisation works and input from contractor Alan Griffiths Contractors.

The updated engineering design is summarised in Table 17 with reference to its associated plan in the figures below. It should be noted that some of the maximum defence heights are from areas with limited topographical information, or are limited to very isolated areas on a defence section. The plan reference are those included as part of the Preferred Options report in Appendix C. Note that the average height is above the existing ground or, where noted in the description, existing defence levels. Defences marked 'SoP' are those providing the required standard of protection.

Plan Ref	Name	Description	Defence Group	Phase 1 Level (mAOD)	Length (m)	Avg. Phase 1 Height above GL (m)
1	Avon Road Embankment	Raise existing embankment	SOP	10.29	530	0.79
2	Marine Parade	Raise existing sheet pile wall	SOP	10.30	440	0.90
3	Watch House Road Floodwall	New floodwall (piled and gravity)	SOP	10.31	320	1.31
4	Lamplighters Embankment	New embankment	SOP	10.30	320	1.60
5	Station Road Floodwall	New gravity floodwall	SOP	10.31	80	1.61
6	Sports Field Embankment	New embankment	SOP	10.32	490	0.62
7	Railway Floodwall North	New gravity floodwall	SOP	10.38	300	0.28
8	North of Tyrm Embankment	New embankment	SOP	10.38	120	2.08
9	Railway Bridge Parapet Retrofit	Bridge parapet retrofit	SOP	10.38	100	0.40
10	Allotment Properties	Raise existing floodwalls	SOP	10.38	170	0.50
11	Railway Defence	New piled floodwall	SOP	10.38	30	0.48
12	Sea Mills Lane Embankment	New embankment	SOP	10.38	310	1.98
13	Riverside Path Floodwall	New gravity floodwall	SOP	10.43	410	1.53
14	Brunel Open Space Embankment	New embankment	SOP	10.20	460	0.40

15	Brunel Way Viaduct Floodwall	New gravity floodwall	SOP	10.20	25	0.40
16	Metrobus Road Raising	New road raising	SOP	10.20	10	0.80
17	Pump Station Floodwall	New gravity floodwall	SOP	10.44	50	0.84
18	Payne's Shipyard Floodwall	New piled floodwall	SOP	10.45	160	1.35
19	Hotwell Road PFR	New PFR	SOP	10.43	N/A	1.03
20	Hotwell Road Floodproofing	New floodproofing	SOP	10.43	120	1.43
21	Bennet Way Floodwall	New gravity floodwall	SOP	10.08	60	0.08
22	Cumberland Basin Road Raising	New road raising	SOP	10.08	10	0.78
23	Entrance Lock Gates	New lock gates	SOP	10.08	25	n/a
24	The Knuckle Floodwall	New piled floodwall	SOP	10.08	180	1.88
25	Brunel Dam	Raise existing structure and floodproof	SOP	10.07	20	n/a
26	Off Ramp	New gravity floodwall	SOP	10.06	45	1.06
27	Bonded Warehouses	New floodwall (piled and gravity) and road raising	SOP	10.30	500	1.50
28	Chocolate Path Floodwall	New piled floodwall	SOP	10.29	770	1.89
29	Cumberland Road Rail Bridge	New floodgate	SOP	10.11	10	1.81
30	Bathurst Dam	Raise existing structure	SOP	10.09	10	1.75
31	Commercial Road Floodwall	New floodwall (piled and gravity)	SOP	10.21	320	0.81
32	Clarence Road Floodwall	New piled floodwall	SOP	10.25	620	1.25
33	Cattle Market Road Floodwall	New piled floodwall	SOP	10.12	90	0.62
34	Coronation Road Floodwall (Phase 2)	New gravity floodwall	SOP	10.08	60	n/a
35	Albert Road Floodwall	New minipile floodwall	SOP	10.25	1520	1.25
36	Sparke Evans Park Embankment	New embankment	SOP	10.20	250	0.9
37	West of Avon Street Floodwall	New piled floodwall	SOP	8.76	200	0.06
38	East of Avon Street Floodwall	New piled floodwall	SOP	8.76	740	0.86
39	Tie into Railway Bridge Abutment	New road raising	SOP	8.76	10	0.86

40	Feeder Canal Flood Gate	New floodgate	SOP	10.91	50	n/a
41	Feeder Road Raising	New road raising	SOP	10.91	10	0.91
42	Netham Lock Floodwall	New gravity floodwall	SOP	10.91	250	1.41
43	Netham Weir Floodwall	New sheet pile floodwall	SOP	10.50	400	1.40
44	Avon Bank Floodwall	New gravity floodwall	SOP	10.54	240	0.34
45	Whitby Road Floodwall	New gravity floodwall	Detriment	10.54	100	0.24
46	North Bank	New minipile floodwall	SOP	11.29	1200	2.39
47	South Bank	New sheet pile floodwall	SOP	11.29	1100	1.29
48	Chapel Way Floodwall	New gravity floodwall	Detriment	11.15	220	0.85
49	Pump House Lane Floodwall	New piled floodwall	Practical Betterment	10.50	70	2.20
50	Beese's Bar	New PFR	Practical Betterment	n/a	n/a	n/a
51	Riverside Cottages Embankment	New embankment	Practical Betterment	10.50	190	1.27
52	Hanham Mills	New PFR	Practical Betterment	n/a	n/a	n/a
53	Ferry Road	New road raising	Practical Betterment	10	75	0.31
54	Lock Cottage	New PFR	Practical Betterment	n/a	n/a	n/a
55	Durley Lane	New PFR and wall floodproofing	Practical Betterment	n/a	60	n/a
56	Bristol Road West	New gravity floodwall	Detriment	11.70	140	1.40
57	Bristol Road East	New gravity floodwall	Detriment	11.70	140	1.40
58	Siston Brook	New PFR	Practical Betterment	n/a	n/a	n/a
59	Marina	New PFR	Practical Betterment	n/a	n/a	n/a
60	Lock Keeper Pub	New PFR	Practical Betterment	n/a	n/a	n/a
61	Broadmead Industrial Estate	New piled floodwall	Detriment	12.10	800	1.10
62	The Meadows	New PFR	Practical Betterment	n/a	n/a	n/a
63	Bath Road, Swineford	New PFR	Practical Betterment	n/a	n/a	n/a

Table 17 - Summary of proposed defences. *indicates height above existing defence rather than height above ground level.

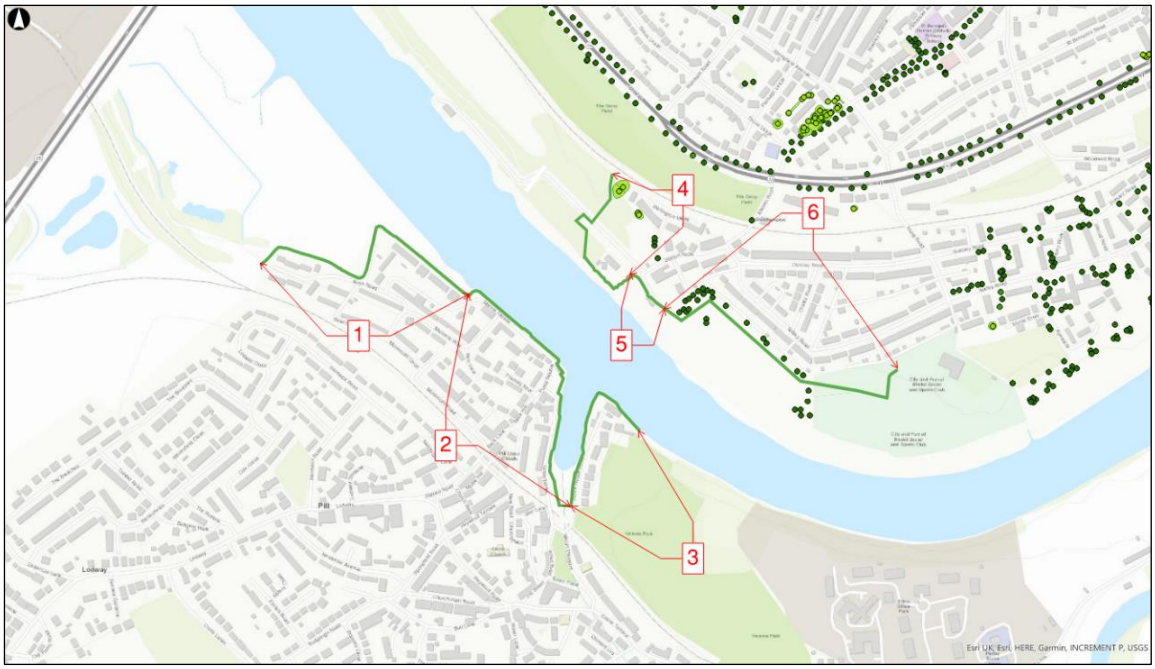


Figure 23 - Layout Plan - Pill & Shirehampton

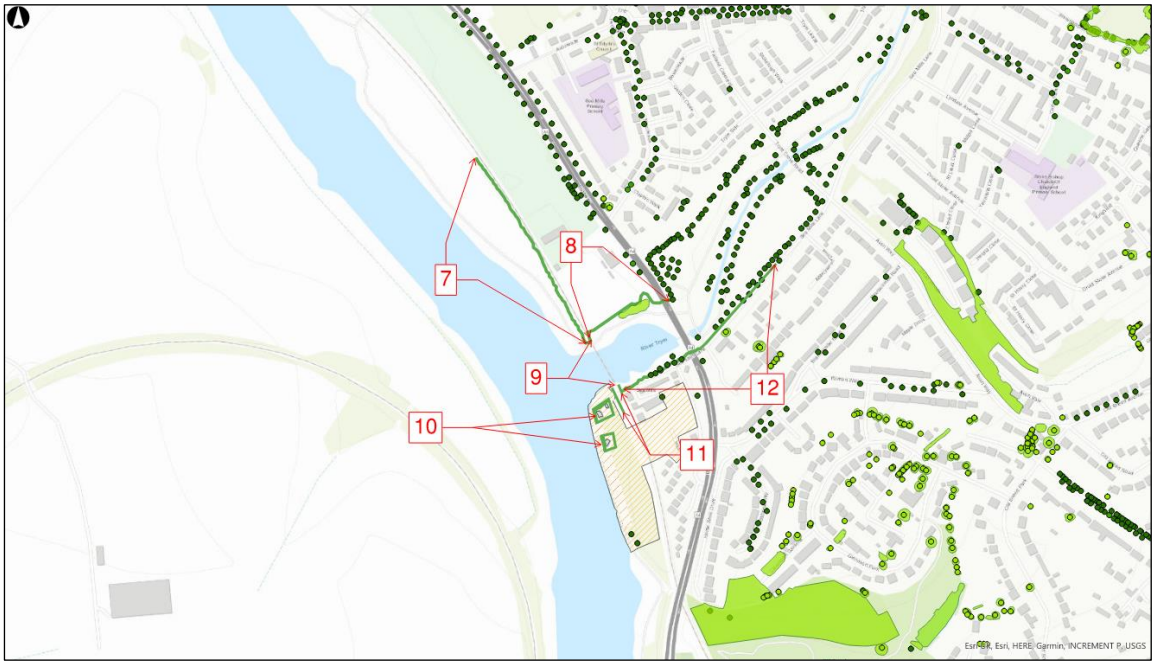


Figure 24 - Layout Plan - Sea Mills

Figure 25 - Layout Plan - Bower Ashton, Entrance Lock and Spike Island

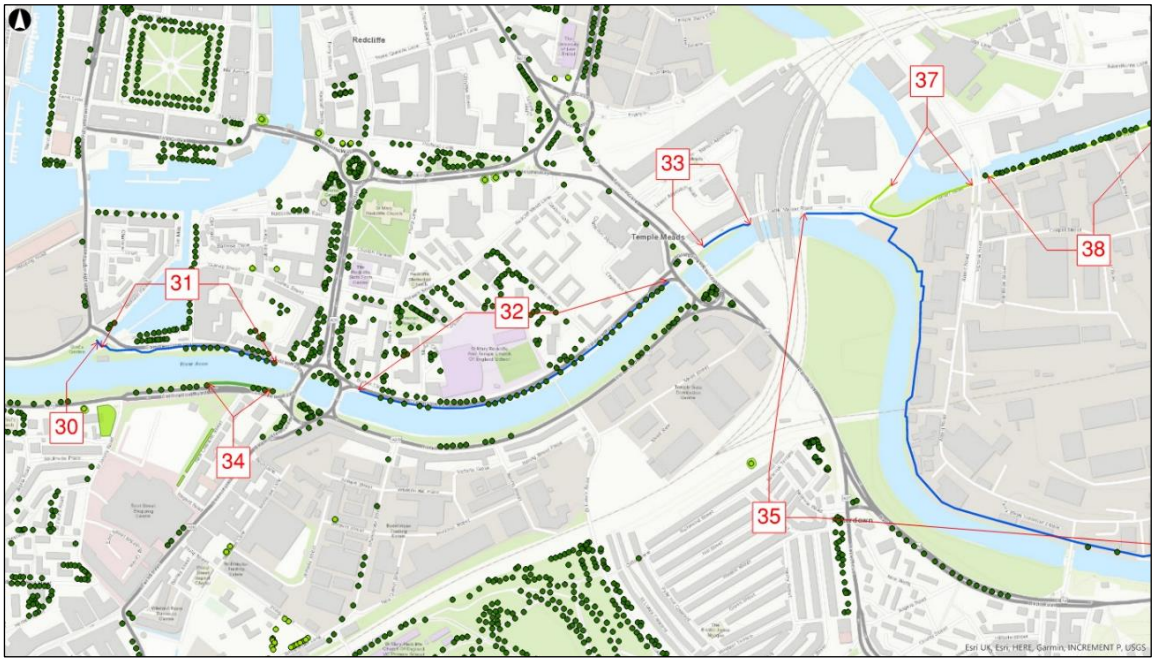


Figure 26 - Layout Plan - Redcliffe, Feeder Road and St Philip's Marsh

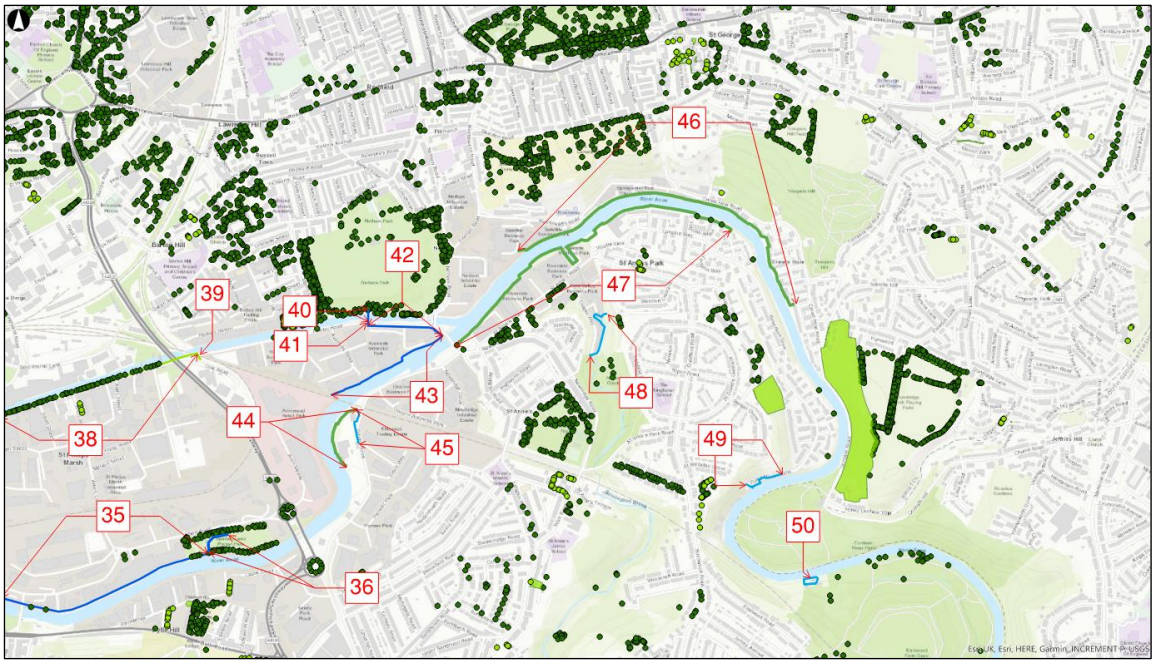


Figure 27 - Layout Plan - Feeder Road, St Philip's Marsh, Netham Lock, St Anne's and upstream

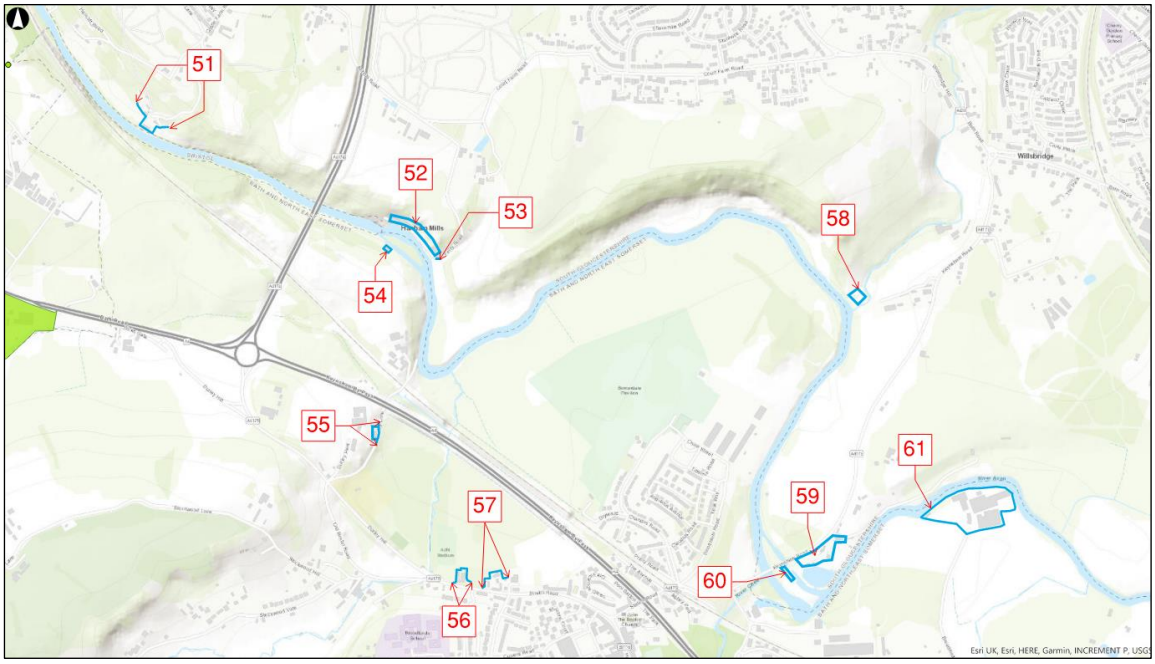


Figure 28 - Layout Plan – Upstream of A4174

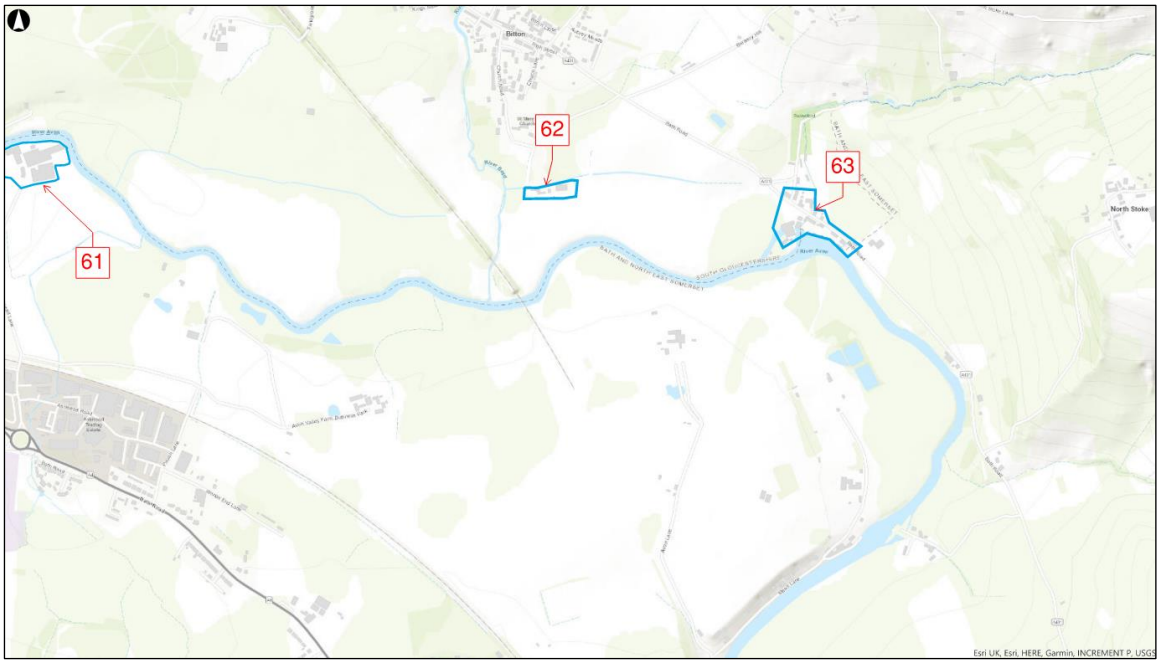


Figure 29 - Layout Plan – Broadmead industrial estate to Swineford

3.9.1.1 Raised defences

In general, defences constructed during phase 1 will be parapets, typically 0.5-1.5m above general ground level, allowing people seated beside immediately adjacent footways or paths unobstructed views of the horizon. Where defence heights do not allow this, measures have been designed to reduce the relative defence height (for instance ground raising or a raised path) to maintain views. It should also be noted that many of the higher defences (such as Cumberland Rd and Albert Rd) are designed to have active travel infrastructure on the river side, allowing unobstructed views outside storm events. Where possible, the route of the defences follows existing walls or other riparian assets.

High defences proposed through Epoch 2 (2069-2130) will be designed to allow for the impact of sea level rises and could require defences to be increased in height a further 0.7m-0.75m. Many defences require construction to their full height in phase 1 to comply with detriment mitigation criteria.

3.9.1.2 Flood gates

The existing lock gate infrastructure at the downstream (Western) end of the floating harbour are designed to maintain the Floating Harbour water levels, when this level is above that in the River Avon. They also have the facility for locking vessels out of the Floating Harbour. When levels are higher in the Avon, the gates are opened and levels are equal in the harbour and river. A key part of the Strategy will be raising the outermost set of lock gates, and changing their design to prevent high water levels in the Avon from entering the harbour and causing flooding.

The same is true at the upstream (Eastern) end of the harbour at Netham. Here, a lock gate allows passage between the River Avon upstream and the Floating Harbour when levels are different. The Strategy proposes a new flood gate on the Feeder Canal which will be open in normal conditions, but shut in flood

conditions. Existing road and bridge infrastructure prevents raising and adapting the existing lock gates (as explained in the preferred options report in Appendix C), although there may be an opportunity to revisit this based on the potential changes to Brislington New Bridge (see 2.14.11)

3.9.1.3 Development interface

The Strategy has been developed with flexibility in mind. For instance, BCC can work with potential developers to incorporate the appropriate SoP into new developments. This may involve bringing forward the delivery of flood defences in areas of developments or changing designs to fit with those constructed by developers. It is also possible that some areas could be delayed to avoid defences being constructed by BCC only to be replaced by developers. However, this would require agreement to ensure that there is not an unacceptable risk to properties should development be delayed.

This is most likely in the Western Harbour (ref. 14-27) and St Philip's Marsh (ref. 35-39) areas of growth and regeneration. Other developments such as the consented Payne's Shipyard will be required incorporate their own flood defences once developed, negating the need for further defences (in this case near ref. 18).

In these areas, the designs outlined in Table 17 and Appendix C should be viewed as a 'backstop' option to allow the costing and assessment of the Strategy, but the preferred outcome is for these areas to be developer-led, allowing the defences to be better integrated into future developments and utilising a wider river corridor.

3.9.2 Placemaking

Flood defences can be integrated into wider multi-functional public realm infrastructure. At SOC stage, a placemaking opportunities study explored aspirational opportunities that align with the Strategy's strategic objectives. The study focused on four character areas, shown in Figure 30. It also shows the network of green spaces around the River Avon and the opportunity to create a green corridor for health, wellbeing and wildlife benefits. The corridor has many strategic transport nodes with the potential to establish strong connections along the E-W river corridor with N-S links into the city.

Figure 30 - Network of green spaces identified around the River Avon to create a green corridor

At this OBC stage, opportunities and constraints for each area have been identified in relation to public space functions, movement, accessibility,

biodiversity, heritage and views. These have been recorded in the Opportunities and Constraints drawings (Appendix C).

Following this, placemaking opportunities were integrated with the flood defences design and optioneering to align the preferred option with the opportunities identified. The sections in Appendix C show indicatively how public space interventions can be incorporated into the new designs.

For costing purposes, indicative quantities of landscaping materials including cladding, surfacing, benches and tree planting were used to ensure sufficient placemaking allowances in the construction cost. Additional allowances for measures to address biodiversity net gain are discussed in 5.1.1.

The opportunities identified relate to the preferred option design for the scheme described in this section. However, it should be noted that there are additional opportunities for integrating more ambitious placemaking interventions through coordination with the areas of growth and regeneration mentioned in 2.14. Primarily, this would be achieved through having a wider available river corridor in which to construct defences.

Placemaking has been incorporated into the Landscape and Townscape Character sections of the Draft EIA Scoping Report as well as Visual Amenity. Sensitive receptors have been identified and general mitigation measures proposed.

Due to the sensitivity of the areas affected by the proposed flood defences, a comprehensive package of works for public space design, including mitigation measures and enhancement will be required at the detailed design stage.

3.9.3 Natural Flood Management (NFM)

As discussed in section 3.3, NFM was excluded from the shortlist of options for the strategy overall due to the required scale of interventions upstream to be effective, and more fundamentally, the need to protect against tidal flooding. However, it is recognised that NFM measures can mitigate localised flood risk from pluvial and fluvial flooding within the study area. NFM also has the opportunity to provide wider benefits including enhancing habitat and sequestering carbon. Moreover, implementation of NFM aligns with the objectives outlined in the Bristol City Climate Change Strategy to achieve by 2030.

An NFM assessment (see Appendix I) has been undertaken to identify NFM opportunities throughout the River Avon catchment and estimate the storage and peak flow mitigation potential within its sub-catchments. As part of the assessment high-level cost and carbon sequestration calculations have been carried out for two sub-catchments of focus within the River Avon, the Brislington Brook and the Malago. A site visit validated the mapping through ground truthing of the identified NFM features, as well as identifying potential additional opportunities.

The storage modelling results show that Brislington Brook could store 20,500m^3 within the catchment, with a downstream mitigated impact of 12.3% during a 1 in 100-year return period fluvial flood event. From the opportunity mapping, the Malago catchment was indicated to be able to store 6,000m^3, with a downstream

mitigation impact of 3.7% during a 1 in 100-year return period fluvial flood event. The site visit indicated that there may be potential for more ambitious NFM interventions within these catchments than those detailed by the opportunity mapping, which is underpinned by conservative assumptions.

Following on from this work, an expression of interest was submitted by BCC to take part in the Environment Agency's new NFM Programme. Successful submissions are expected to be announced in early 2024. If Bristol is successful, the works proposed in the Malago catchment area will be complementary to the Strategy.

Further work is planned to quantify the potential benefits to property and infrastructure in terms of flow reduction on the Brislington Brook and Malago, as well as BNG and water quality improvements.

3.10 Residual risk

Residual risk for the Strategy has two main elements: risks associated with the failure of the defences and risks associated with events occurring which exceed the design parameters of the defences.

It should also be noted that some flooding will still occur in the design event once the Strategy has been implemented, however as demonstrated in Figure 31 and Figure 32 **the reduction in flooded area for the city of Bristol is significant for each SoP**.

For all figures, the smaller flood extent is placed on top of the next smallest flood extent. Therefore, the green areas show the additional flooding from the 1.33% AEP SoP option compared to the 1% AEP SoP option and the light blue areas show the additional flooding from the 1% AEP SoP option compared to the 0.5% AEP SoP option.

The results show significant areas of Bristol would benefit from the proposed scheme even if a 1.33% AEP SoP was selected. The 1.33% AEP and 1% AEP SoP results are similar. While there is significant benefit for fluvial events, there is greater benefit in tidal events. The benefit in 2130 is significantly greater than in 2069 due to the significant increase in flooding between 2069 and 2130 for the baseline Do Minimum option.

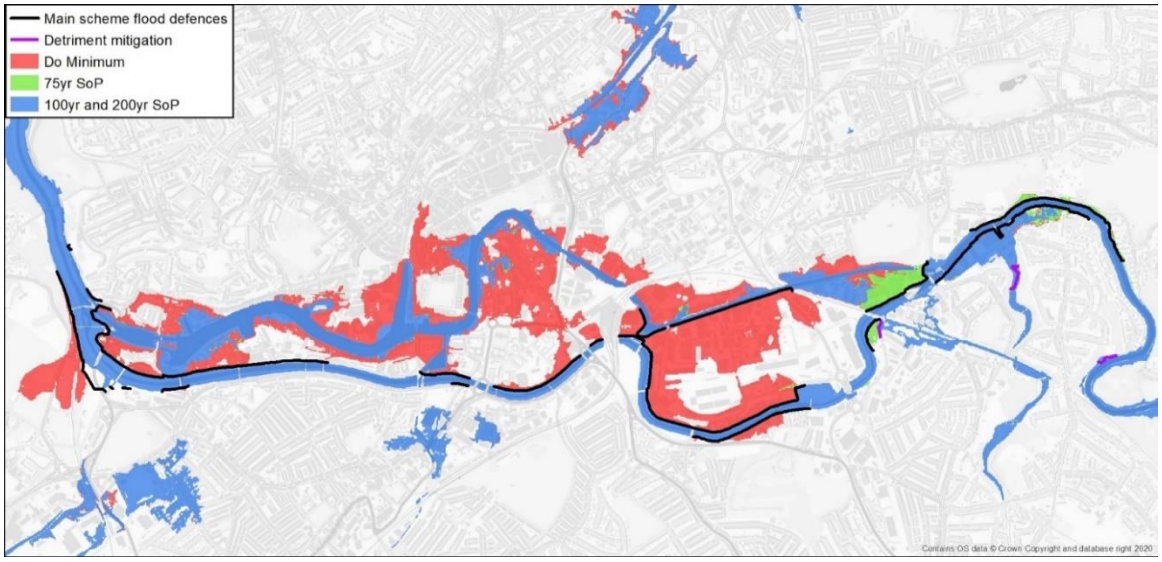


Figure 31 - Flood extents of raised defences options at local choice SoP vs Do Minimum for 2130 fluvial 1% AEP event.

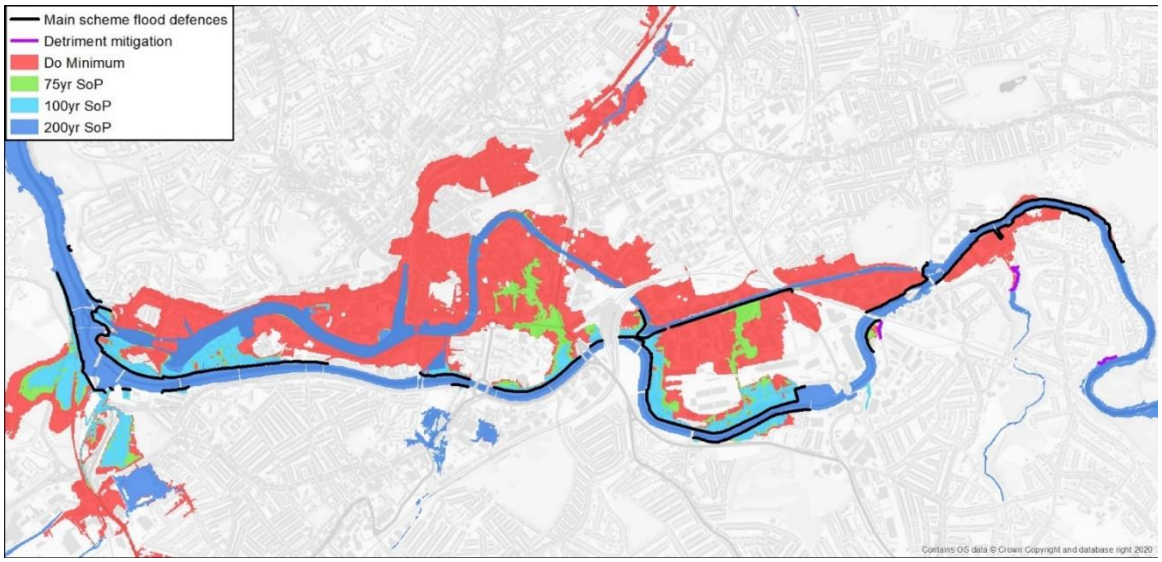


Figure 32 – Flood extents of raised defences options at local choice SoP vs Do Minimum for 2130 tidal 0.5% AEP event.

3.10.1 Risk of defence failures

The 2017 Strategy included model runs to investigate residual risk, including those associated with defence breaches at locations along the raised defence alignments and at entrance points to the Floating Harbour. For the worst case design event, the flood risk during a 2115 0.5% AEP event with Entrance Lock gates failing, led to flooding in areas around Entrance Lock, Junction Lock, Victoria Street, Temple Back and St Philip's. Failure of the proposed gates at Netham for the same event showed flooding in Netham and St Philip's. The flood risk associated with the breaching of raised defences was also modelled extensively.

It should be noted that this modelling considered only tidal flooding and will require updating at future stages.

When the preferred way forward is implemented, the chance of failure of the defences will be greatly reduced compared with the present day, considering:

- New flood gates will be constructed with multiple levels of redundancy to protect against failure.
- Most of the new defences are ‘hard’ defences (concrete walls, sheet piles or ground raising) and are generally not susceptible to failure.
- Defences will be designed to accommodate loading from the design water levels plus a freeboard allowance for uncertainty. In practice this will lead to them being designed structurally for a larger event

To reduce the risk of manually operated gates being incorrectly deployed during a flood event, current operations procedures will require updating and refining following the implementation of the Strategy.

3.10.2 Risk of events greater than the design flood

The process for choosing the SoP for the proposed defences is explained in section 3.5.4. It should be recognised that the Strategy is unable to completely protect the city and surrounding areas from flooding, since larger, rarer events can always occur, however unlikely. This is to some extent mitigated by the provision of freeboard on the defences, which increase defence levels in practice.

Residual risk analysis has been carried out to determine the impact on Bristol of climate change allowances greater than those allowed for in the design of the defences (see section 3.5.1), with the phase 1 defences in place. The scenarios are given in Table 18, and results are available in the modelling report (Appendix D).

With / Without freeboard?	Climate change allowances	Epoch	Flood event AEP
Without	Fluvial HC* & Tidal UE**	2069	Fluvial 1%
Without	Fluvial HC & Tidal UE	2069	Tidal 0.5%
Without	Fluvial CE*** & Tidal HC	2130	Fluvial 1%
Without	Fluvial CE & Tidal HC	2130	Tidal 0.5%
Without	Fluvial HC & Tidal UE	2130	Fluvial 1%
Without	Fluvial HC & Tidal UE	2130	Tidal 0.5%
With	Fluvial CE & Tidal HC	2130	Fluvial 1%
With	Fluvial CE & Tidal HC	2130	Tidal 0.5%

Table 18 - Climate change scenarios

*HC = Higher central allowance **UE = Upper end allowance

***CE =Central allowance

4.0 Commercial Case

4.1 Procurement strategy and timescales

4.1.1 Regeneration and Development

The Strategy sets out a clear route to deliver the safe management of flooding across the city without increasing flood risk elsewhere. Dependencies on which the Strategy could become reliant have been identified and mitigated to avoid barriers to reasonable certainty of delivery.

A proportion of the defences interface with areas of growth and regeneration (discussed in 2.14) where proposals are at an early stage of their development. Work on masterplans for these areas is expected to commence in 2024. Implementation of these plans is constrained and anticipated over the long term.

The preferred option approach for the Strategy is phased standalone flood defences. The Strategy avoids reliance on defences integral to new development, delivered over a period of time to a degree as the market dictates. However, integration of the defences into the urban landscape as part of developments offers many opportunities. To maximise these opportunities BCC has developed a phasing plan for the detailed design which aligns with the G&R masterplan programmes, focused on ensuring the flood defences will be integrated with high-quality public spaces in future developments, providing defences that benefit Bristol all year round, not just in times of flood.

BCC continues to work closely with the Environment Agency to ensure the Strategy is delivered in an appropriate timeframe to enable new development to rely on the proposed defences. The draft Local Plan provides new planning policy to support the delivery of the Strategy. The plan sets out the requirement for defences to be accommodated or implemented as part of development, and safeguards land for delivery. Prospective developers are provided with the details necessary to incorporate any mitigation measures to address residual risks through information provided in the Level 2 Strategic Flood Risk Assessment.

To deliver a flood strategy which achieves the wider benefits, some sections of the flood defences located in areas on Growth and Regeneration will need to be funded and delivered by the development. BCC will continue to work with private developers to seek agreement to integrate defences within proposals, along with gaining contributions towards the Strategy to address the additional funding requirement.

4.1.2 Maintenance

In accordance with FCRM GiA allocation (specifically the conditions relating to the Grant Memorandum), it is the responsibility of the Risk Management Authority (in this case, BCC) applying for the grant to obtain sufficient funds to carry out all maintenance operations for the proposed assets linked with the GiA allocation.

Where the projected maintenance and operational costs for the Strategy are existing, derived from the need to continue Floating Harbour operations, or relate

to defences which are replacing existing infrastructure within the harbour, these costs will be funded by the harbour authority.

Beyond this, BCC will be responsible for obtaining the funds to operate and maintain any new flood defence infrastructure, which will be sourced through a combination of BCC internal funds, external sources and in the form of commuted sums from third party owners who have incorporated flood defences within their developments.

The Environment Agency operate and maintain the tidal flood defences at Pill and Shirehampton. The Environment Agency also currently provide funding to BCC to operate the existing harbour stop gates under a Memorandum of Understanding. These principles will remain, even where existing infrastructure is replaced.

BCC and the Environment Agency have worked closely to develop a forecast for the operational and maintenance costs for the Strategy, as included in the OBC. With the Harbour Revision Order currently under review, the final decision on the split between operation and maintenance liability of assets between the harbour authority and BCC cannot be finalised. This will be completed during the FBC stage.

BCC and the Environment Agency have a Memorandum of Agreement and Collaborative Agreement in place, which sets out the respective roles and responsibilities. It is expected that a further legal agreement will be required to enable the Council to build and maintain the defences.

4.1.3 Procurement Strategy

Procurement of the Strategy will be in accordance with public sector procurement rules under the Public Contracts Regulations 2015, via the e-notification service Find a Tender (FTS). This will be achieved by following the HM Government's 'The Construction Playbook' – mandatory guidance on sourcing and contracting public works projects and programmes.

The focus of the Playbook is to get projects right from the start, including the procurement and management of public works projects. The Strategy's procurement strategy considers project outcomes to create the right environment to embed social value; utilising incentivised contracting arrangements (modern methods of construction) to deliver sustainable, whole life carbon approach based solutions that works for the city.

At SOC stage, the Strategy considered multiple OBCs, followed by a single FBC for the scheme. Through discussions with members of the LPRG, it was agreed that the strategy will deliver a single OBC, followed by multiple FBCs.

There are key considerations BCC need to assess when deciding on the number of FBCs required, these include:

- available funds.
- phasing requirements.
- priority works.

- complexity of design.
- early supplier involvement.
- skills, knowledge and experience of supply chain.

At FBC, the Strategy will undertake the detailed design, associated surveys and investigations, consenting, and supporting specialist advice and expertise required to successfully manage and deliver a major capital programme.

The Strategy will need to conclude its assessment of the preferred consenting approach. Through advice, it is understood that an application to the Secretary of State under the Transport and Works Act Order 1992 (TWAO) - including to grant planning permission to obtain powers to carry out and use works that interfere with navigation rights will be required. Recognising TWAO applications are a set of complex legal documents, BCC as promoter will appoint a legal advisor to act as their parliamentary agent, responsible for advising BCC on their application to the Secretary of State, and subsequent decision-making process.

Although the Strategy has been developed as a strategic approach to a single benefit area for GiA funding (plus measures upstream or downstream of central Bristol) to mitigate adverse impact, the multiple FBCs offer flexibility to lengths of defences within areas of Growth and Regeneration (Western Harbour and BTQ), with potential developer led opportunities, whilst always prioritising flood risk mitigation in the context of the overall flood risk strategy. The GiA benefits and funding will be apportioned between the FBCs.

An assessment of the procurement approaches for the construction phase has been undertaken, by BCC. A summary of the advantages and disadvantages are provided in Table 19 below.

Procurement option	Summary	Application for the flood strategy
Open Procedure:	In the open procedure, any interested supplier can submit a bid in response to a public sector procurement opportunity. This method is typically used for low to medium-value contracts where competition is encouraged.	**Not Suitable** for the full BAFS programme due to its overall size and complexity however this method could be utilised for smaller bespoke projects within the programme
Restricted Procedure:	In the restricted procedure, suppliers must express their interest in participating in the procurement process. Only those suppliers who meet the pre-qualification criteria are invited to submit bids. This method is used for more complex or high-value contracts.	**Not Suitable** for the full BAFS programme but as with the Open procedure could be utilised for a smaller standalone project or groups of projects
Competitive Dialogue (CD):	The competitive dialogue procedure is used for complex contracts where the contracting authority engages in dialogue with potential suppliers to identify the most suitable solution. This method is often used for innovative or technically challenging projects.	**Preferred Solution** as this method enables the specification to be developed through dialogue with potential bidders before award of contract(s). The focus of this method is more around the specification of the requirement and its delivery.
Competitive Procedure with Negotiation (CPN):	This method involves a competitive process where negotiations with selected suppliers are allowed. It is used for particularly complex contracts that require negotiation to determine the final terms.	**Possible Option.** A solution to appoint a delivery partner for the BAFS programme. The CPN method requires all bidders to submit an initial tender which can then each be individually negotiated. The focus of this method is more on price than the CD method.
Create BCC Framework Agreements:	Framework agreements are long-term agreements with one or more suppliers that establish the terms and conditions for future contracts. Public sector organizations can call off from these frameworks when they need specific goods or services without going through a full procurement process each time.	**Not Suitable**. A bespoke Framework to deliver BAFS would likely be too complex to put in place and would require multiple call offs to support the programme.

Innovation Partnerships:	Innovation partnerships are used when a public sector organization wants to develop innovative products, services, or works with the help of one or more partners. The process involves a competitive dialogue to select suitable partners.	**Not Suitable** for BAFS as the majority, if not all of the required works are in existence and therefore do not require an innovative/new solution.
Utilise existing Framework Agreements	Multiple Frameworks exist that could be utilised e.g. CCS, Pagabo, Scape and the Environment Agency's own Collaborative Delivery Framework.	**Possible Option** either for the entirety of the BAFS programme to appoint a delivery partner or for multiple call offs of individual projects. However framework total values, limited choice of suppliers and need for competitive prices restricts the value of this option for the Strategy.

Table 19 - Procurement options

4.1.4 Full Business Case

At this stage, the Strategy considers the following approach to the delivery of multiple FBCs:

- FBC1 - All defences outside of the areas of growth and regeneration.
- FBC2 - Defences linked to Western Harbour development area. Separating this particular interface/dependency to one area, allows alignment on programme and emerging design.
- FBC3 - Defences linked to BTQ development area. Again, separating this particular interface/dependency to one area, allows alignment on programme and emerging design.

Splitting the next stage into three FBCs provides the ability to react accordingly to the progress of G&R areas, whilst mitigating the reliance on the development of their masterplans to start design work on defences located elsewhere.

4.1.5 FBC Contract Strategy

There are multiple contract strategies, including but not limited to the following options as outlined in Table 20:

- a traditional design-bid-build.
- a specialist design and build contract (fixed price or target cost).
- incorporating the works as part of developer-led works.

Approach	Advantages	Disadvantages
Traditional (design-bid-build)	• **Quality**; full design pretender • **Design flexibility**, variations and instructions Specialist subcontractors • **Design control** • **Cost**; there may be a lump sum cost benefit unless multiple changes are made	• **Time;** requires full detailed pack pretender • **Cost;** not a benefit if many changes are made once the design is tendered.
Design and build – Option A Lump Sum Fixed Price	• **Time;** fast track, overlap of design and construction • **Cost;** lump sum / guaranteed maximum price • Single point of responsibility; contractor design and build responsibility • **Buildability;** Early contractor input to design	• **Scope;** Need to develop the employer's requirements and design to a significant level where the contract with the contractor can be let without passing over too much risk as this will drive the costs up. • **Quality;** cheapest route to meet contract specification can lead to low quality products / build quality • **Innovation;** limited benefits to contractor to provided value engineering proposals • **Design flexibility;** request for changes will have high cost / time implications • Cost; Can end up paying for risks which are not realised.

Design and build – Option C Target Cost	• **Budget setting**; Forecasts provided for stage 2 costs during design development. Opportunity to not proceed with stage 2 if total of the Prices can not be agreed for the target cost. Transparency on costs during stage 1 and 2 through open book and audit procedures • **Time**; fast track, overlap of design and construction, detailed scope to be developed by supply chain • **Cost**; incentivised to beat target cost during construction through value engineering proposals • **Single point of responsibility**; contractor design and build responsibility • **Innovation**; can benefit quality Low risk for the client • **Buildability**; Early contractor input to design	• **Quality**; cheapest route to meet contract specification can lead to low quality products / build quality • **Cost**; risk of cost increase, with spend over target shared between contracting parties • **Design flexibility**; request for changes will have high cost / time implications
Growth and Regeneration / Private Developer led	• **Cost**; Defences funded by others • **Responsibility**; Reduced responsibility for BCC to manage Defence levels can still be met	• **Control**; Less control over solution. Lack of design flexibility • **Programme**; outside of BCC control • **O**&**M**; Greater complexity for assurance, inspection and maintenance

Table 20 - Contract strategies

4.1.6 Procurement route and timescales

To achieve a consented strategy, as well as assurance of the FBC(s), a design that is coherent for a single flood strategy is required. Given the strategic context on which this scheme is being delivered, the need to align the Strategy with masterplan developments, and continued control over the design is required at this stage. As such, the preferred approach is design-bid-build, two stage open tender with support through Early Supplier Engagement on buildability considerations for detailed design and consenting of the FBC(s).

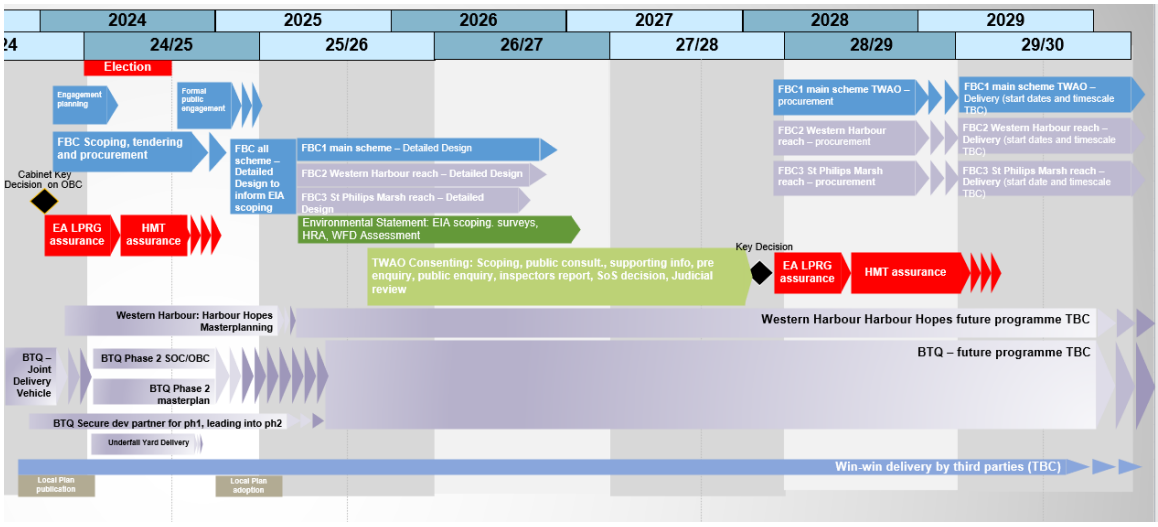


Figure 33 - Indicative Strategy delivery timeline

4.2 Efficiencies and commercial issues

Identifying and realising efficiencies has been and will continue to be an integral part of the delivery of the scheme, with an aim to deliver a minimum 10% efficiency saving on the overall scheme costs (as per the Defra/Environment Agency FCRM six-year capital programme-level target for efficiency savings).

It is understood that the Defra funding condition applies to all capital GiA spend, whether led by the Environment Agency, or by another Risk Management Authority (RMA), as set out in the Grant Memorandum issued along with the GiA funding allocation. The project delivery team will work with Environment Agency local Area Programme and PSO teams on the future reporting of efficiencies.

It should be noted that the scale of inflationary pressure on the scheme from Gateway 0 to present day (OBC submission), far exceeds any realisable efficiency saving. Despite this challenge, significant design development, value engineering and collaborative working has brought about notable cost reductions from the SOC design. These include:

- Cumberland to Clarence Road – through further geotechnical desk studies, the extent of piling required at SOC has been significantly reduced. Despite the increase in construction costs generally due to inflation, and the later assumed construction start date, the cost of these defences has reduced by approximately £30m.

- Incorporating further topographic and threshold survey into the hydraulic model has reduced the length of the defence on the North bank at St Anne's by approximately 250m, saving ~£4m.
- The height of the Chapel Way defence has been significantly reduced through further hydraulic modelling, to allow limited overtopping without flooding properties.
- Reduced defence lengths at Shirehampton, Sea Mills and Bower Ashton to take advantage of natural high ground.
- The use of practical betterment measures upstream of central Bristol (see 3.5.3)

4.2.1 Contract management

Contract management for the FBCs (detailed design) and construction will be delivered in accordance with the BCC procedures ensuring compliance with all relevant legislation.

5.0 Financial Case

5.1 Summary of financial appraisal

5.1.1 Approach to costing

To develop the costing of the preferred option, a bottom-up approach has been used. The updated hydraulic modelling work defines the levels, height and lengths of the flood defences and works to meet the scheme objectives and prevent adverse impacts.

For flood defences that are designed to provide protection to receptors behind the defence, allowance has been made for freeboard to manage the uncertainty in modelled water levels. However, where the flood defence is used purely to prevent detriment, a freeboard allowance is not required. The freeboard allowance has been determined via a residual uncertainty analysis following the latest Environment Agency guidance (Appendix B), and ranges from 290 to 760mm.

To enable the benefit-cost assessment for the strategy, the cost of the scheme has been derived for a number of scenarios with different SoPs. The report and associated spreadsheet in Appendix F gives details, summarised below. Input from early supplier engagement has also been used to inform the costs.

Allowances have been made for other costs including:

- Utilities diversions – based on returns from statutory undertakers, an uplift of Capex costs ranging from 0-5% has been applied.
- Environmental mitigation – based on initial analysis of BNG requirements, a 3% uplift has been applied.
- Site investigation costs covering topographic and utilities searches, as well as ground investigation, have been estimated.
- Costs for design, FBC development, site supervision and other consultancy services have been estimated and applied. These are described further in section 5.1.6.
- An allowance for compensation to landowners has been applied at 5%, based on analysis of previous similar projects.

At SOC stage, placemaking was costed by applying an indicative rate per linear m of defence across the scheme, set as either ‘high’ or ‘low’ depending on location. A full placemaking ‘design’ has not been carried out at this stage (see 3.9.2), but placemaking opportunities have been incorporated into the engineering design – for instance through terracing, inclusion of active travel opportunities and landscaping.

Indicative quantities of these elements have been costed to include in the overall cost estimate. For some areas, an indicative per metre rate has been applied to the scheme.

Cladding allowances for each flood defence have also been updated. This was undertaken with information and assumptions provided by the placemaking team.

Inflation has been calculated according to the Environment Agency's guidance document *'Allowing for inflation in FCERM projects'.* Costs are inflated based on whether they are 'construction' activities (Capex and service diversions) or 'non-construction' (site investigation, staff and consultants, environmental mitigation and compensation). Inflation is applied based on the construction programme in Appendix G. Further information is available in Appendix F.

5.1.2 Capital cost

Capital costs are defined as construction and preliminary costs associated with building the new defences. This includes construction works to raise existing embankments, replace existing floodgates, introduce new floodwalls and foundations, alter road infrastructure and other adaptions to the river where flood defences are required.

The capital cost estimates have been produced from professional advice from Arcadis and Arup. Their cost estimate is derived from volume and unit rates and cost precedents of similar flood defence schemes. They have taken into account the Environment Agency's FCRM projects and funding guidance (FCRM-AG). The phasing of capital works relates to sequencing of constructing the flood defence works, acknowledging further flood defence work will need to be undertaken in phase 2 by raising and where necessary extending raised defences as described in 3.4.2.

5.1.3 Operation and maintenance cost

The Operation & Maintenance (O&M) costs for the scheme developed at SOC have been updated to reflect the preferred option development. Working with the Environment Agency, a standard template of O&M costs for each defence type being proposed has been developed that could be replicated across the reaches and factored for its length.

It should be noted that a significant part of the projected maintenance and operational costs for the Strategy are derived from the need to continue Floating Harbour operations and these costs would have been incurred anyway. The preferred option described in 3.9 will also modernise many of the harbour assets, which is expected to reduce future operations and maintenance costs. In addition, Maintenance funding is discussed further in 4.1.2.

For each defence type, these are described below. It is assumed that there will be an overall "Tidewatch" cost associated to personnel monitoring and managing the operation of the floodgates across the scheme.

The costs were aggregated over the strategy's 100 years design life and summed across the scheme before being discounted accordingly to provide a present value cost. It has been assumed that when defences are raised in the 2060s to provide an increased SoP, existing defences will also be fully refurbished. Further information is included in Appendix F.

Raised wall costs (gravity and piled):

- Inspection of walls, flap valves, joints and pile caps
- CCTV survey and jetting of outfalls where necessary
- De-vegetation
- Flap valve replacement

Embankment costs:

- Inspection
- Grass cutting
- ‘Top up’ of low spots where necessary

Floodgate costs:

- Monthly and pre-tide inspections
- MEICA inspection and repair
- Structural and mechanical inspection and repair
- Replacement every 45 years in line with Environment Agency guidance

Property Flood Resilience:

- Inspection
- Replacement

Dams:

- Inspection
- Localised repairs where necessary

The cost of operating the new flood gates at Entrance and Netham Lock have been estimated by analysing the cost per operation of the existing lock gates at Entrance Lock, and estimating how many times per year the flood gates will be required. Likewise, an allowance for routine inspections of the gates has also been included.

5.1.4 Risk

The Strategy’s delivery risk register has been updated (see Appendix H). Several key risks identified at SOC have been closed out, in particular around hydraulic modelling uncertainty, environmental assessment and the definition of detriment mitigation proposals. The remaining identified risks have been qualitatively and quantitatively analysed to determine their cost and programme impacts, as well as likelihood of occurrence. Those with the highest impact include:

- Delays to project delivery due to challenge, stakeholder agreement and the change in governance at BCC expected in 2024.
- Adverse ground conditions
- Landowner and occupier agreements
- Temporary works and traffic management or restrictions

This data has been used to inform probability modelling, also known as a Monte Carlo analysis, of the required risk allowance in the scheme. The 50th percentile risk value is £9.0m in cash cost terms, and the 95th percentile value is £18.3m. The 95th percentile represents more of a worst case scenario of risk materialising and subsequent costs. 50th percentile represents a credible average level of risk materialising. These have been included in the project costing as appropriate.

A 49% optimism bias has been applied to the costs, following FCRM technical guidance and using project-specific factors to reduce from the average allowance for flood defence projects at this stage of development.

For areas where the chosen defences involved property flood resilience (PFR), a lower 41% was used, however as a weighted proportion of the scheme costs, this does not have a significant impact on the overall Optimism Bias of the scheme. This is broken down in Table 21.

Risk components contributing to above factors		Average % Risk Component for Flood Projects	Non-PFR defences	PFR
Procurement	Late contractor involvement in design	1	1	1
	Dispute and claims occurred	11	11	11
	Other	1	1	1
Project specific	Design complexity	4	3	2
	Degree of innovation	4	1	1
	Environmental impact	**13**	13	3
	Other	9	9	9
Client specific	Inadequacy of the Business Case	23	12	12
	Funding availability	2	3	3
	Project management team	1	1	1
	Poor project intelligence	8	6	6
Environment	Public relations	5	5	5
	Site characteristics	4	4	2
External influences	Economic	5	5	5
	Legislation/regulations	4	4	3
	Technology	4	1	1
	Other	1	1	1
	TOTAL	**100**	**81**	**67**
Optimism bias %		**60**	**49**	**41**

Table 21 - Optimism bias calculation

Risk allowances have been applied to each length (site reference) of the full programme of capital works. These risk categories can be defined as ‘Risk on Construction items’, ‘Risk on Non-Construction items’ and ‘General’.

5.1.5 Project costs

The total capital works cost expressed in cash cost is shown in Table 22.

Cost heading	Cash cost (£)
Cost up to OBC	3,200,000
Salary costs	Included in ‘Professional Advice’
Cost of Professional Advice	15,000,000
Site investigation and survey	3,600,000
Construction	170,500,000
Supervision	Included in ‘Professional Advice’
Environmental mitigation	4,600,000
Land purchase & compensation	7,700,000
Other (Inflation)	16,000,000
Risk and Optimism Bias	117,500,000
Future cost (Construction + Maintenance)	115,700,000
Optimism Bias on future cost	40,700,000
Total	**494,700,000***

Table 22 - Whole life project costs

*All numbers in this table are rounded for ease of reading. Total is as written.

Table 23 provides an overview of the total value of project, which excludes future costs and those incurred up to OBC.

Cost Heading	Total value of project (cash cost, £) (For approval)
Cost up to OBC	Exclude previous applications
Salary costs	Included in 'Professional Advice'
Cost of Professional Advice	15,000,000
Site investigation and survey	3,600,000
Construction	170,500,000
Supervision	Included in 'Construction'
Environmental mitigation	4,600,000
Land purchase & compensation	7,700,000
Other (inflation)	16,000,000
Risk and Optimism Bias	117,500,000
Total	**335,000,000**

Table 23 - Total value of the project in cash terms

5.1.6 Strategy development costs

Project Development cost	Cost (cash cost, £)
SOC	1,300,000
SOC to OBC	1,900,000

Table 24 - Project development cost up to OBC

So far, the strategy development costs have been funded by BCC, WECA, and the Wessex Regional Flood and Coastal Committee via Local Levy.

The Environment Agency's Collaborative Delivery Framework (CDF) Lot1 PSC Cost Curve has been used to give an indication of the expected FBC development costs, based on analysis of previous Environment Agency FCRM schemes. From this, an FBC cost of around £6.5m is suggested. However, it is important to recognise that the cost curve has very few high values, and no directly comparable scheme data points. It is expected that the development of a TWAO and all associated legal costs, extensive consultation and the production of multiple FBCs (as may be required to align with the areas of regeneration) may increase this cost significantly in comparison with an average scheme that would otherwise fit the cost curve more closely. Furthermore, an initial high-level estimate of £3.5m has been identified for ground investigation costs in support of the FBC work.

It could therefore be reasonably expected that development costs up to FBC submission may be in the region of £15m. This figure has not been derived from a detailed bottom-up costing exercise.

Project Development cost	Cost (cash cost, £)
OBC to FBC	15,000,000*

* this figure has not been market-tested at this time, so a suitable optimism bias should be applied.

Table 25 - Project development cost from OBC to FBC overview

5.2 Identified funding sources

5.2.1 FBC delivery funding

Funding of £2.2m has been programmed from Local Levy. The remaining funding required to develop the FBCs is being sought between a balance of Bristol City Council flood reserves funding and new WECA grant funding.

5.2.2 FCRM Grant in Aid

Grant-in-Aid (GiA) has been estimated as £197.7m (present value terms). A full explanation of how this figure has been assessed is provided in section 3.5.4 and Appendix E.

Eligibility for 100 year duration of benefits

Grant in Aid is assessed against a duration of benefits matching the full 100 year appraisal period, i.e. based on the benefits of both Phase 1 and Phase 2. This reflects BCC's legal and planning commitments made for implementation of Phase 2.

LIT 58360[36] sets out that the duration of benefits can match the appraisal period provided the next major capital investment is less than 20% of the value of the investment being considered today in today's prices. The future capital costs of implementing Phase 2 are estimated as £10.85m pv or £47m cash (including 49% Optimism Bias). Compared to the initial project construction costs of £255.1m pv or £320.1m cash, it is either 4% or 15% of the initial capital expenditure, and hence well below the 20% guide figure.

Further to this, the 100 year duration of benefits is justified by the high value of the Phase 1 when considered over a 100 year period, even if not raised in 2070. Estimates suggest that an **absolute lower bound** estimate of the benefit for this scenario would be £1664m (OM1a), which with people related benefits of £403m (OM1b) would make this scenario eligible for GiA of £143m. Phase 1 therefore will still represent a healthy 8.5:1 return on GiA investment (and an overall benefit cost ratio of 6:1) even if Phase 2 does not proceed as planned in line with BCC's commitments.

[36] Environment Agency 2023, "Calculate GiA funding for FCERM projects," LIT 58360

The Phase 1 investment delivers on a 100 year duration of benefits period by virtue of the following elements of the proposals:

- Delivery of defence locations to the 2130 standard on a precautionary basis (typically works to mitigate detriment upstream and downstream of the city centre, and any lengths delivered by development)
- Delivery of key elements that do not require raising in 2070: works to the flood locks and protection of the approach to the locks, ensuring their continued effective function; erosion protection to Cumberland Road.
- The residual standard of protection in 2070 is still very high. Whilst it would decline over time to a low standard by 2130, it would still deliver significant benefits over the 2070-2130 period (8.5:1 return on GiA investment).
- Approximately 9% of the Phase 1 capital costs are associated with increased foundations to enable Phase 2 to be developed efficiently, both cost-effectively and environmentally.

If funded in 2 separate phases, simply separated into before and after 2070, Phase 1 would be eligible for an estimated pv £88.2m GiA. Phase 2 would in theory be eligible for the remaining pv £109.5m GiA. However this would not account for the phase 2 benefits delivered in phase 1 as listed above. Some benefits would be lost because the residual benefit of Phase 1 would change the baseline; for example, the residual erosion benefit to Cumberland Road would not be measured at Phase 2 unless the Standard of Service of the Phase 1 defence had significantly declined. To separate funding in this manner significantly understates the benefit case for Phase 1, effectively presenting Phase 2 as a separate scheme, rather than (more appropriately) as an enhancement to Phase 1.

5.2.3 Other allocated funding

- The WECA Economic Development Fund (EDF) has a programme allocation of £10.0m (today's prices). Seeking further funding from this source could be explored but given that the EDF is fully subscribed this could only be via a substitution with other BCC programme allocations.
- In an October 2022 key decision, BCC allocated £20.4m of future Community Infrastructure Levy (CIL) funding towards the project.
- The 2022/2023 BCC budget earmarked £10.0m of reserves for the project.

5.3 Expenditure and income profile

Table 26 provides an overview of the expenditure and income of the flood scheme over the FBC and construction period (2024/25 to 2035/36). Cost less contingency is the total capital costs, excluding sunk costs. Contingency is defined as the sum of optimism bias and 95th percentile risk allowance. Contributions are defined as all identified funding other than GiA, as outlined in 5.2.

All funding amounts have been committed in today's prices apart from GiA, which is calculated in present value terms. For consistency with the presentation of

costs in this financial case, all funding amounts are presented below in cash terms. To convert from today's prices to cash terms, it is assumed that GiA is spread across the construction period in proportion to project costs and that remaining funding is drawn down on the date of need. Inflation is then applied in line with the GDP deflator. These assumptions need to be confirmed with funding providers.

	Year	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total (cash)	Total (pv)
	Discount factor	1.00	1.00	1.00	1.00	1.00	0.97	0.93	0.90	0.87	0.84	0.81	0.79		
Costs	Appraisal to date	3.204												3.2	3.2
	FBC	3.377	3.377	3.377	2.434	2.434								15.0	15.0
	Cost						30.92	43.64	18.75	27.84	39.07	14.86	11.51	186.6	165.8
	Inflation						0.83	2.16	1.38	2.70	4.72	2.19	1.99	15.96	13.7
	Risk (95%ile)						3.03	4.28	1.84	2.73	3.83	1.46	1.13	18.3	16.3
	OB (on cost and inflation)						15.56	22.44	9.87	14.96	21.45	8.35	6.61	99.2	88.0
Total cost		**6.6**	**3.4**	**3.4**	**2.4**	**2.4**	**50.3**	**72.5**	**31.8**	**48.2**	**69.1**	**26.9**	**21.2**	**338.3**	**302.0**
Funds (£m)	Local Levy (towards SOC & OBC)	2.14												2.1	2.1
	BCC funding of OBC	1.064												1.1	1.1
	Local levy (towards FBC)	2.2												2.2	2.2
	Grant in Aid							39.9	28.9	43.2	69.1	26.9	21.2	229.2	197.7
	BCC Reserves						10.00							10.0	9.7
	WECA EDF						5.00			5.00				10.0	9.2
	Committed CIL						14.568	2.91	2.91					20.4	19.4
Total funding secured		**5.4**	**0.0**	**0.0**	**0.0**	**0.0**	**29.6**	**42.8**	**31.8**	**48.2**	**69.1**	**26.9**	**21.2**	**275.0**	**241.4**
Funding to secure		**1.2**	**3.4**	**3.4**	**2.4**	**2.4**	**20.8**	**29.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**63.3**	**60.6**

Table 26 - Expenditure and income profile from 2024-35, £m

5.4 Funding strategy

5.4.1 Summary of current funding position

The current cost and funding position is summarised below. This is presented in present value and cash terms for comparison across the rest of the OBC. The remainder of the Financial Case is presented in cash terms only.

Summary Table	Cash Cost (£m)
	95 %ile risk, inflated to outturn year, undiscounted
Project capital costs, including inflation, risk and optimism bias	320.1
Identified funding (excl local levy)	269.6
Additional funding requirement (excl FBC)	**50.5**
Project capital costs plus FBC costs	335.1
Identified funding (incl local levy)	271.8
Additional funding requirement (incl FBC)	**63.3**

Table 27 – Summary of cost and funding position

Table 28 shows a more detailed breakdown of allocated funding for project costs (in cash terms only).

Source of Funding	Value (£, cash terms)
Flood Defence Grant in Aid	229,200,000
BCC reserves	10,000,000
WECA Economic Development Fund	10,000,000
Allocated CIL	20,400,000
Local Levy	2,200,000
Total funding	**271,800,000**

Table 28 - Sources of funding

This translates into partnership funding scores as set out below.

Source of Funding	%
Raw Partnership Funding score	70
Adjusted Partnership Funding score	86

Table 29 - Partnership funding scores

Based on allocated funding and including FBC costs there is a current additional funding requirement of £63.3m in cash terms . A wide range of other funding sources have been explored to maximise local contributions to the Strategy. Further work is planned to determine the quantum of each option, however, analysis completed to date has identified sufficient funding to achieve an adjusted partnership funding score of up to 120%. Only a small proportion of the identified funding opportunities needs to be secured to achieve a score of 100%. The options considered are detailed further in 5.4.3.

5.4.2 Overall approach

BCC will act as the accountable body for the Strategy's delivery. BCC has experience of managing capital construction projects and will be responsible for performance and compliance to ensure the activities supported fit within the programme objectives, are value for money and are an efficient use of public resources.

Following approval of the SOC, considerable work has been undertaken by BCC in close consultation with the Environment Agency's partnership funding specialists and other partners to develop a funding strategy for the project. The overarching approach has followed the 'beneficiary pays' principle i.e. the approach should distinguish between:

- National contributions towards the 'public good' elements of the programme
- City-wide and/or broader regional contributions, to reflect the role that Bristol city centre plays in the West of England economy.
- Specific contributions from those who are directly subject to flood risk, or benefiting from the defences, where appropriate and feasible.

There is a compelling case for other sources of funding for the Strategy. In terms of the local economy, the Strategy will help deliver significant benefits through avoided damage to businesses and infrastructure (£858m), avoided disruption to local businesses (£360m), protection of the tourism industry (£354m) and the creation of construction jobs (£23m). There are emerging/proposed developments that could be capable of generating an estimated £5.3bn in GVA, and £1.7bn in other benefits, located in the benefitting floodplain of the strategy and whilst the progression of these developments is not solely dependent on delivery of a flood strategy, it removes a significant constraint and will enable these to progress to a faster timescale and lower cost. By protecting the city centre, it will safeguard a transport hub that is central to plans for economic growth in the wider West of England region. This transport hub is currently the

key location within proposals being considered for mass transit systems for Bristol, worth several £bn.

A wide range of funding options has been considered. These fall into the following broad categories: BCC and WECA funding; central government funding; land value capture; and other beneficiaries. Each possible funding option was rated according to its relevance of funding to flooding; scale of funding available; and feasibility of accessing funding. Following this sift, a series of options were shortlisted for further analysis.

5.4.3 Shortlisted funding options

Developer contributions

Developers are key potential beneficiaries of the Strategy due to the scale of development unlocked, so significant emphasis has been placed on maximising contributions from developers. In addition to CIL payments, BCC's draft local plan includes an expectation that developers in areas benefitting from the scheme will make financial contributions and/or deliver flood protection infrastructure where appropriate.

The financial contributions would take the form of negotiated contributions, following the principle of beneficiary pays. The potential scale of these contributions is subject to further consideration, but when combined from sites across the areas in the city set to benefit, could form a significant contribution to the overall funding need.

Delivery of flood protection infrastructure has potential to form a significant level of in-kind contribution if developers construct the required level of flood defence as part of their developments. Again, this follows the principle of beneficiary pays because developers need to deliver a sufficient level of flood protection for their schemes. Doing so in a coordinated manner will benefit the wider flood Strategy too. Estimating the amount that could be captured from in-kind contributions is challenging at this stage, but it has potential to be a significant proportion of that cost.

Bristol City Council is in early discussions with developers in relation to both these types of contributions, with several already in negotiation.

Additional grant funding contributions

Additional grant funding could come from various sources. Given the substantial regional benefits of the Strategy there is a strong argument for WECA funding. £25m (today's prices) has been provisionally identified as a potential future allocation, but this is not yet confirmed.

There may also be a case for additional central government funding, if required. The Strategy will unlock significant development and regeneration, supporting DLUHC and Homes England objectives. DLUHC has already awarded £95m, mainly for transport infrastructure, to support regeneration at Bristol Temple Quarter. Further grant funding could be explored to maximise the value of this investment and spread the benefits across a wider area. There are several other central government departments with objectives aligned to the project and further

work is needed, supported by a strong and unified regional voice, to build a case for additional central government support.

Additional CIL

In an October 2022 key decision, BCC allocated £20.4m of future Community Infrastructure Levy (CIL) funding towards the project from FY 2025/6 to 2031/2 inclusive.[37] Any future additional CIL allocation would be a decision for BCC, taking account of CIL collection rates and other infrastructure priorities. However, given the importance of the delivery of flood defences for Bristol there is a rationale for considering future additional allocations.

Recognising that there are numerous demands on CIL, it is however reasonable to assume that a portion of future CIL growth could be allocated to support the delivery of the Strategy. Key assumptions, each subject to change, include development volumes and timing, the level of the CIL charging rate, and proportions of eligible floorspace.

Public sector land value

There are substantial public sector land holdings in areas that will benefit from a reduction in flood risk as a result of the scheme. Where this reduced flood risk increases the potential for development on public sector land, there is an opportunity to capture the associated increase in land value.

[37] This time period will need to be reviewed based on the anticipated spend profile for the project.

5.4.4 Indicative funding solution

Potential funding solutions totalling £119m (cash terms) have been identified from the shortlisted options described above. These are indicative amounts, subject to further refinement at future stages of development. However, the analysis gives confidence that an adjusted partnership of at least 100% can be secured (or potentially up to 120%, should funding from each of identified sources be maximised).

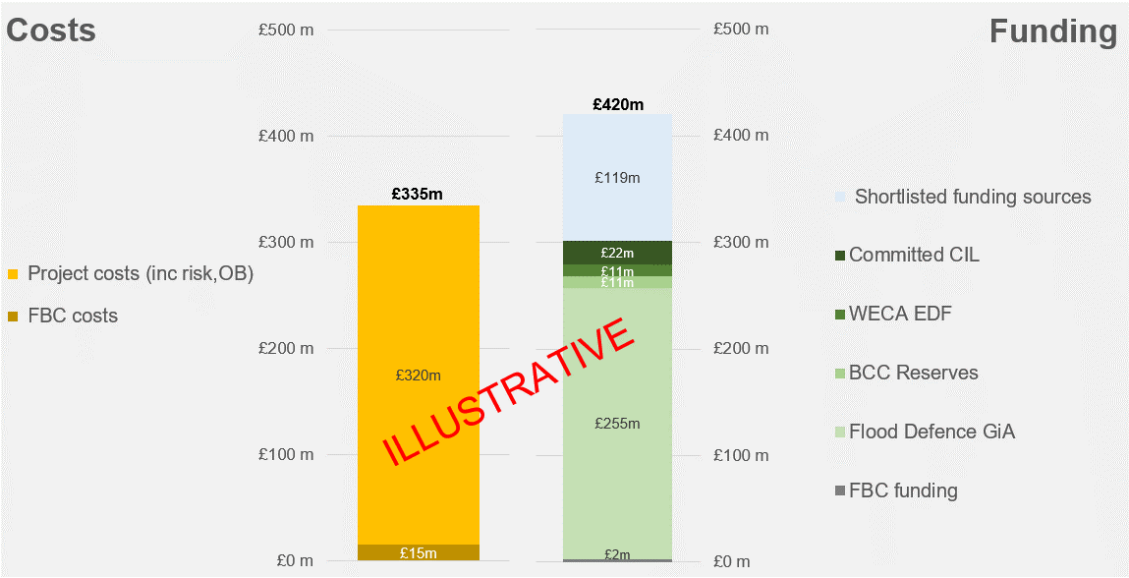


Table 30 – Indicative funding solution (cash terms)

5.5 Future capital and revenue costs

A series of flood risk management assets will be created. The revenue costs associated with the maintenance required over the whole life of the Strategy have been estimated and responsibility for meeting them has been identified.

FCRM GiA cannot be used for maintenance and operational costs. In general, the Strategy is dependent on the continued serviceability of some of the existing New Cut and harbour structures. In practice, a significant part of the projected maintenance and operational costs for the Strategy are derived from the need to continue Floating Harbour operations and these costs would have been incurred anyway.

Further detail on maintenance costs and responsibilities is set out in section 4.1.2.

6.0 Management Case

6.1 Project Management

6.1.1 Roles

BCC will lead the delivery of the Strategy in recognition of the potential impact and opportunity for the city, and the Strategy's interface with BCC's harbour, highway, planning, lead local flooding, coastal protection, civil protection and major landowner roles. The Environment Agency intends to delegate statutory powers for flood risk management works to Main Rivers to BCC, as necessary through legal agreements. The scheme elements pertaining to flood risk management will primarily be carried out under the Environment Agency's powers; Section 165 of the Water Resources Act, 1991. The Environment Agency will issue notices of entry under Section 172 of the Water Resources Act authorising BCC to enter land.

A Memorandum of Agreement, followed by an Initial Collaboration Agreement (see Appendix L) is in place to formalise the roles and responsibilities of delivery of the Strategy between BCC and the Environment Agency. Further legal agreements are planned. Such an approach has been successfully used to support the Derby City Council led, Environment Agency supported Our City Our River partnership project and lessons have been shared.

6.1.2 Project structure and governance

The first phase of construction works is planned for 2029 onwards. Delivery of the Strategy will be managed by BCC, supported by the Environment Agency and WECA. Roles and responsibilities are outlined below and in Figure 34.

6.1.3 Project board

A multi-agency Project Board comprising senior management representation from BCC, the Environment Agency and supplier(s) will provide direction and management for the Strategy's implementation. The board will give direction for the Strategy and be accountable for its success. The board will have sufficient authority to carry out their responsibilities effectively. Membership from the Environment Agency and BCC includes flood risk, planning and development, city docks, estates, harbour and regeneration. The collective responsibilities of board members include:

- Accepting and demonstrating ownership of the Strategy.
- Working as a team to provide collective and unified direction.
- Effective delegation with appropriate project tolerances and exception management processes.
- Facilitating cross functional working ensuring that the project structure is recognised and respected by line management.
- Supporting development and delivery of the funding strategy.

- Committing all of the resources required to successfully complete the project.
- Effective decision-making including risk, issue and change management.
- Project assurance and quality control.
- Ensuring timely and effective communication within the project and with external stakeholders.
- Ensuring the Strategy deliverables are reliable, sustainable and can be maintained effectively.

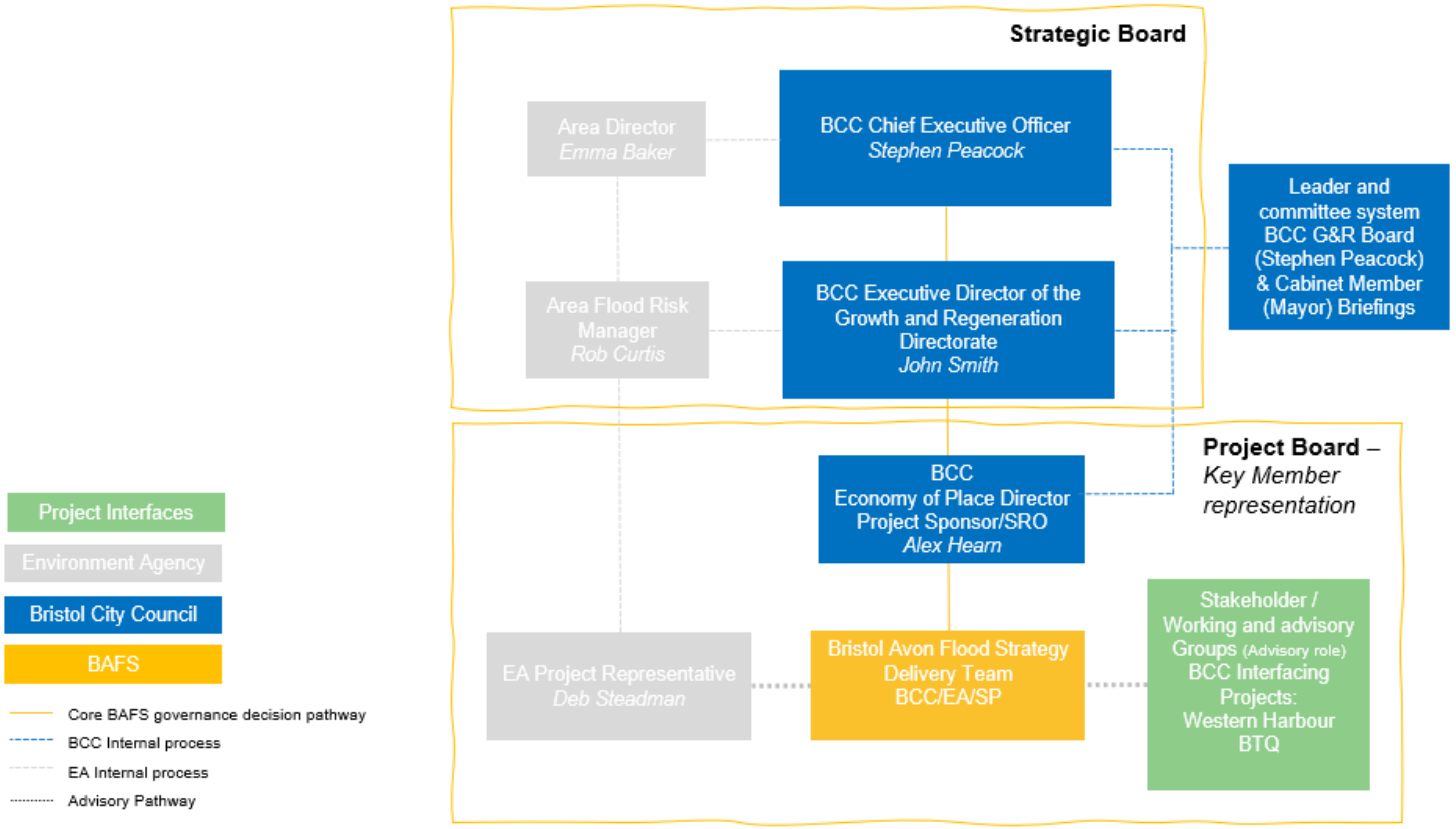


Figure 34 - Management structure

6.1.4 Strategic Board

Overseeing the Project Board will be a Strategic Board comprising representation from BCC, the Environment Agency and WECA.

This governance structure provides appropriate routes for escalation, steer on key strategic decisions, and interface management with parallel projects such as BTQ and Western Harbour, as shown in Figure 34. Decisions will be made through the Project Board, escalated to the Strategic Board by exception. Project board meetings are held monthly.

The Strategic Board is the senior decision-making forum represented by BCC's Executive Director for Growth and Regeneration and the Environment Agency's Area Flood Risk Manager supported by officers. The Strategic Board is formed by the Mayor or delegated cabinet member (to be replaced by a Committee Chair following the change in governance to a committee system in 2024) and the Environment Agency's Area Director.

It is also noted that both the Environment Agency and BCC have their own decision-making pathways. These will be followed to ensure appropriate internal officers and members are well informed of the decisions that are to be taken at each level. BCC's Economy of Place Director takes responsibility for managing the interfaces as Sponsor, such as BTQ and Western Harbour Growth and Regeneration projects.

6.1.5 Project Manager

The Board will be supported by a team led by a dedicated Project Manager who has the authority to run the projects to deliver the Strategy on a day-to-day basis on behalf of the Project Board. The Project Manager's primary responsibility is to ensure that the project produces the required outcomes to the required standard of quality and within the specified constraints of time and cost.

6.1.6 Project representative

The Environment Agency provide a Project Representative from the Wessex Area team to work with BCC on a weekly basis to represent the interests and requirements of the Environment Agency and provide general advice for delivery of the Strategy. This time will not be charged directly to the Strategy. Advice from the Environment Agency cost and carbon lead, NEAS, modelling, legal or other specific advice will be charged to the FBCs and funded through Local Levy.

Other statutory bodies with an interest in the Strategy (specifically Historic England, Natural England, Wessex Water, Port of Bristol, and neighbouring risk management authorities as well as BCC and En3vironment Agency in their role as regulators) support through a stakeholder working group

6.1.7 Project roles and responsibilities

Specific roles for the Strategy are subject to change but listed below:

- Project Sponsor – Alex Hearn
- Project Executive – Shaun Hartley

- Project Manager – Matt Sugden
- Environment Agency Project Representative - Deborah Steadman

6.1.8 Change management

Robust change management control procedures will be used for the FBCs (detailed design) and construction phases of the schemes, managed by exception.

Project changes will be agreed with the Project Board, seeking endorsement to ensure consistency in reviewing all project changes and also whether there is a need to implement the change.

6.1.9 Safety plan

Public health and safety elements will form a key consideration in scheme development, will be considered throughout further design stages and will form part of the designer's risk assessment. This will be continued through detailed design with any residual risks included in the Health and Safety file.

Consideration will be given to the Construction (Design and Management) Regulations (CDM) and key health and safety issues as the preferred strategy is advanced through the development of FBCs (detailed design) stage. Designer risk assessments will be written, and appropriate records will be kept throughout future stages of the schemes. Where risks are identified that cannot be resolved entirely then appropriate mitigation measures will be developed wherever possible to reduce the probability of the risk occurrence.

Public Safety Risk Assessments (PSRAs) will be carried out prior to any work starting on site to ensure the safety of the public during and after construction.

A health and safety file will be produced for all stages of a scheme to ensure that the operation and maintenance of any built asset can be carried out safely.

6.1.10 Safety of harbour management

An essential component of the strategy is the installation of new flood gates at the upstream and downstream ends of the Floating Harbour. The gates will require routine operation and with this brings operational safety risks. BCC Harbour Authority will operate these gates, in the same way as they operate the existing harbour gates by agreement with the Environment Agency by way of a memorandum of understanding. This sets out the funding provisions by the Environment Agency, and also sets out the expectations of both parties associated with operation, including the requirement to use every endeavour to perform the works with due skill, care and diligence, and to the highest appropriate accepted standards of public sector accountability. Appropriately trained personnel are to be made available by the Authority to carry out the works. By continuing with these approach, adequate safety protocols will be ensured for the operation of the new gates.

6.1.11 Post project evaluation

Upon closedown of the FBCs and construction projects a post project evaluation will be completed. This will be to verify that all objectives are met, the intended

benefits realised, and lessons learnt are captured and shared with the Project Board.

Reviews will be carried out periodically during the development stages.

6.1.12 Contingency plans

BCC Emergency Preparedness, Resilience and Response Team have an emergency response plan for flood events. The BCC Harbour Operational Protocol is well-established and constantly reviewed for improvements, with new telemetry to be installed at Netham and the River Frome network to support intra-organisational communication and management. Contingency plans will be established during the FBC stage of the scheme delivery.

6.2 Schedule

The following milestones have been agreed at a high level for the Strategy OBC and FBCs. Further detail of the programme is given in Appendix G.

SOC Strategy Adoption	March 2021
Phase 1 OBC key decision	January 2024
EA assurance (LPRG) and Defra endorsement	Autumn 2024
Phase 1 FBC 1 design and consenting:	2024-29
Phase 1 FBC 1 construction	2029 onwards
Phase 1 FBC 2 design and consenting	2026-29 (incorporating Western Harbour engagement and masterplanning for areas of growth and regeneration)
Phase 1 FBC 2 construction	2029 onwards
Phase 1 FBC 3 design and consenting	2026-9 (incorporating BTQ engagement and masterplanning for areas of growth and regeneration)
Phase 1 FBC 3 construction	2029 onwards
Supportive planning instruments	Ongoing (Local Plan Regulation 19 publication November 2023, adoption 2025 with subsequent Supplementary Planning Document anticipated)

The Strategy interfaces with many projects and programmes. Phasing of the proposed construction works is discussed in 6.2.1.

6.2.1 Phasing Plan

The strategy has been divided into two phases, as described in 3.4.2. The first phase to be delivered over several years, split into a number of areas.

Construction is planned from 2029 onwards. The delivery of some areas will be reliant on external factors outside the control of the flood strategy and will require continued alignment throughout the FBC stage. There are key elements in different areas that need to progress in advance.

Complex areas are likely to be delivered by BCC, with support from the Environment Agency. The proposed flood gates at Entrance Lock and Netham Lock will require ongoing operation and maintenance and require full consideration to ensure no impact on navigation, with Entrance Lock flood gate also to replace the navigation lock gate. Upstream and downstream raised defences interface with existing Environment Agency assets, particularly at Pill and Shirehampton. Raised defences along lengths of the New Cut interface with highways, the harbour railway and other BCC assets.

Elsewhere, in areas of Growth and Regeneration, lengths of the Strategy could be delivered by developers. Phasing the scheme, assured through multiple FBCs, such that the construction of defence lengths located along the Western Harbour and St Philip's frontages are separated from other works will maximise the chance of integration with Bristol City masterplans and enable the potential opportunity for the delivery of lengths by developers. A review of the following impacts on the timing of the key reach areas has been assessed. These impacts include:

- Reliance on other BCC projects
- Reliance on private developers
- Abortive work
- Construction inefficiency
- Impairment of development opportunities
- Adverse flood risk impact elsewhere
- Disruption to the city through major infrastructure works
- Flood risk benefits

Components with a low risk of impact have been prioritised, leading to the initially suggested build priority of the Phase 1 works, shown in Figure 35. The variety of defence forms may favour splitting delivery into further discrete packages to be procured separately, especially at the FBC and construction stages.

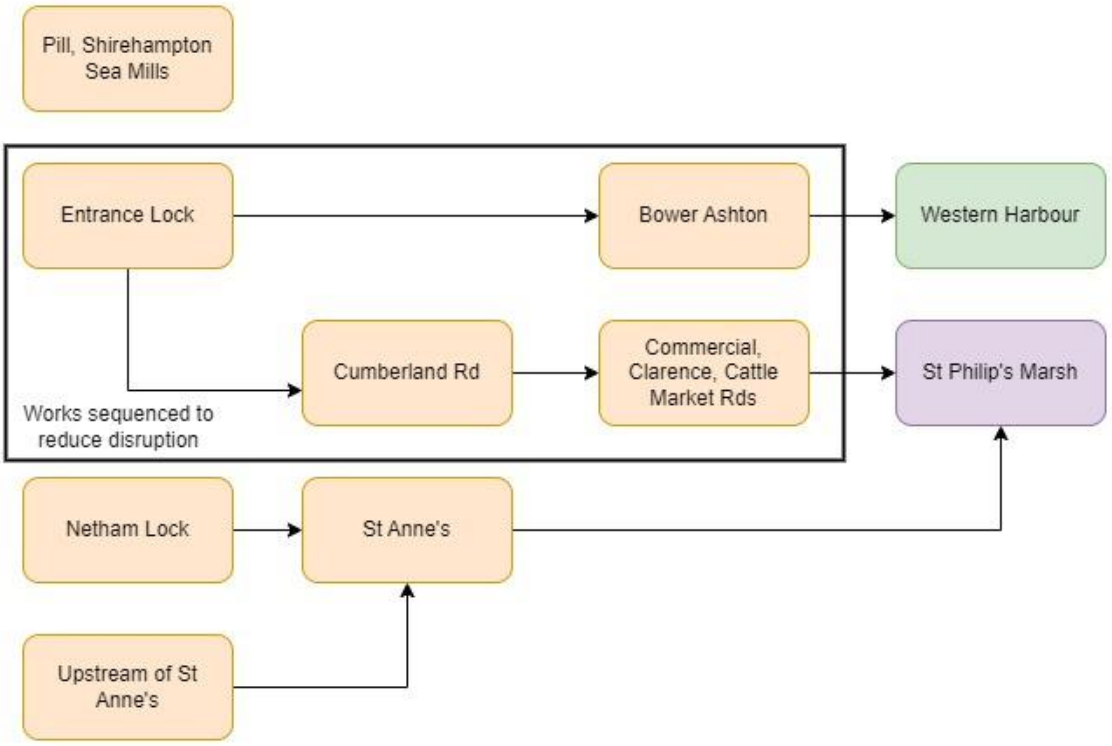


Figure 35 - Phasing of the works

Key points of this approach:

- Detriment mitigation addressed upfront, so that strategy is NPPF/flood risk assessment compliant. Locations with generally low differences in flood defence height will be constructed on a precautionary basis, typically works to mitigate detriment located in areas upstream and downstream of the city centre.
- Reduction of disruption, in particular around the city centre
- Areas that could be constructed by developers in areas of growth and regeneration are last to be required to maximise flexibility

The BCC and Environment Agency Memorandum of Agreement requires a Phasing Delivery plan to set out the proposed tranches of construction work, costs and funding requirements. Its purpose is to ensure each phase contributes to the overall delivery of the Strategy, that funding is distributed to allow delivery of the whole Strategy, that delivery constraints are managed, and that timescales and delivery goals align with the Local Plan, development masterplans and other projects. This is a live plan that evolves as circumstances change.

6.2.2 Phase 2

The strategy has been divided into two phases, as described in 3.4.2. The first phase is designed to allow for modifications to accommodate a smaller second phase constructed in the 2060s. The case for a managed adaptive approach was demonstrated since Strategic Outline Case offering significant benefits over a precautionary approach; including:

- More efficient use of money and carbon, with investment in raising/extending defences only at the point when required (see Appendix E)
- Ability to adapt to the latest climate change science and to take advantage of emerging technologies to reduce the cost and carbon emissions of the raised defences and public realm
- Additional time to gather additional partnership funding, maximising contributions and alignment with emerging regeneration masterplanning and the evolving needs of the city
- Better placemaking, with features only developed when necessary and greater flexibility to adapt to changing development needs

BCC and the Environment Agency are committed to delivery of both phases of the adaptive approach. The Strategy also has written support and committed funding from the West of England Combined Authority. A Funding Strategy has been produced and will be updated regularly, which covers both phases of the Strategy and demonstrates that no further FCRM Grant in Aid will be needed for Phase 2.

BCC and Environment Agency recognise the risk if Phase 2 was not delivered and therefore the importance of improving confidence in its delivery. We have therefore taken these steps to improve confidence at OBC:

- The Memorandum of Agreement and Collaborative Agreement between BCC and the Environment Agency set out the respective roles and responsibilities, including actions to ensure confidence in delivery of Phase 2. BCC will continue to lead on monitoring the adaptive strategy, identify and collect funding as necessary to deliver phase 2 and start planning for Phase 2 delivery sufficiently early. 6.2.1
- Reviews of the Strategy are proposed at least every six years until phase 2 is delivered to review the latest observations and projections of the impact of climate change on River Avon flood risk predictions. The reviews will enable BCC and the Environment Agency to determine the timing and form of Phase 2 when the magnitude and rate of sea level and peak river flows increase can be better determined. This shall include assessing residual flood risk from overtopping of the phase 1 defences with expected flood levels in 100 years to demonstrate the benefit of phase 2 and to determine the residual flood risk for new development in the meantime incorporated into the Strategic Flood Risk Assessment. These reviews will include an update to the Phasing & Delivery Plan (see section 6.2.1), legal agreements, funding strategy and planning instruments
- As outlined in section 2.2.4, the emerging Local Plan safeguards land required for delivery of the Strategy, requires development contributions and/or delivery of flood defences to the higher (phase 2) level.
- With works upstream and downstream of the city centre delivered on a precautionary basis, Phase 2 is located within solely BCC's administrative area and the majority of defences are located within land within BCC's control.

- During FBC, further sensitivity testing into increases in inflation and cost for Phase 2 is planned to inform the Funding Strategy and Delivery Phase Plan.

6.3 Outcomes

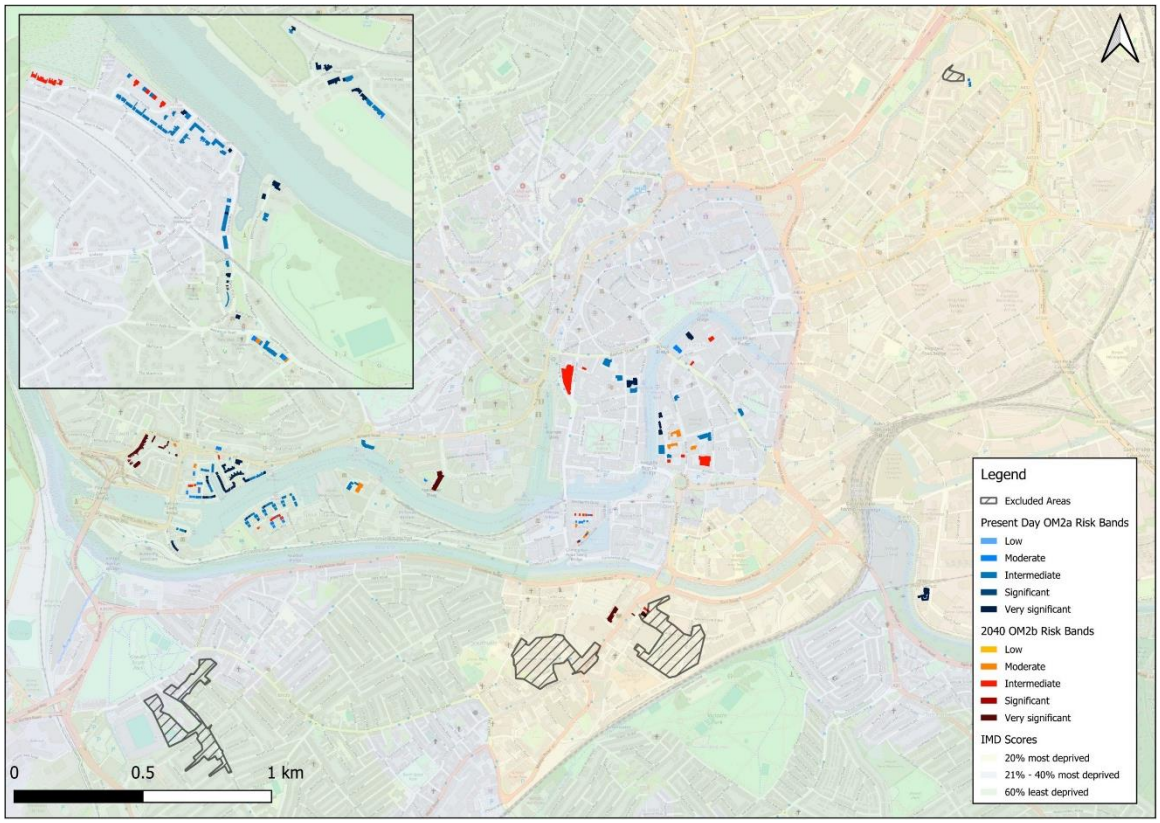
The realisation of benefits will be managed by BCC in their capacity as the lead organisation for delivering the Strategy. All benefits will be realised when construction works have been completed. The location of the households moving to lower flood categories (in relation to OM2) is shown in Figure 36. The number of properties are:

- **Households moved out of any flood probability category to a lower category:** 414
- **The number of households for which the probability of flooding is reduced from the very significant or significant category to the moderate or low category:** 139
- **The number of households in the 20% most deprived areas moved from the very significant or significant flood probability category to the moderate or low category:** 0

The households in the 20% most deprived areas currently at very significant or significant flood probability are moved to intermediate risk.

The first phase works are currently expected to be completed between 2029-36 (as per Figure 5) and therefore BCC will report the realisation of benefits at that time.

Ongoing realisation of benefits will be achieved through a co-ordinated response to ensure flood gates and lock gates are closed prior to future flood events. This will be achieved by continuing forecasting of flood events and asset operations.


Legend
Excluded Areas
Present Day OM2a Risk Bands
Low
Moderate
Intermediate
Significant
Very significant
2040 OM2b Risk Bands
Low
Moderate
Intermediate
Significant
Very significant
IMD Scores
20% most deprived
21% - 40% most deprived
60% least deprived
0
0.5
1 km

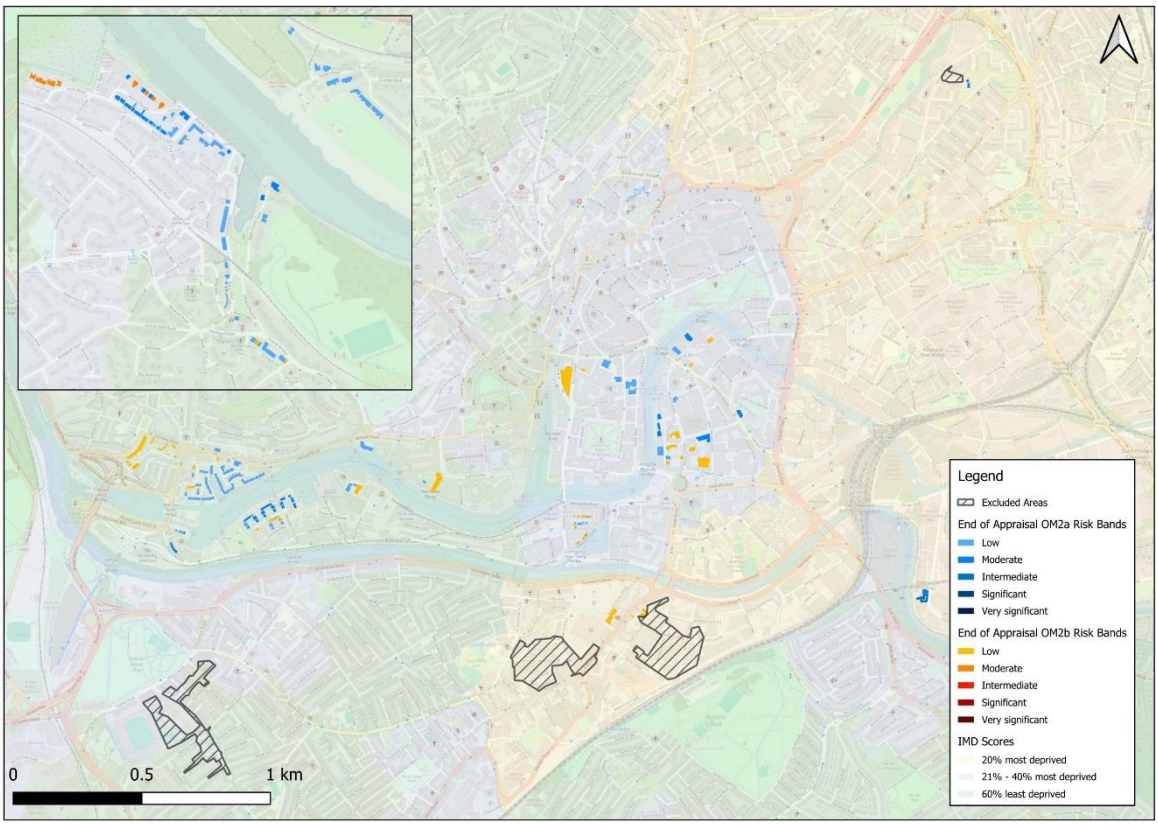

Legend
Excluded Areas
End of Appraisal OM2a Risk Bands
Low
Moderate
Intermediate
Significant
Very significant
End of Appraisal OM2b Risk Bands
Low
Moderate
Intermediate
Significant
Very significant
IMD Scores
20% most deprived
21% - 40% most deprived
60% least deprived
0
0.5
1 km

Figure 36 - Shows the change in flood probability for households in the present day (above) and at the end of the appraisal period for the 1.33% AEP SoP (below)

6.4 Risk, assumptions, issues and dependencies management

The key delivery risks for the Strategy are summarised in section 2.11. Refer to the risk register included in Appendix H for more information.

6.4.1 Strategy asset dependencies

The condition of river and harbour assets is variable and maintenance will be required to maintain their current serviceability. The costs of the Strategy are dependent on the serviceability of the New Cut retaining structures, banks of the River Avon, dam structures (Brunel and Bathurst) and the harbour water control assets at Underfall Yard (see section 2.13).

However, there are significant synergies such as the new gates at Entrance Lock, and the preferred option includes the replacement of riparian walls along much of the New Cut and sections of the River Avon. In general BCC will need to identify funding to maintain those assets where the Strategy is dependent on the structures.

Assets	Preferred Option assumption	Impact commentary
Entrance Lock	Relies on existing masonry gate cill and dockside wall structures. Replaces Outer Lock gate.	Recent BCC asset visual surveys did not identify significant defects with the dockside wall structures. Potential saving opportunity to reduce maintenance / operational costs through decommissioning part / all of the two tidal stop gates at Junction Lock if both sets of Entrance Lock gates were replaced Opportunity for placemaking design around the Knuckle to increase separation between publicly accessible and operational areas.
Brunel and Bathurst Dam	Works to increase crest level of existing dockside structures.	Recent BCC asset visual surveys did not identify significant deficiencies with these structures.

Riparian retaining walls at Cumberland, Commercial and Clarence Road	Capital costs assume new raised defences with new replacement retaining structures.	Cumberland Road costs take into account recent remedial works to Chocolate Path and railway retaining wall. Elsewhere riparian retaining wall to be replaced.
Netham	New flood gate and gate cill	Preferred option assumes short length of existing Feeder Canal dockside structures replaced.
Pill and Shirehampton	Flood walls/ embankment replaced except Pill sheet pile wall where allowance has been made to raised existing.	Aligns with emerging Environment Agency proposals at Pill.
Brunel Way	Existing off-ramp to be utilised as defence	No condition surveys carried out on this asset recently.
Other reaches	Preferred option has been costed so that flood defences are independent of riverbank stability (for instance through using new raised defences founded on mini-piles). Stability during construction may require additional mitigation.	At St Philip's preferred option costing also allows for cantilevered path to maintain the footpath. Riverbank defences costed to avoid requirement for land assembly however BCC's ambition is to integrate flood defence proposals into emerging wider development opportunities as part of a green corridor.
		No repair works to existing retaining walls or bank allowed in preferred option costing. Should major slippage occur during construction or operation, BCC funded repairs will be needed independent of Strategy.
		Opportunity at Netham and St Anne's to utilise existing sheet piles pending further investigation. Some aspects of Netham sheet piles were rated as 'poor' in condition assessment, however this may only apply to some areas. No inspection carried out at St Anne's.

Floating Harbour water level management	Strategy dependant on continued serviceability and BCC operation/maintenance outside of preferred option costing.

Table 31 – Strategy asset dependencies

6.5 Assurance

The Strategy's Integrated Assurance and Approvals Plan (IAAP) is included in Appendix A, which has been developed in line with the Environment Agency's Integrated Assurance and Approval Strategy (IAAS) and following the model structure presented by the Infrastructure and Projects Authority.

The governance structure laid out in section 6.1 will be responsible for project assurance for the FBCs. Due to the scale of work required over the lifetime of this strategy, the Strategy will be subject to assurance from the Environment Agency's LPRG for this OBC and the subsequent FBCs. This will complement the BCC scrutiny process including the Growth and Regeneration Scrutiny Commission.

The council's assurance process for major projects including those funded by external grants is known as the decision pathway (see Figure 37). The pathway ensures that the Council can show how spend taxpayers' money is being spent and to ensure accountability. Any proposal must demonstrate that it is legally and financially viable, and to assist with that all proposals are scrutinised by finance and legal teams before they are presented to senior leadership and elected members. Furthermore, projects are subject to scrutiny in public by the members of the relevant scrutiny commission which in the case of the Strategy is the Growth and Regeneration scrutiny commission. Once the proposal obtains approval from the relevant committee and / or full council meeting, authority is then delegated to the appropriate officer(s) to proceed. In the case of major projects such as this, that authority is delegated to the Executive Director in consultation with Section 151 officer and relevant BCC elected members. The pathway provides a rigorous assurance process to ensure that authority to proceed with a proposal is only given following financial, legal, environmental, and equalities due diligence.

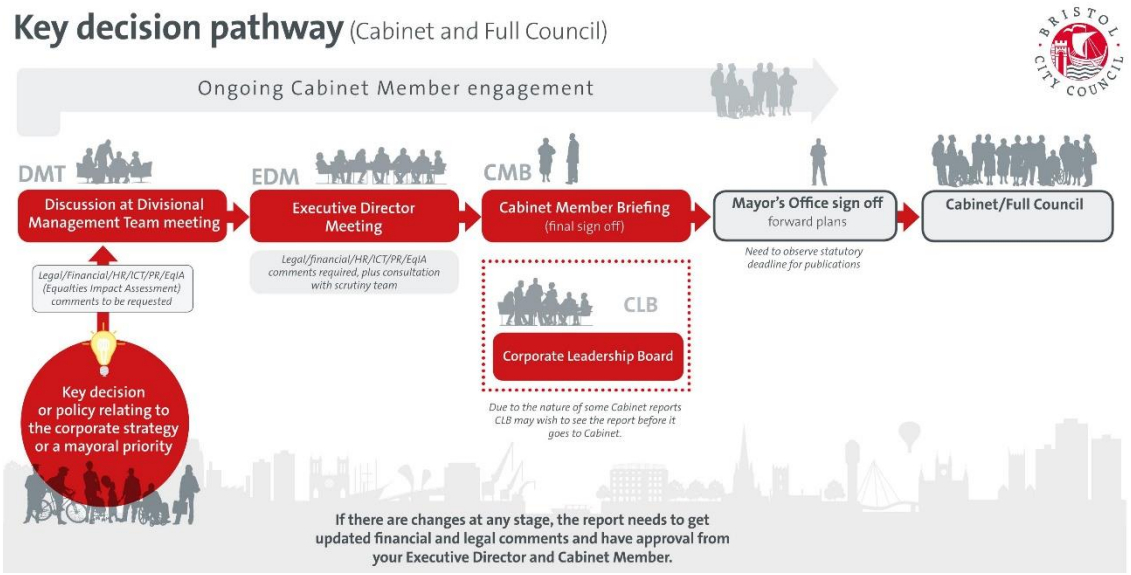


Figure 37 - Illustration of BCC's key decision pathway (

In addition, because this project is eligible for more than £100m of FCRM GiA, it is intended to seek approval from Defra and HMT at FBC. Assurance on the OBC from LPRG and approval from the Environment Agency to continue work on the FBC will be sought. At this point the best route for further OBC assurance including giving Defra the opportunity to influence the development of this scheme will be agreed. However, as no FCRM GiA is being spent until FBC approval, the intention is to progress work on the FBC in parallel to this process, using other funding from BCC, Local Levy and WECA. This will avoid major cost increases and delay to the delivery of these flood defences, which are urgently needed to manage the hazardous flood risk, especially for new development that is coming forward now.

6.6 Communications and stakeholder engagement

6.6.1.1 Statutory stakeholder engagement

Stakeholder engagement with statutory bodies has helped shape early technical stages of the Strategy. These include BCC, Environment Agency, Natural England, Historic England, North Somerset, South Gloucestershire, Bath & North East Somerset and Wessex Water.

The organisations have formed the stakeholder working group who meet regularly to provide assurance and support to the project team. Emerging work is shared for observation and information.

6.6.1.2 Public engagement and consultation

In Autumn 2020, public consultation informed BCC's decision-making to adopt the Strategy, specifically Cabinet approval, and subsequent stages. The consultation raised awareness on the need for the Strategy and views on the strategic approach. Views on alternative strategic approaches that were not proposed were also invited.

BCC will work with neighbouring authorities to ensure that the communities affected by the proposals outside of Bristol are also appropriately engaged and consulted.

Specific objectives of the consultation are:

- To create understanding of the need for the Strategy and the benefits it will bring to the city.
- To seek the views of local people, businesses, stakeholders and developers about the preferred strategic approach outlined in the strategy, placemaking opportunities and to ensure that they have the opportunity to comment on the approaches that the council is proposing not to take forward.
- To ensure that those outside of Bristol who may be affected by flood measures in their areas are adequately consulted.
- To ensure citizens and stakeholders have the opportunity to comment on other options that the council is not proposing to take forward.
- To ensure that consultees understand how flood measures can be successfully designed into developments and create opportunities for placemaking.
- To consult on the Strategic Environmental Assessment.

Further rounds of engagement and consultation are planned as the first phase of the Strategy progresses to design, consenting and construction. For example, when initial designs are drawn up to help develop the proposals at a local level. Feedback will inform the case and then design of the first phase of measures.

6.7 Next steps

- Finalise detailed scope for the FBC stage and outline programme, noting necessary interfaces with other projects in the city and the development of the areas of strategic regeneration.
- Procure FBC supply chain and resources in accordance with the Management Case. Surveys and defence design, including engagement, consultation and suitable Early Constructor Engagement/Involvement.
- Continue work with funding specialists to refine and update detailed funding strategy.
- Re-assess consenting requirements in respect of detailed designs, and consult on proposed approach for reaches located within areas of strategic regeneration, co-ordinating development proposals
- Support planning authority working towards adoption of planning policy as part of Local Plan refresh, and then subsequent Supplementary Planning Guidance or detailed planning instrument(s) supporting the implementation of the Strategy as/if required.
- Commence engagement and surveys to inform design and consenting as part of FBC. Ascertain scheme costs and benefits.

- Further consideration to maintenance aspects including assessment on a site by site basis.
- Further consideration of environmental mitigation and net gain enhancement such as landscaping, public realm and habitat improvements, adopting, as/if appropriate, a city-wide approach beyond the immediate geographical boundaries of the project.
- Environmental consenting – i.e. EIA, HRA, WFD. Additional work on defence encroachment areas and numerical modelling to establish the impacts of the scheme on low and high tide levels within the study area. This will be used to ascertain the scale of potential impacts to habitats and areas of loss to inform the requirements for compensatory habitat.
- Further investigate opportunities and enhancements in relation to the Strategy with regards to heritage, environmental and cultural outcomes, interfaces with the Harbour asset management, and areas of growth and regeneration, under the guiding principle of the core need being flood resilience.
- Progress design and quantification of benefits from potential NFM measures, including in relation to Environment Agency's new NFM Programme.

7. Glossary

ABCR	Average Benefit Cost Ratio - the ratio of project benefits to costs over the lifetime of the project, with all benefits and costs discounted to the present day
AEP	Annual Exceedance Probability is the probability associated with a return period, or chance of occurrence in any given year. An event of return period 50 years has an AEP of 1 in 50 or (2%). • ***High risk*** means that each year this area has a chance of flooding of greater than 3.3%. • ***Medium risk*** means that each year this area has a chance of flooding of between 1% and 3.3%. • ***Low risk*** means that each year this area has a chance of flooding of between 0.1% and 1%. • ***Very low risk*** means that each year this area has a chance of flooding of less than 0.1%.
BCC	Bristol City Council
BCR	Benefit Cost Ratio – This is an indicator, used in the cost–benefit analysis to summarise the overall value for money of a project
BAFS "The Strategy"	Bristol Avon Flood Strategy focusing on managing the risk of flooding from the River Avon to Bristol and neighbouring communities.
BNG	Biodiversity Net Gain
BTQ	Bristol Temple Quarter – the area around Temple Quarter and St Philip's Marsh
CAFRA	Central Area Flood Risk Assessment completed 2010 to assess flood risk in central Bristol from the River Avon and its tributaries.
EA	Environment Agency
EIA	Environmental Impact Assessment
FBC	Full Business Case recording the procurement phase, to identify the option that offers the best public value, records the contractual arrangements, confirms affordability and puts in place the agreed management arrangements for the delivery, monitoring and post-evaluation of the project. Document for submittal to Environment Agency to secure GiA funding of a scheme.

FCRM-AG	Flood and Coastal Erosion Risk Management Appraisal Guidance
Flood defence	Structures built to reduce flood risk
Flood risk	A combination of the chance and the impact of flooding in an area. Could be caused by high tides and storm surges, high river levels, heavy rainfall, sewers and drainage overflowing or high groundwater.
Fluvial flood	Flooding caused when excessive rainfall across the upstream catchment causes flows to exceed the river's capacity.
GiA	Grant in Aid
HMT	HM Treasury
HRA	Habitat Regulations Assessment
IBCR	Incremental Benefit Cost Ratio, the marginal benefit-cost ratio of one scheme compared to a less costly one, used as a test of whether the additional benefits justify the additional costs.
LPRG	The Environment Agency's assurance Large Project Review Group.
LNR	Local Nature Reserve
NNR	National Nature Reserve
NPPF	National Planning Policy Framework
OB	Optimism Bias – HM Treasury Guidance advises there is a demonstrated, systematic, tendency for project appraisers to be overly optimistic. To redress this tendency appraisers are required to make explicit, empirically based adjustments to the estimates of a project's costs.
OBC	Outline Business Case identifying the investment option which optimises Value for Money, prepare the scheme for procurement and put in place the necessary funding and management arrangements for the successful delivery. secure in-principle GiA
PLP or PFR	Property Level Protection or Property Flood Resilience measures applied to individual properties to provide flood proofing
PFC	Partnership Funding Calculator, the tool used to determine the allocation of FCRM Grant in Aid
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment

SOC	Strategic Outline Case to establish the case for change and to provide a preferred way forward
SoP	Standard of Protection, the return period up to which a flood defence is designed to be effective and beyond which the flood defence will be overtopped/exceeded.
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
Storm surge	When storms create a surge of higher water levels out at sea that can travel inland, increasing the water level in the River Avon.
Tidal flood	A flood caused by a high tide and/or a storm surge.
WFD	Water Framework Directive
WLC	Whole Life Cost costs are the total costs of investing in an option over its entire life. For example, all costs associated with the build phase, operation, maintenance and decommission.
1 in 200 (0.5% AEP)	An event that would have a 1 in 200 chance or 0.5% probability of occurring in any given year.
2017 study	Study completed in 2017 appraising options to manage the risk of tidal flooding.

Appendix A

IAAP

Appendix B

Partnership Funding Calculator

Appendix C

Preferred option Report

Appendix D

Modelling report

Appendix E

Economic Appraisal

Appendix F

Cost breakdown

Appendix G

Project schedule

Appendix H

Risk register

Appendix I

Environmental reports

Appendix J

Carbon calculator

Appendix K

Equality Analysis

Appendix L

MoU