

Bristol City Council

Bristol Avon Flood Strategy Outline Business Case

OBC Economics Technical Report

Reference: 2-30-1

P03 | 19 June 2024



This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 285982-00

Ove Arup & Partners Limited
12 Wellington Place
Leeds
LS1 4AP
United Kingdom
arup.com

Document Verification

Project title Bristol Avon Flood Strategy Outline Business Case
Document title OBC Economics Technical Report
Job number 285982-00
Document ref 2-30-1
File reference 2-30-1

Revision	Date	Filename		
P01	11/01/2023	Description	First draft	
			Prepared by	Checked by Approved by
		Name	Luke Ballantyne/Peter Spokes/Martin Smith	Luke Ballantyne Ben Murray
		Signature		Pp
P02	30/01/2023	Filename	Update	
		Description	Incorporating comments from BCC and EA team members	
			Prepared by	Checked by Approved by
		Name	Luke Ballantyne/Peter Spokes	Luke Ballantyne Ben Murray
		Signature		BJMurray
P03	19/06/2024	Filename	19-06-2024 BAS OBC Economic Appendix P03	
		Description	Addressing feedback from LPRG	
			Prepared by	Checked by Approved by
		Name	Luke Ballantyne	Luke Ballantyne Dave Hunt
		Signature		

Issue Document Verification with Document

Contents

1.	Introduction	1
1.1	The need for the strategy	1
1.2	This assessment	2
2.	Grant in Aid eligible benefits	3
2.1	Benefit areas	4
2.2	Property damages	7
2.2.1	Overview	7
2.2.2	Residential property	7
2.2.3	Re-accommodation	8
2.2.4	Non-residential properties	8
2.2.5	Damages to heritage properties	8
2.3	Risk to Life	9
2.4	Vehicle damages	9
2.5	Mental health damages	10
2.6	Intangible health benefits	11
2.7	Utilities	11
2.8	Emergency services	14
2.8.1	Disruption to emergency services	14
2.9	Assumptions	14
2.9.1	Residential Property Values	17
2.10	Culture & Heritage	20
2.11	Amenity & Recreation	29
2.12	The Environment	29
2.13	Education	32
2.14	Railway Disruption	32
2.15	Traffic Disruption	35
2.16	Active Travel	35
2.17	Erosion disruption to Traffic and Active Travel	36
2.18	Rapid drawdown impacts on harbour walls	37
2.19	Rapid drawdown impacts on exposed utilities	38
2.20	Carbon	39
3.	Options	40
3.1.1	Do Nothing	40
3.1.2	Do Minimum	41
3.1.3	Defend	42
3.2	Treatment of climate change	44
3.3	Flood Mechanisms	44
4.	Overlaps	45
4.1.1	River Frome flood risk / Pill flood risk	45
4.1.2	Pluvial flood risk	45

4.1.3	Local economy	46
4.1.4	Culture & Heritage / Amenity & Recreation – Parks	47
4.1.5	Culture & Heritage / Tourism	47
5.	Impacts on the local economy	48
5.1	Overview	48
5.2	Approach to quantification of local economy benefits	48
5.2.1	Direct impacts on commercial property and infrastructure	49
5.2.2	GVA loss saved through reduced flood risk to existing businesses	50
5.2.3	GVA earned through the jobs created by construction	50
5.2.4	GVA saved through the reduced flood risk to Bristol’s tourism industry	50
5.3	Summary of quantified benefits to the local economy	51
5.4	Unquantified benefits	52
6.	Flood damages results	54
6.1	Present Value Damages	54
6.2	Risks to Property	56
6.3	Critical Infrastructure	60
6.3.1	Electrical supply	60
6.3.2	Education	60
6.3.3	Emergency services	60
6.3.4	Healthcare facilities	60
6.3.5	Community centres at risk	61
7.	Strategy costs	62
7.1.1	Approach to costing	62
7.1.2	Capital cost	62
7.1.3	Operation and maintenance cost	63
8.	Selection of the preferred option	64
8.1	Application of the Decision Rule	64
8.2	Grant in Aid	65
8.2.1	Overview of the Partnership Funding Calculator	65
8.2.2	Calculator inputs	67
8.2.3	Calculator outputs	68
8.3	Local Choice	71
9.	Sensitivity Test	75
10.	Available partnership funding	76
11.	Conclusion	77
11.1	Preferred strategy	77
11.2	Grant in Aid eligible benefits	77
11.3	Grant in Aid Funding	77
11.4	The case for other sources of funding	77
11.5	Further considerations	78

Tables

Table 1: Duration of disruption to electrical supply following a flooding event	12
---	----

Table 2: Median electricity density by type of building	13
Table 3: Assumed resilience to electrical outages, by business type and size.	13
Table 4: Key Assumptions	15
Table 5: 2021 Census data used in Risk to Life calculations.	17
Table 6: Residential property values.	19
Table 7: Definition of culture and heritage assets (extract from DCMS 2021)	21
Table 8: Main non-market valuation techniques	22
Table 9: Benefit Transfer Table of Economic Values for Culture (regional museums) (reproduced from DCMS 2020)	24
Table 10: Estimating economic value of museums – main inputs (extract from DCMS, 2020)	26
Table 11: Worked example – Benefit transfer from Benefit Transfer Table of Economic Values for Culture to case study of a museum in Manchester (2020 prices). Reproduced from DCMS 2020.	27
Table 12: EHOV changes to land cover inputs	30
Table 13: EHOV annual environmental benefits	31
Table 14: EHOV PV environmental benefits to 2021 price base	31
Table 15: EHOV PV environmental benefits to 2028 price base	31
Table 16: Approximate value of time and type of user	34
Table 17: Percentage of passenger services delayed or cancelled.	34
Table 18: Estimated residual life of harbour walls and expected year of failure.	38
Table 19: Approximate cost per m for each type of utility	39
Table 20: Carbon benefits & disbenefits (present value 2028)	39
Table 21: Climate change guidance for fluvial events, % changes to 1961-1990 baseline	44
Table 22: Climate change guidance for tidal events, % changes to 1981-2000 baseline	44
Table 23: Assumed timelines for development	47
Table 24: Quantified benefits to the local economy	51
Table 25: Summary of unquantified benefits	52
Table 26: Capped present value damages	54
Table 27: Damages and benefits.	55
Table 28: Property at risk in the Do Minimum scenario, assuming Floating Harbour flood gates are successfully operated.	57
Table 29: Net Present Value strategy costs (NPV to a base year of 2028)	64
Table 30: Benefit cost ratios for each phase	65
Table 31: glossary of the PFC calculator outputs.	66
Table 32: Outcome measure 2a- households at risk today that are better protected against flood risk by this project	67
Table 33: Outcome measure 2b- additional households at risk in 2040 that are better protected against flood risk by this project	67
Table 34 Partnership Funding Calculator payment for outcomes, NPPF option.	68
Table 35: Comparison of phasing options (Green: best; Amber: next best; Red: worst)	72
Table 36: Make up of benefits in estimate of Phase 1 (no Phase 2)	73
Table 37: identified potential sources of funding	76

Figures

Figure 1: Do Nothing 1 in 2 annual chance tidal flood outline, 2030 (solid blue), 2069 (mid blue) and 2125 (light blue). Inset: Pill & Shirehampton.	2
Figure 2: Benefit areas within the study area.	5
Figure 3: Benefit areas within the study area. Central Bristol	6
Figure 4: Types of values for culture and heritage assets to an individual	25
Figure 5: 2130 flood outlines (Light blue- tidal; dark blue – fluvial) at Bristol Temple Meads, showing flood mechanism impacting on passageways under station (east side of station) and isolation of the station in flood events.	33
Figure 6: Progression of the standard of protection against time, for a strategy designed to a 1 in 75 annual chance, and uplifted in 2069	43
Figure 7: Surface Water hotspots for which damages are not claimed	46
Figure 8: Overlaps between Grant in Aid eligible impacts, and impacts to the local economy	49
Figure 9: Properties that are subject to the phenomenon of inconsistent flood damages with increasing standard of protection.	56
Figure 10a: Residential (red) and non-residential (green) properties within the 2130 200yr tidal (pale blue) and 100yr fluvial (dark blue) flood extents for central Bristol. Inset: Pill & Shirehampton.	58
Figure 11b: Residential (red) and non-residential (green) properties within the 2130 200yr tidal (pale blue) and 100yr fluvial (dark blue) flood extents upstream of Bristol.	59
Figure 12: OM2a and OM2b before flood strategy.	69
Figure 13: Distribution of OM2a and OM2b eligible properties at the end of the appraisal period, assuming implementation of 75yr Standard of Protection.	70

Drawings

No table of figures entries found.

Pictures

Picture 1: Flood flows bypassing the lock gates.	42
--	----

Photographs

No table of figures entries found.

Attachments

No table of figures entries found.

Appendices

No table of contents entries found.

1. Introduction

This report outlines the work undertaken by Ove Arup and Partners Limited (Arup) on behalf of Bristol City Council in the economic appraisal for an Outline Business Case for the Bristol Avon Flood Strategy (BAFS).

This report sets out the options appraised, the methodology used to estimate the benefits of each option and the findings. A proportionate cost benefit analysis has been completed.

1.1 The need for the strategy

The City of Bristol is centred on the historic Floating Harbour. The Floating Harbour today is the heart of the city, providing a significant leisure amenity and containing many of the city's cultural and heritage highlights, as well as its commercial centre.

The Floating Harbour is however at risk of flooding from both tidal events and high flows on the River Avon (as well as inflows from other watercourses).

The Harbour's flood 'stop' gates are vulnerable to bypassing mechanisms and failure that, regardless of investment to the gates in isolation, would mean that the Harbour remains at high risk. Studies highlight the operational risk posed to harbour water level control infrastructure from boats, cars and other potential floating debris.

Climate change is increasing sea levels, storminess and peak river flows, all of which increase the risk of flooding. In the absence of investment (the theoretical "Do Nothing" scenario), the effects of climate change would lead to write-off of many cultural and commercial assets in the area of the Floating Harbour, massively impacting on the city's tourism and financial sectors. Future flood risks are a significant consideration for planning policy now. They influence, constrain and could potentially blight development and investor confidence.

Figure 1 shows the future climate 1 in 2 annual chance flood outline: under the rules set out in the Flood Hazard Research Centre's Multicoloured Manual, all properties within this area would be assumed written off.

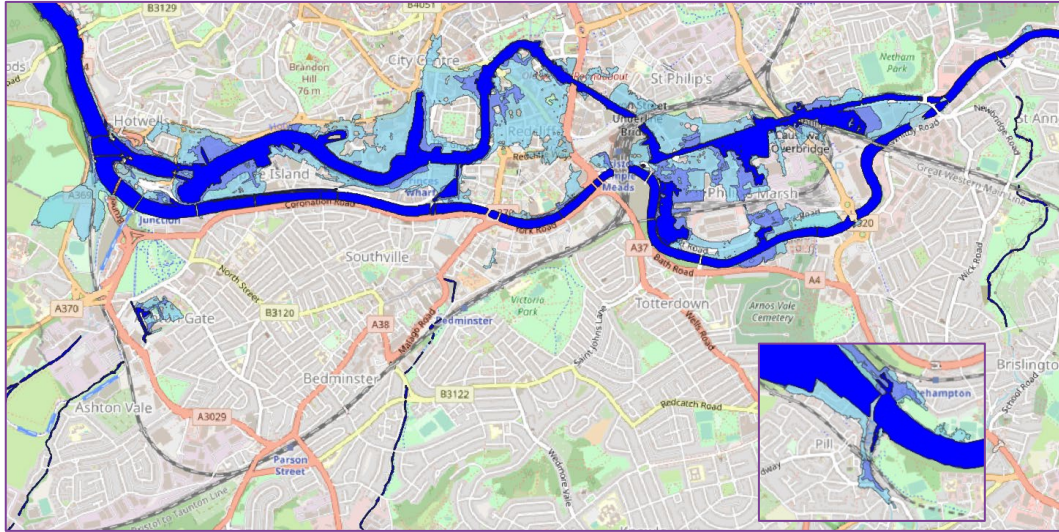


Figure 1: Do Nothing 1 in 2 annual chance tidal flood outline, 2030 (solid blue), 2069 (mid blue) and 2125 (light blue). Inset: Pill & Shirehampton.

Bristol has significant ambitions to grow, with key areas of growth and regeneration proposed for the Western Harbour, Bristol Temple Quarter and St. Philip’s Marsh areas of the city, focused on providing housing, education, and a focus on science and technology.

The transport links provided by Bristol Temple Meads station are recognised as being a key component of these ambitions, not just in the area around the quays but for the whole city, and indeed the South West region. The station and connecting transport links are however subject to disruption in flood events. Proposals to develop a flood defence also provide a Partnership Opportunity for the promotion of sustainable growth and active green travel.

1.2 This assessment

This assessment looks at the economic case for the strategy. It considers a number of options, and applies the Flood and Coastal Erosion Risk Management (FCERM) “**Decision Rule**” to select the “**preferred strategy on economic grounds**”.

The main source of funding attributable to flood and coastal erosion risk management is **DEFRA Grant in Aid (GiA)**.

Grant in Aid eligible benefits, which are predominantly attributable to the reduction of flood risk, reflect economic *impacts on the nation* (as opposed to benefits to the local region).¹ The Environment Agency allocation of Defra Flood Defence Grant in Aid is subject to detailed rules that focus investment on better protecting existing properties. No flood scheme BCR and economic case includes for any regeneration (indeed only properties constructed before 2012 are counted).

The amount of Grant in Aid available to the strategy is calculated using the **Partnership Funding Calculator (PFC)**. The PFC provides different rates of

¹ <https://assets.publishing.service.gov.uk/media/5a7c89f1ed915d448c2410708/pb13896-flood-coastal-resilience-policy.pdf>

payment for different kinds of outcomes, and higher payment rates are provided for moving residential properties out of high flood risk into lower risk, as well as for reductions in flood damages that affect people on a personal level.

Grant in Aid is only payable up to the magnitude identified for the preferred strategy on economic grounds. However Bristol City Council have greater ambitions, focussed on the delivery of strategic local development, for which a greater standard of protection is required to satisfy the flood risk terms of the National Planning Policy Framework. This option is Bristol's "**local choice**", and this assessment goes on to make the case for the local choice.

To enable the local choice, and to close out the gap between the cost of the strategy and Grant in Aid, partnership funding contributions will need to be sought, from local government and other organisations and businesses. The case for securing funding from local government is driven by impacts to the local economy, and no longer limited to impacts on the nation.

To this end, this assessment has also analysed local benefits, that reflect the financial benefits to the City of Bristol of addressing flood risk. This assessment, presented in detail in Appendix B, and summarised in Section 5 of this document, may form the basis of bids to access alternate sources of funding, further supporting the development of the strategy.

We have been very mindful of the interface between areas of growth and regeneration and BAFS. The potential contribution that areas of growth and regeneration could deliver to BAFS is through developer (in-kind) contributions whereby the measures they take to make their site flood resilient effectively deliver the flood strategy requirements for that reach (e.g. raised features forming the defence line within the fabric of the development plot).

2. Grant in Aid eligible benefits

Floods' devastating economic costs to the nation stem from direct physical damage to property contents and fabric, indirect impacts on critical transport, communications, utilities or other essential services. The social impacts of flooding are widespread, interconnected and may be long-lasting; these intangible impacts are both direct and indirect.

Economic losses from the predicted flood risk have been estimated using the Flood Hazard Research Centre's Multi Coloured Manual (MCM) methodology². The following direct economic impacts have been estimated:

- Damages to residential and non-residential properties
- Emergency Services
- Indirect commercial impacts due to flooding to businesses
- Costs of evacuation / re-accommodation of residential properties
- Vehicle damages

² Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal, 2013 Flood Hazard Research Centre

- Risks to Life
- Mental health
- Intangible benefits
- Active travel benefits
- Culture and heritage
- Recreation and amenity
- Environmental
- Carbon impacts
- Education
- Utility damages
- Transport disruption due to flood events, including rail and road traffic
- Erosion and rapid drawdown impacts
 - Transport disruption including road traffic and active travel
 - Harbour wall repairs
 - Utility diversions.

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.

Predicted flood depths are estimated from the average ground level at each property, the modelled flood water level and an allowance for the property threshold height. MCM depth damage curves were used to derive property damages, based on hydraulic modelling of water level predictions for the modelled scenarios of the project phases.

2.1 Benefit areas

The study area was sub-divided into benefit areas to facilitate a more detailed breakdown of the results and data input parameters. Each of these benefit areas corresponds to a key area within the city region at risk of flooding. See Figure 2 and Figure 3.

The benefit areas do not correspond to flood cells as such, which are technically hydraulic independent, but provide the necessary detail to be able to report (coarsely) on individual communities, reaches between key restrictive structures, and individual flood mechanisms (e.g. the River Frome).

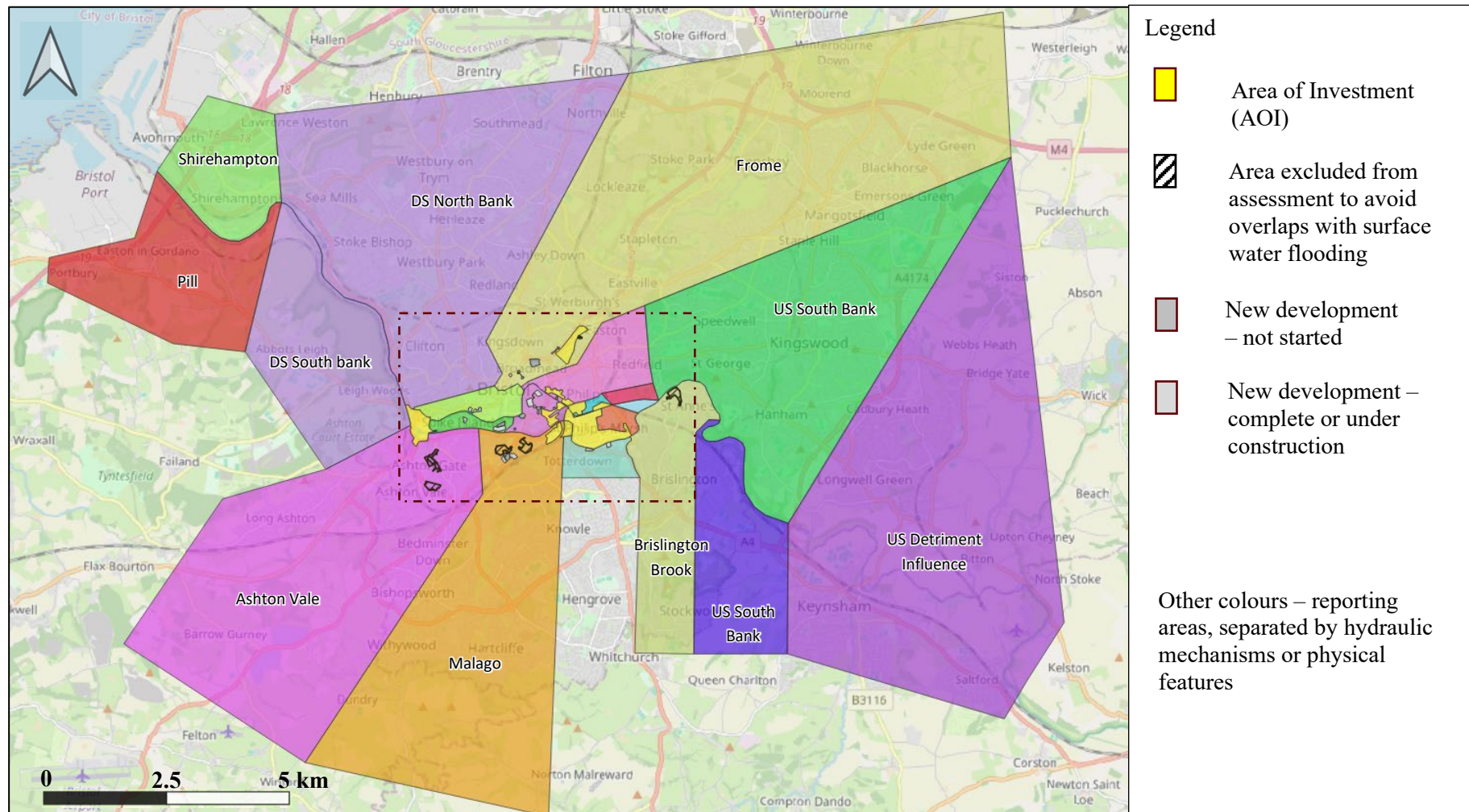


Figure 2: Benefit areas within the study area.

2.2 Property damages

2.2.1 Overview

The FHRC “Multicoloured Manual” provides many techniques for the evaluation of different types of flood damage at individual properties; these relate flood depths to flood damages for each individual flood event.

Property damages are calculated for a range of different event probabilities and integrated to find the annual average damage (AAD) over the appraisal period.

Climate change means that the relationship between probability and event magnitude changes over time, and this means that the AAD value also changes against time. AAD has been calculated for four different climate change epochs in line with current English guidance.

The damages accrued over the proposals’ lifetime have been calculated in Net Present Value (NPV) terms by interpolating between the values of AAD in each epoch and discounting into present day values based on the Treasury Green Book discount rates.

Properties are considered to be written off if they are flooded on average more than once every 3 years. The write off value of the property is converted to a Net Present Value also using Treasury Green Book Discount rates.

Finally, the NPV damages and Write off are capped so that they do not exceed the market value of that property in total. Uncapped damages in the Do Nothing are approximately 3 times as large as the capped damages, reflecting the high level of flood risk.

Benefits, represented by damages avoided, are then calculated by comparison of the damages observed during the baseline “Do Nothing” option with the damages observed during each of the Do Something options.

The damage estimates have been reviewed for potential sensitivity to individual properties. No properties comprise more than 1% of Do Nothing damages, and only 5 properties comprise more than 0.5% of Do Nothing damages. The top 50 properties are responsible for 12.2% of the Do Nothing damages. These properties have been inspected to see if any of their parameters appear particularly responsible for the magnitude of their influence – in general they simply reflect that these are large, high value properties at high risk of flooding.

2.2.2 Residential property

The MCM values flood damage to residential properties based on age, property type and social class (although this latter point is subsequently adjusted for by equity adjustment factors).

Residential MCM codes from the National Receptor Dataset were inspected and updated where necessary to match the category of the housing; detached, semi-detached, terraced, flat or bungalow. Historical maps, Consumer Data Research

Centre³ dwelling age maps and Google Street View were used to update property ages. Properties post-dating 2012 construction have been removed from the analysis (as per Grant in Aid funding rules, which do not provide funding for property that should have been developed to be at low risk of flooding in accordance with National Planning Policy Framework guidance).

Only properties with ground level and basement level occupancy are included in the direct property damage calculation. Upper floor properties have been kept in for the assessment, but only Risk to Life and Vehicle damages are associated with these properties.

Social grade is used in the calculation of flood damages to residential properties, together with property age data, giving the 4 digit MCM code. This allows use of individual depth damage curves per property age, per local authority, which are subsequently adjusted using the Distributional Impact factors to calculate property damages.

2.2.3 Re-accommodation

The costs of evacuation and rehousing of residents during floods, and while their properties are restored following flooding are calculated based on the “Mid” value of the “Full Scale Evacuation Cost” tables from the MCM. These provide a cost based on the depth of flooding, and a given property type.

2.2.4 Non-residential properties

The study area includes non-residential properties (NRP). The MCM values flood damage to NRP building fabric and contents on the basis of various NRP categories and ground floor areas estimated from Ordnance Survey Mastermap. The area attributed to each property is based on the floor area of the building polygon.

The number of upper floors is identified by combining Valuation Office Agency rental yield data with the OSMM and NRD. Direct damages are not associated with the upper floors.

2.2.5 Damages to heritage properties

Bristol is a city with a high number of heritage buildings within the floodplain. These structures often include elements of timber construction that might be considered more susceptible to flood conditions.

Prior assessment of this issue has drawn on a PARNASSUS research project⁴ by a University College London student on flood vulnerability of Bristol’s listed buildings. This project however made erroneous assumptions regarding the potential water level difference between the interior and exterior of the buildings, and this meant its key conclusions greatly exaggerated the potential risk to the

³ <https://maps.cdrc.ac.uk/#!/metrics/dwellingage/default/BTTTTFFT/11.132837961736747/-2.5777/51.4782/>

⁴ Parnassus v2.0, “Vulnerability of Historic Buildings to Tidal Flooding in Bristol due to Climate Change”, Chee Cheek Foo and Christopher King-Wah Wong, University College London, 2016

buildings, at least in terms of the mechanisms considered. The report did however provide mapping of the heritage properties, and this has been used to identify the same properties within the damage assessment.

2.3 Risk to Life

The economic impacts of potential loss of life from a flood event have been assessed by application of the approach in “Assessing and Valuing the Risk to Life from Flooding for the Use in Appraisal of Risk management measures”⁵. Risk to life assesses the likely impact of floods of different severities on the properties affected.

The analysis defines a value for the number of fatalities likely, taking into account the severity of flooding defined by the flood hazard (based on depth, velocity and debris), as well as the demographics (the amount of population in the floodplain, and the vulnerability of the population based on census data) and characteristics of the area at risk (including speed of flood onset and available flood warning). This value is multiplied by the valuation of a life, over the appraisal period, listed in Table 4, and is subject to health based discounting factors to provide a Present Value.

The calculation is based around the population within the floodplain, and in this respect takes into account the residential and worker population present.

The calculation is conservative in that it does not take into account the visitor population present. Tourism calculations estimate 1.6m visitors per annum to the harbour area in 2019; other “visitors” not taken into account include customers visiting retail and dining establishments, or the worker population from outside the floodplain that might be attracted to the city centre for lunchbreaks etc.

2.4 Vehicle damages

Economic losses associated with damage to vehicles are estimated for all residential properties, based on an average of 1.27⁶ vehicles per residential property. This value represents a “Urban City and Town”. Guidance suggests that flood depths of greater than 390 mm are almost certain to lead to a vehicle being written off (FCERM-AG, 2013)⁷.

The Bristol floodplain contains a high proportion of non-residential properties (buildings with any usage other than residential). The sole adoption of the above approach would lead to gross under-estimates of vehicles at risk, and an approach is taken to calculate vehicle damages based on both residential and non-residential properties.

⁵ Defra (2008), “Supplementary Notice to Operating Authorities – Assessing and Valuing the Risk to Life from Flooding for the Use in Appraisal of Risk Management Measures”

⁶ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/906062/nts9902.ods

⁷ “FCERM: A Manual for Economic Appraisal”, 2013 Flood Hazard Research Centre and Environment Agency

Damages equal to the write-off value of all vehicles at the property are assumed for all residential properties where flood depth exceeds the 390mm threshold, minus an assumed 25% for vehicles that might be moved during a flood event.

2.4.1 Sensitivity test – percentage based write-off of vehicles.

A sensitivity test was conducted using the assumption that 1 vehicle is written off for 42% of properties flooded (or put another way, 0.42 vehicles are written off for each flooded property), minus an assumed 25% for all vehicles that might be moved during a flood event where warning was provided. While the Multi-Coloured Handbook denotes this as an “Overview” methodology, it was considered as approaches suggested for “Initial” and “Full Scale” methods take no explicit account of commercial property numbers. This method was found to result in a 20% reduction in Do Nothing vehicle damages.

2.4.2 Discussion: merits of different vehicle damage methods

Both the depth based and percentage based methods are believed to underestimate vehicle damages where Bristol is concerned. This is an artefact of the low ratio of homes to non-residential properties in the Bristol floodplain, which is approx. 2:1. By comparison, ABI figures from the 2007 and 2012 floods (the basis for the percentage based approach) indicate a ratio of 14:1. The implication is that in a flood event, a large number of the vehicles present in the Bristol floodplain would be from outside of the floodplain, and this ratio is far higher than accounted for in either of the methods covered above.

The basis of the depth based write-off approach assumes that when vehicles are away from the home they are registered to, they are at another location within the floodplain. RAC data suggests that vehicles spend 73% of their time parked at their home, and 4% driving². If we assume a reasonable 1-3% of their time is spent visiting other homes, this leaves approx. 20-22% of their time spent at non-residential properties, largely for work, leisure and shopping. If therefore Bristol has 7 times as many non-residential properties as typically found in the floodplain, vehicular damages should be approx. 2.2x greater than calculated by the depth based residential approach, and this would be worthy of reconsideration at Full Business Case.

2.5 Mental health damages

The impacts of mental health due to the higher rates of anxiety, depression and post-traumatic stress disorder after a flood event have been calculated using the latest guidance from Environment Agency⁸. The costs associated with these illnesses include the treatment costs and the loss of employment. Co-morbidity and the proportion of those seeking treatment have also been considered.

⁸https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879942/Mental_Health_Guidance.pdf

The number of adults in each residential property was based on the national averages determined from census data as presented in the Mental health guidance⁹ and this was then multiplied by the mental health costs per adult for each flood depth band. Mental health costs are discounted at the health discount rate, and only applied to ground floor and basement residential properties.

The current approach is conservative as it does not take into account similar mental health impacts that might apply to business owners and workers who have their livelihoods and long term investments placed at risk; who might be involved in the clean up of their place of work, and who may experience low mood from working in a lower quality work environment while their business recovers. It also does not take into account the (lesser) impact on visitors whose holiday / break may be cancelled or disrupted during their stay.

2.6 Intangible health benefits

Intangible health benefits reflect the longer-term personal impact of flooding on the health and wellbeing of those affected; a reduction in flood risk is correlated with an approximate equivalent financial benefit.

The MCM 2013 methodology was used to estimate intangible benefits with flood risk management improvements at a property level. The basis of the estimation is that flooding of residential properties causes stress, disruption, illness and other losses that are not assigned a value in the main economic assessment. Rather than increase the losses in each flood event to include this, the Intangible Benefits assessment provides a positive benefit that can be added to the ‘damages avoided’ by each option. The magnitude of the benefit is dependent on the number of residential properties benefitting (i.e. with a reduced threshold of flooding), and the size of the change in threshold frequency of flooding at each property.

Intangible health benefits are discounted at the health discount rate, and only applied to ground floor and basement residential properties.

2.7 Utilities

Direct flood damage to electricity substations were calculated on the basis of the MCM depth damage curve for MCM Code “960”.

Disruption to the electrical grid has been explicitly calculated. The properties served by each flooded substation have been identified from GIS.

In the event of flooding to a substation, the assumed duration of electrical disruption is as follows:

⁹<https://www.gov.uk/government/publications/mental-health-costs-of-flooding-and-erosion/mental-health-costs-of-flooding-and-erosion>

Table 1: Duration of disruption to electrical supply following a flooding event

Number of substations flooded	Duration of electrical disruption (hours)
0-29	39
30-60	63
60-89	87
90+	111

The duration assumes 15 hours of flooding (based on historic flood events), plus 24 hours to repair damage up to the present day 75yr return period event (tidal) or 100yr event (fluvial). At events in excess of this threshold, it is considered that the large number of substations affected leads to increases in the duration to repair, and is assumed to increase by 24 hours for each approximate multiple of the impact in that event. This reflects that not only would human and equipment resources be stretched by the number of substations within the study area, but also that there would be high numbers of substations affected outside of the bounds of the study area. Moreover, National Grid offices and facilities at Avonbank, off Feeder Road contain engineering offices, administrative facilities, and repair equipment. Disruption to this site due to either direct flooding, and/or the surrounding area and transport links would further delay the repair effort.

Willingness to pay for businesses was £62.19/hr and £17.77/hr for domestic users, based on 2023 MCM data, uplifted to 2028 using the GDP Deflator.

Electrical consumption for businesses was based on the figures in Table 2, which are from 2020 data in the Non-domestic National Energy Efficiency Data Framework 2022¹⁰. A value of 2,700 KWh/yr for domestic users was taken from Ofgem's average gas and electricity usage estimate¹¹.

¹⁰ <https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2022>

¹¹ <https://www.ofgem.gov.uk/information-consumers/energy-advice-households/average-gas-and-electricity-use-explained#:~:text=Individual%20appliances%20can%20vary.,of%20gas%20in%20a%20year.>

Table 2: Median electricity density by type of building

Type of building	Median Electricity Intensity KWh/m ² /yr
Factories	30.04
Offices	59.18
Shops	83.75
Warehouses	26.90
Restaurants	111.46
Other	42.90

Some businesses may have implemented resilience measures to prevent disruption due to electrical outages. Assumptions as to the likelihood of this were made based on the Frontier methodology, which provides an indicative matrix for a business's adaptive capacity based on type and size. These are presented in Table 3.

Table 3: Assumed resilience to electrical outages, by business type and size.

Business type	Business Area (m ²)	Business Size	Adaptive capacity	Assumed Resilience
Retail	< 270	Micro	Low	0%
Office	< 560			
Warehouse	< 150			
Factory	< 700			
Retail	< 5,700	Small / Medium	Medium	30%
Office	< 3,600			
Warehouse	< 17,500			
Factory	< 14,000			

The National Grid Avonbank site also includes a 20MW biofuel generation facility intended to provide supply head room to sustainably manage peaks in demand. While this facility would only be run for 200 hours in a year (max 2 hours at a time), it allows National Grid to operate with lower supply head room, which means that flooding to this facility would have a significant impact on the sustainability of local electricity supply. The benefit of protection to this facility has not been assessed as its location within the floodplain is not known, and its role as peak supply "top-up" makes assessment of its impact more difficult. This could be reviewed at FBC.

2.8 Emergency services

Emergency services have been assumed at 5.6% of capped direct property damages (discounted at the health discount rate), based on the economies of scale of an urban environment.

2.8.1 Disruption to emergency services

Two ambulance stations (and a fleet servicing facility) are sited within the St Phillips floodplain; 32 ambulances can be seen parked at them in satellite photography and presumably more would have been distributed around the city. It is understood that Bristol is served by 200 ambulances, so these stations may reasonably be interpreted as 15- 30% of the city's capacity. No allowance has been made for disruption to or loss of this capacity.

It is noted that most hospitals in Bristol are located to the north of the Avon and Floating Harbour; there would therefore be a significant increase in emergency response times for south Bristol while transport is impacted during a flood event. There is only one ambulance station south of the Avon, located at Keynsham; only 1 ambulance can be seen parked at this station in satellite photography, and at face value it therefore appears likely that there would be serious shortfalls in service during major flood events.

No monetary allowance has been made for this impact, but if necessary the associated disruption and impacts on risk to life could be assessed at FBC.

2.9 Assumptions

Present value damages have been estimated for a 100-year appraisal period, based on the assumed design life of the proposed works. The assumed date for submission of FBC is 2028, and all costs are inflated to this year using the GDP Deflator (Nov 23), and pv. costs are discounted to this year using Treasury Green Book discount rates.

The National Receptor Dataset (NRD) was supplemented with the OS MasterMap Topographic Area data to maximise the available information on each property, and then 'cleaned' to exclude those property points with no land-use categories or floor areas.

Property threshold level has been assumed off LiDAR digital terrain ground level plus 150mm, or survey data where available, as per guidance from MCM. Thresholds have been inspected in Google Streetview, and the 150mm value is considered broadly appropriate.

Non-commercial NRPs, including PO Boxes and telephone boxes, were excluded from the assessment by assigning an MCM code of 9 – which does not accrue any damages for any level of flooding. The assessment also does not value the impact of flooding to agricultural or amenity land.

Any properties with an MCM code of 999 (undefined) were checked against Google aerial maps and street view imagery to determine whether a more appropriate value could be given or whether the property needed to be removed

from the analysis (often garages, outbuildings, etc.). The same process was used to determine the correct MCM code when the NRD and MasterMap values did not correspond.

The assessment assumptions are summarised in the below table.

Table 4: Key Assumptions

Parameter	Assumed Value		
Properties			
Property Threshold	Residential	150 mm	Nominal assumed
	Non-residential	150 mm	Nominal assumed
Residential Property Value	Detached	Various – see Table 5.	
	Semi-Detached		
	Terraced		
	Bungalow		
	Flat		
NRP Rateable Value (£/m ²)	Factory	47.09	Taken from MCM Table 5.4 for the South West region
	Retail	175.63	
	Office	127.27	
	Warehouse	47.09	
	Other	73.82	
NRP Rental Yield %	Factory	5	Taken from MCM Table 3.4
	Retail	6.5	
	Office	6	
	Warehouse	5.5	
	Other	5.5	
GDP Deflator	117.216	GDP deflator to 2028 is 117.216, used to adjust the damage data used by the tool, for which the GDP deflator for the MCM 2023 data is 107.033	
Flood Characteristics			
Flood Type	Fluvial (storm)	Tidal	
Flood Duration	Over 12 hours	Under 12 hours	
Flood Warning	Over 8 hours	Over 8 hours	
Risk to Life Parameters			
Average number of people per property	2.12 – 2.42		
Percentage elderly (> 75 years old)	2.1 – 13.90	See Table 5	

Parameter	Assumed Value		
Percentage disabled or infirm	16.2 – 19.4	See Table 5	
Reference value of a life (at 2025)	£2,249,765	Based on value of £1,646,800 from 2010 uplifted to 2028 using GDP Deflators from 77.568	
Flood warning	England – 2.15		
Speed of Onset	1 - Very gradual		
Nature of area	2 – typical residential area, industrial and commercial areas		
Nature of catchment	Urban		
Vehicle Damage			
Vehicles Per Household	1.3	Urban City and Town. Household car ownership by region and Rural-Urban Classification: England, 2022	
Threshold for vehicle write-off	390mm	As recommended by the Multi-Coloured Manual.	
Average Value Per Vehicle	£6,550	Based on £5,600 figure from 2019, brought up to date for 2028 using GDP Deflators from 90.612	
Additional Assumptions			
Susceptibility	Indicative	Indicative assumed as default	
Social Class Distribution	Class AB	27.4%	Social Grades for the City of Bristol Local Authority
	Class C1	34.1%	
	Class C2	16.9%	
	Class DE	21.6%	
	Class AB	27.1%	Social Grades for the North Somerset Unitary Authority
	Class C1	35.2%	
	Class C2	21.2%	
	Class DE	16.6%	
Emergency Service allowance	5.6% of direct property damages ¹²		
Utilities damage allowance	Calculated explicitly as per Section 2.7.		
Indirect commercial losses	3% of non-residential property damages		

¹² FCERM: A Manual for Economic Appraisal, 2013 Flood Hazard Research Centre and Environment Agency

Parameter		Assumed Value	
Mental health parameters		Assumed value	Source
Adults per property	Detached	2.01	Mental health guidance ¹³
	Semi-detached	2.00	
	Terrace	1.95	
	Bungalow	1.99	
	Flat	1.45	
Mental health losses per adult by flood depth	0 – 0.3m	£1,878	Based on values from 2018 mental health guidance ¹⁴ , brought up to date for 2028 using GDP Deflators from 88.735.
	0.3 – 1m	£3,028	
	> 1m	£4,136	
HM Treasury Green Book Discount Rates			
Green Book Discount Rates	0-30 years	3.5%	
	31-75 years	3.0%	
	76-100 years	2.5%	
Green Book Discount Rates (Emergency Services, mental health, intangible benefits, Risks to Life)	0-30 years	1.5%	
	31-75 years	1.3%	
	76-100 years	1.1%	

Table 5: 2021 Census data used in Risk to Life calculations.

Ward	Percentage aged 75 plus	Percentage Households with a Disability or Long Term Health Problem
Keynsham South	10.1	16.2
Westerleigh	8.7	16.5
Hartcliffe	7.75	19.4
Frome Vale	8.15	19.4
Staple Hill	10.25	16.5
Filwood	4.9	19.4
Southmead	6.9	19.4

¹³<https://www.gov.uk/government/publications/mental-health-costs-of-flooding-and-erosion/mental-health-costs-of-flooding-and-erosion>

¹⁴https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879942/Mental_Health_Guidance.pdf

Ward	Percentage aged 75 plus	Percentage Households with a Disability or Long Term Health Problem
Kingsweston	7.8	19.4
Henbury	6.6	19.4
Bishopsworth	9.1	19.4
Whitchurch Park	8.5	19.4
Keynsham East	13.7	16.2
Hengrove	8.5	19.4
Lawrence Hill	2.45	19.4
Filton	8.1	16.5
Avonmouth	7.5	19.4
Rodway	10	16.5
Keynsham North	11.5	16.2
Lockleaze	6.8	19.4
Kings Chase	10.1	16.5
Stockwood	11.8	19.4
Hanham	11.9	16.5
Hillfields	5.3	19.4
Bathavon North	12.1	16.2
St George West	6.2	19.4
Knowle	6.3	19.4
Publow and Whitchurch	9.2	16.2
Downend	12.55	16.5
Saltford	13.6	16.2
Parkwall	7.7	16.5
Boyd Valley	8.7	16.5
Winterbourne	14.7	16.5
Bedminster	6.3	19.4
Woodstock	8.5	16.5
Eastville	4.6	19.4
Brislington East	7.5	19.4
Easton-in-Gordano	12.4	17.7
Westbury-on-Trym	14	19.4
Chew Valley North	12	16.2
Bitton	11.3	16.5
Backwell	11.7	17.7
Southville	5	19.4
Easton	3.8	19.4
Horfield	5.433333333	19.4
St George East	7.65	19.4
Farmborough	13.6	16.2
Henleaze	11.4	19.4

Ward	Percentage aged 75 plus	Percentage Households with a Disability or Long Term Health Problem
Pill	12.4	17.7
Brislington West	6.9	19.4
Oldland Common	7.9	16.5
Longwell Green	12.6	16.5
Ashley	2.3	19.4
Wraxall and Long Ashton	11	17.7
Emersons Green	5.6	16.5
Stoke Gifford	8.1	16.5
Windmill Hill	3.3	19.4
Siston	8.7	16.5
Stoke Bishop	10.5	19.4
Frenchay and Stoke Park	5.6	16.5
Gordano	11	17.7
Winford	12.4	17.7
Bishopston	3.3	19.4
Redland	4.266666667	19.4
Clifton	5.45	19.4
Cabot	2.1	19.4
Cotham	3.6	19.4
Clifton East	3.5	19.4

2.9.1 Residential Property Values

Residential property prices are based on the regional values for the southwest of England. The most recent values (March 2024)¹ have been used uplifted to 2028 values based on the GDP deflators. The table below lists the uplifted average property prices.

Table 6: Residential property values.

Property type	Average value
Detached	£528,227.70
Semi-detached	£351,321.67
Terraced	£282,663.71
Flat	£207,331.22
Bungalow	£207,331.22

2.10 Culture & Heritage

2.10.1 Methodology

Cultural and heritage assets from museums to festivals are of vital importance to the economy of Bristol. Sites such as the M Shed and the SS Great Britain draw 100,000s of tourists each year.

Cultural and heritage assets at risk of flooding were identified using a range of data sources. These include the following:

- Historic England shapefiles identifying listed buildings, World Heritage Sites, and Scheduled Monuments
- Museums as shown on <https://www.bristolmuseums.org.uk/> and <https://visitbristol.co.uk/things-to-do/museums-and-galleries>
- Festivals as shown on <https://visitbristol.co.uk/whats-on/festivals>

The value of these cultural/heritage asset was calculated using the DCMS Rapid Evidence Assessment methodology in conjunction with the DCMS Culture and Heritage Valuation Studies Evidence Bank. This valuation approach aligns with the Social Cost Benefit Analysis (SCBA) methods in the UK HM Treasury Green Book Guidance.

This method uses a contingent valuation to estimate a person's willingness to pay to keep the asset in a good condition. These willingness to pay values were obtained from the Cultural and Heritage Capital Valuation Studies Evidence Bank.

The assessment used these valuations along with estimated disruption due to flood risk across the assets to provide an Annual Average Damage value for cultural/heritage capital.

The methodologies discussed above are outlined in further detail in the following sections.

2.10.2 DCMS Rapid Evidence Assessment Methodology

The DCMS Rapid Evidence Assessment methodology provides a framework for how to quantify and monetise economic benefits related to culture and heritage. DCMS have grouped culture and heritage assets into broad categories, as shown in Table 7.

Table 7: Definition of culture and heritage assets¹⁵ (extract from DCMS 2021)

Type of asset	Definition	Examples
Built Historic Environment	A historic structure identified as having a degree of significance because of its heritage interest	Listed and unlisted historic buildings and structures
Landscapes and Archaeology	Historic features in the natural environment	Archaeological sites, battlefields, canals, gardens, parks, ruins, shipwrecks
Collections and Movable Heritage	An object that can be moved into a collection or is mobile	Art, archives, libraries, museum collections, plaques, sculptures, transport such as aircraft and trains
Performance and Performance Venues	Artistic content for an audience	Theatre, cinema, concerts halls, dance, festivals, multi-purpose spaces, music venues, and other performance venues
Digital Assets	A virtual collection for engagement	Digital archives, online collections

The DCMS Rapid Evidence Assessment uses contingent valuation to estimate the value that a person places on a good or service. The survey-based economic technique focuses on asking people to report their willingness-to-pay (WTP) for obtaining the good/service. This technique is applied in the absence of market-driven valuation of the good/service. There are four methods of valuations:

¹⁵ DCMS, 2021, “Valuing Culture and Heritage Capital: a framework towards informing decision making”

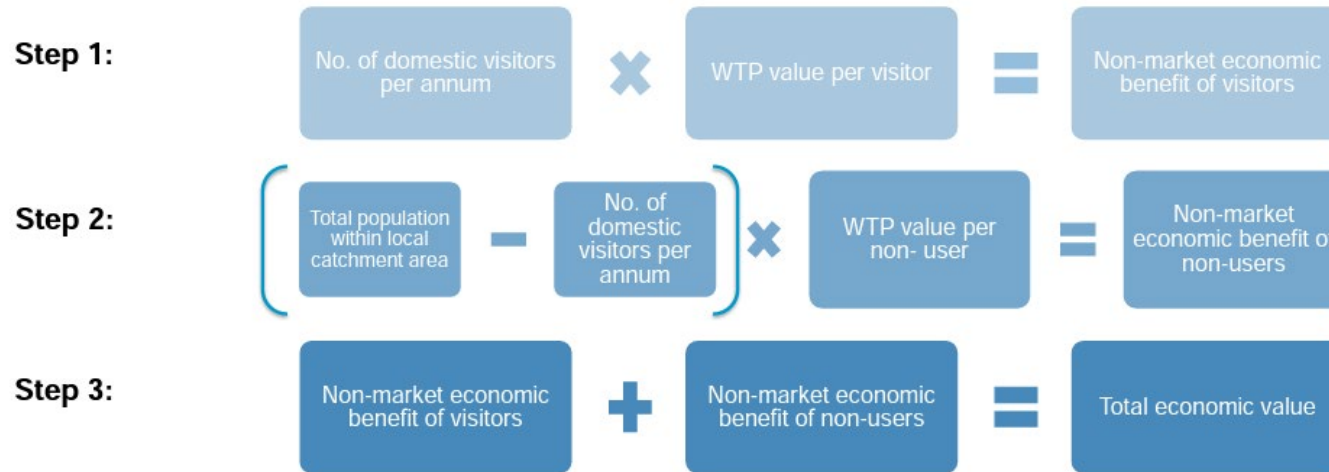
Table 8: Main non-market valuation techniques¹⁶

Valuation method	Description	Example
Revealed Preference (RP)	Applied to goods and services that result in observable changes in behaviour in indirect markets	Value of built heritage may be revealed indirectly in housing markets across regions where the level or quality of provision of built heritage differs.
Stated Preference (SP)	Applied to goods and services that do not result in observable changes in market behaviour but are amenable to direct monetisation	Willingness to pay to access a hypothetical entry fee to access a cultural institution that is currently free to the public, e.g. museums, art galleries.
Wellbeing Valuation (WV)	Applied to goods and services that do not result in observable changes in market behaviour and are difficult to monetise directly, but may have measurable effects on individual wellbeing measures and so can be monetised indirectly.	Regular engagement with culture and heritage
Benefit, or Value, Transfer (BT)	Method of transferring values from one site to another. Values can be obtained from the literature using source studies.	

The economic valuation is based on visitors and local residents' Willingness-to-Pay (WTP)¹ to keep the site in good condition. It uses a technique known as Benefits Transfer² (BT).

The BT is the calculation to qualify the public benefit. It is an exercise which takes estimated values from a sample of sites and applies them to another site. For sites with similar characteristics to the site under assessment, the following three steps can be performed:

¹⁶ Simetra-Jacobs, 2020, "DCMS Rapid Evidence Assessment: Culture and Heritage Valuation Studies – Technical Report".



In order to quantify the public benefit both visitor and non-visitor values are calculated. Non-use value refers to the value for a cultural/heritage asset stated by those who have not visited or engaged with it within a designated period (e.g. the past three years). These non-visitors may hold elements of use value, such as the option to visit the asset in the near future or having it online for research or recreational reasons.

Assets were mapped to willingness to pay (WTP) values using the DCMS’s Culture and Heritage Capital Evidence Bank. For visitors, WTP values were set to the greater of the value drawn from the Evidence Bank, and current ticket prices, uplifted to 2028. The lower end of the WTP range from the evidence bank was used to determine the WTP value for non-users for all assets.

An example of WTP values for regional museums is shown in Table 9.

Table 9: Benefit Transfer Table of Economic Values for Culture (regional museums)¹⁷ (reproduced from DCMS 2020)

Willingness to pay for regional museums. Based on WTP values for Great North Museum (Newcastle), World Museum (Liverpool), National Railway Museum (York), Ashmolean Museum (Oxford)	
Population Group	2020 WTP value (2018 value)
Visitor WTP for access – user value per visit	
Visitor WTP entry fee for access museum (per visit)	£6.16 (£6.01)
General population WTP to maintain museum and its collections – Non-user/Non-visitors	
Non-visitor (non-user) WTP	£3.25 (£3.17)

Non-use value is an important element of the societal benefits that museums and other cultural institutions provide to the public. As non-use values are still in early development, the guidance recommends using the most conservative approach where possible.

¹⁷ Source: Art Council England, DCMS, Nesta, Simetrica Jacobs

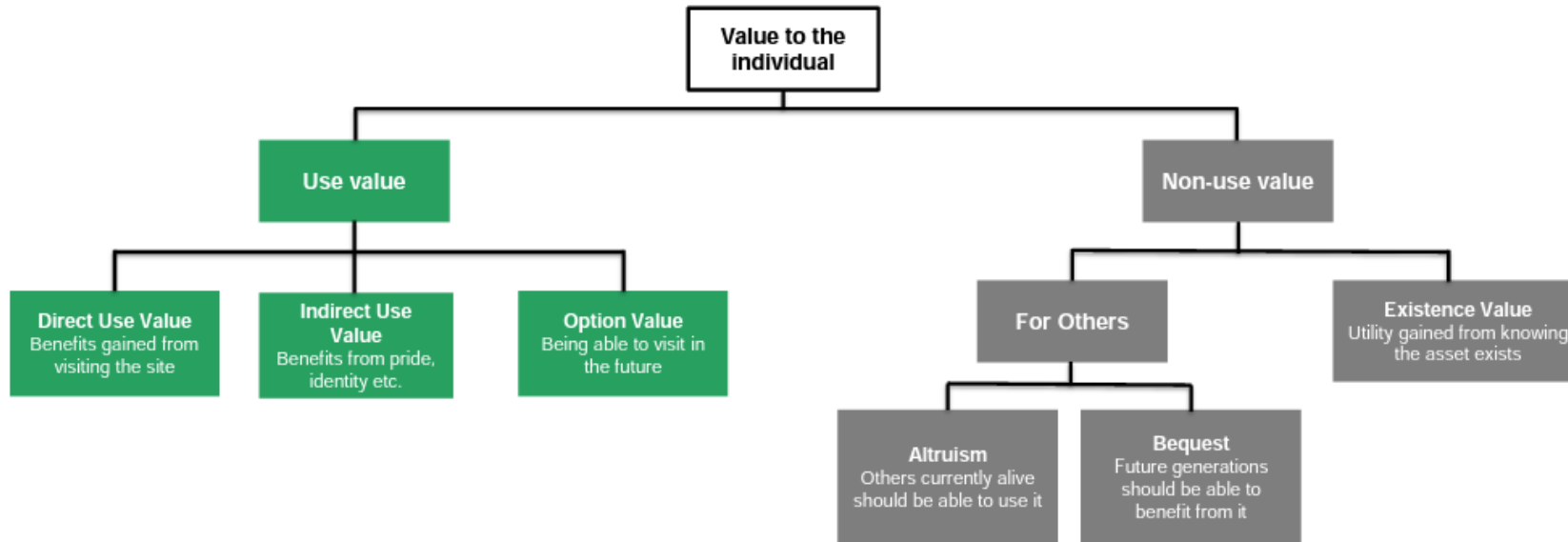


Figure 4: Types of values for culture and heritage assets to an individual¹⁸

To calculate the combined user and non-user value of a regional museum, three sets of inputs are required as shown in Table 10. Visitor numbers for each asset were obtained where possible and estimated where not available (from Orval data, or other comparable ‘analogue’ assets). Of the museums, art galleries, archives and festivals assessed, only 7% of the visitor numbers used in this analysis are based on estimates. Local population figures will be sourced from the Office for National Statistics (via NOMIS) and WTP values from the Culture and Heritage Capital Evidence Bank. This method could be strengthened by undertaking a bespoke survey of the local population to determine more accurate estimates of visitors in the local population as well as pooled surveys of WTP values across a range of different assets.

¹⁸ Source: Art Council England, DCMS, Nesta, Simetrica Jacobs

Table 10: Estimating economic value of museums – main inputs (extract from DCMS, 2020)

Inputs	Description	Source / Assumption
Number of visitors per annum (historic and/or forecast)	<ul style="list-style-type: none"> Number of domestic visitors to feed into visitor value calculation and number of households in local catchment* area minus local visitors to feed into non-user value calculation. To derive accurate estimates of visitors in the local population, the guide recommends that analysts run a bespoke survey of the local population. 	<ul style="list-style-type: none"> Museums Surveys
Local population figures	<ul style="list-style-type: none"> Population estimates within a local catchment area of the museum 	<ul style="list-style-type: none"> Office for National Statistics (via NOMIS)
Visitor and non-visitor Willingness-to-Pay (WTP) values	<ul style="list-style-type: none"> The WTP values from the guidance were estimated based on average regional museum WTP for visitors (or users) and non-visitors (or non-users) from a pooled set of survey responses, done across four museums**, for visitors (use WTP) and non-visitors (non-use WTP) respectively. Table 3 provides representative estimated values that can in principle be transferred to other comparable museums in England Alternatively, WTP values from the Culture and Heritage Capital Evidence Bank may be used. 	<ul style="list-style-type: none"> Table 1: Benefit Transfer Table of Economic Values for Culture: Regional Museums (Arts Council, 2020) Culture and Heritage Capital Evidence Bank (DCMS, 2021)

*The appropriate local catchment area may be defined as the geographical area within which residents are likely to have heard of your museum even if they have never visited. We note that this definition of 'local reach' is subjective

** The Great North Museum, Newcastle; The Ashmolean museum, Oxford; The National Railway museum, York and The World Museum, Liverpool).

The inputs identified above along with the outlined calculation steps produce the total non-market value combining User and Non-User WTP in 2020 prices. This is an estimate of the public benefit that an institution produces in monetary terms in a way that aligns with the Green Book principles of Social Cost Benefit Analysis. This non-market value can then be used alongside the flood risk mapping data to determine economic impact evaluations.

The Benefit Transfer Values calculated are updated to 2028 using the GDP Deflator Index. A worked example of the Benefit Transfer for regional museums is shown in Table 11.

**Table 11: Worked example – Benefit transfer from Benefit Transfer Table of Economic Values for Culture to case study of a museum in Manchester (2020 prices).
Reproduced from DCMS 2020.**

	Visits (user WTP)	Local population non-visitor (non-user WTP)
Worked example museum WTP	£6.16	£3.25
Worked example relevant group	426,367 visits	408,597 local households of non-visitors (510,746 local households – 20% of possible local visitors)
Aggregate Value	£2,626,421	£1,327,940
Total non-market value: Combined User and Non-user WTP		£3,954,361
Indicative annual museum operating costs		£1,978,146

2.10.3 Disruption due to flood risk

It was assumed that for any asset directly flooded, they may suffer 20 week's disruption to business (based on the data of the Frontier methodology). For listed buildings and scheduled monuments, it is assumed that this disruption is limited to 3 weeks (since they are not businesses as such).

2.10.4 Losses to Cultural/Heritage capital

Using the above assumptions on disruption alongside observed flood risk from the hydraulic modelling allowed an assessment of the annual average disruption per option. This was in turn be built into a Net Present Value (NPV). The NPV value for each asset was capped at the non-market value as calculated using the DCMS Rapid Evidence Assessment Methodology.

2.10.5 Sensitivity for Bristol

2.10.5.1 Estimations of Non-use

As applied to Bristol, visitor survey data was available for the vast majority of paid visitor attractions; 20% of Lower Super Output Area population data was used to estimate numbers of population benefitting from non-use of paid visitor attractions.

The definition of catchment area in the guidance is “*the geographical area within which residents are likely to have heard of your museum even if they have never visited.*” The BAFS analysis has used a tiered approach to the estimation of the number of people who use a site, as follows:-

For sites with visitor numbers in excess of 200,000, (the Harbour Festival, M Shed, SS Great Britain, We the Curious and the Arnolfini gallery) it is considered reasonable that 50% of the population of Bristol are likely to have heard of the museum.

For other museums, festivals, galleries and archives, the catchment area has assumed 50% of the population within 2km of the site (estimated at 66,000 residents from Middle Super Output Area (MSOA) data). This is considered a conservatively low estimate.

For built heritage, listed buildings and scheduled ancient monuments, the catchment area has assumed 50% of the Lower Super Output Area (LSOA) that they lie in.

The average non-use value for the study area was £93 per capita, which sounds reasonable for an environment with a rich heritage. The impact of flood risk on this number is significantly smaller.

A table of Assets, Use and Non-use WTP values, and assumed User and Non-user beneficiary numbers are given in Appendix D.

2.10.5.2 The value of the Floating Harbour

The value of the Floating Harbour itself as a destination in its own right is not assessed by this analysis.

2.11 Amenity & Recreation

The use of greenspace and outdoor recreation is one of the leisure activities of the population of Bristol. Greenspaces are known to improve physical health, mental health and provide social & amenity value to all socio-economic groups. The recreational value of these greenspaces is therefore important to a community and their loss can be tangible.

Estimated recreational losses have been valued based on OS Green Space data and the valuation of recreation and number of visits estimated in the Outdoor Recreation Valuation Tool (ORVal, Version 2.0) created by the University of Exeter¹⁹.

The flooded area of each park as a percentage of the total area was used to proportionate the lost recreational value taken from ORVal. The total damages as recreational losses were then calculated for all the events with a varying probability of occurrences. These were then used to find the annual average damage over the appraisal period. The damages accrued over the proposals' lifetime was calculated in present value terms by application of the relevant annual average damages in each epoch, discounting to present day values based on the Treasury Green Book discount rates.

The value of the Floating Harbour itself as an amenity and recreation asset in its own right is not assessed by such this analysis.

2.12 The Environment

The Environment Agency Environmental and Historic Environment Outcomes Valuation (EHOV) tool has been used to quantify the anticipated environmental benefits from the scheme.

EHOV is a tool that is built around a set of indicative values for a small number of natural environment impacts that are expected to be (relatively) common for FCERM options.

The metrics used by the EHOV tool are as follows:

- Changes in land cover for habitat creation.
- Changes in agriculture or Forestry.

¹⁹ <https://www.leep.exeter.ac.uk/orval/>

- Changes in waterbody quality.
- Changes in recreation.
- Changes to historic environment.

Changes to land cover

The baseline habitat areas have been translated from the existing habitat areas from the Biodiversity Net Gain (BNG) reporting into the categories used within EHOV. Unfortunately, BNG reporting at the OBC stage only covers negative impacts of the scheme. Investigation into where and what types of habitats will make up the mandatory 10% BNG (and aim of 15%) will not be undertaken until FBC. Therefore, a high-level estimate has been produced where a 10% increase for all habitats is assumed. This is not an accurate representation as in reality the different habitat types have different weightings, and we could for example lose grassland but gain types of habitats and still meet the 10% targets. However, this allows for an estimate at this stage which can be updated further at FBC. Table 12 below shows the habitat areas for the baseline and estimates for the scheme.

Table 12: EHOV changes to land cover inputs

Broad habitat	Baseline habitat extent (ha)	Scheme habitat extent (ha)
Enclosed farmland (all types)	0	0
Semi-natural grassland	9.05	9.96
Woodland	6.84	7.52
Mountain, moors and heath	4.65	5.12
Coastal margin	7.02	7.72

Note – the “with scheme” habitat extent does not vary significantly between the options.

Changes in agriculture or Forestry

There are no anticipated changes to agriculture or forestry from the scheme. The woodland included above is not used for commercial timber.

Changes in waterbody quality

This metric is based on changes in WFD status. The scheme is unlikely to result in a change in status (either for better or worse) so there is nothing to include this category.

Changes in recreation

This is included in other parts of our appraisal as part of the cultural / heritage assessment and the separate leisure assessment. Therefore, this has not been included as part of the EHOV assessment to avoid double counting.

Changes to historic environment

Again, this should be covered by the Culture and Heritage assessment and has therefore not been included as part of the EHOV assessment to avoid double counting.

Total environmental damages/benefits

These inputs combine to give the following annual environmental benefits.

Table 13: EHOV annual environmental benefits

Impact category	Baseline	Proposed Scheme
Regulating services (air pollutant removal, carbon sequestration, biodiversity)	£32,973	£36,270
Forestry and agriculture (timber, food provision)	£-	£-
Water quality	£-	£-
Recreation	£-	£-
Total AV, £/yr	£32,973	£36,270

These annual values then give the following PV values to a 2021 price year.

Table 14: EHOV PV environmental benefits to 2021 price base

Impact category	Baseline	Proposed Scheme
Regulating services (air pollutant removal, carbon sequestration, biodiversity)	£983,003	£1,081,303
Forestry and agriculture (timber, food provision)	£-	£-
Water quality	£-	£-
Recreation	£-	£-
Total Present Value of Benefits, 100 years, £	£983,003	£1,081,303

These values have then been uplifted to a 2028 price base using the GDP deflator to 2028 which is 117.216, and the GDP deflator to 2021 which is 95.107 for the EHOV data.

Table 15: EHOV PV environmental benefits to 2028 price base

Impact category	Baseline	Proposed Scheme
-----------------	----------	-----------------

Regulating services (air pollutant removal, carbon sequestration, biodiversity)	£1,211,516	£1,332,668
Forestry and agriculture (timber, food provision)	£-	£-
Water quality	£-	£-
Recreation	£-	£-
Total Present Value of Benefits, 100 years, £	£1,211,516	£1,332,668

This gives an environmental benefit for the scheme of p.v. £121,152.

2.13 Education

The impact of flooding on provision of education have been accounted for assuming losses related to lost educational value, and for primary aged students lost productivity for parents or guardians having to stay off work to look after children when schools are shut.

Educational losses have been calculated based on the number of pupils at each school impacted by flooding. Pupil numbers have been taken from Gov.uk²⁰ and the value of education taken from MCM data. The number of days disrupted is assumed to be 5 days. This is the maximum disruption time recommended in MCM for assessing the impacts of school closure before alternative accommodation is secured by the Local Authority. The costs of providing this alternative accommodation, or ongoing disruption to education while in this alternative provision, or additional travel costs associated with this alternative provision are not calculated by the method.

A monetary loss of productivity is taken from the MCM and a single parent or guardian is assumed per primary school aged pupil, with the same length of disruption assumed as for educational losses. The number of pupil days lost is then divided by a factor of 3 in line with MCM guidance to account for siblings being cared for by a single parent or guardian, and for situations where a parent or guardian would already be at home or able to secure alternative care arrangements.

2.14 Railway Disruption

Bristol Temple Meads station itself and its track are relatively well elevated compared to the local floodplain. However, the passageway that allows passengers to access different platforms is subject to flood risk (by overland flow from Cattle Market Road to the south), and if flooded, the station would be unable to operate. The station is also the changeover point for train crews, and therefore

²⁰ <https://www.compare-school-performance.service.gov.uk/>

disruption to the station (and flooding to the surrounding approach roads) also impacts services to the southwest. In major flood events, while the track itself may remain dry, the station itself would be isolated and inaccessible (see Figure 5). This also would have a knock-on effect for connecting transport services.

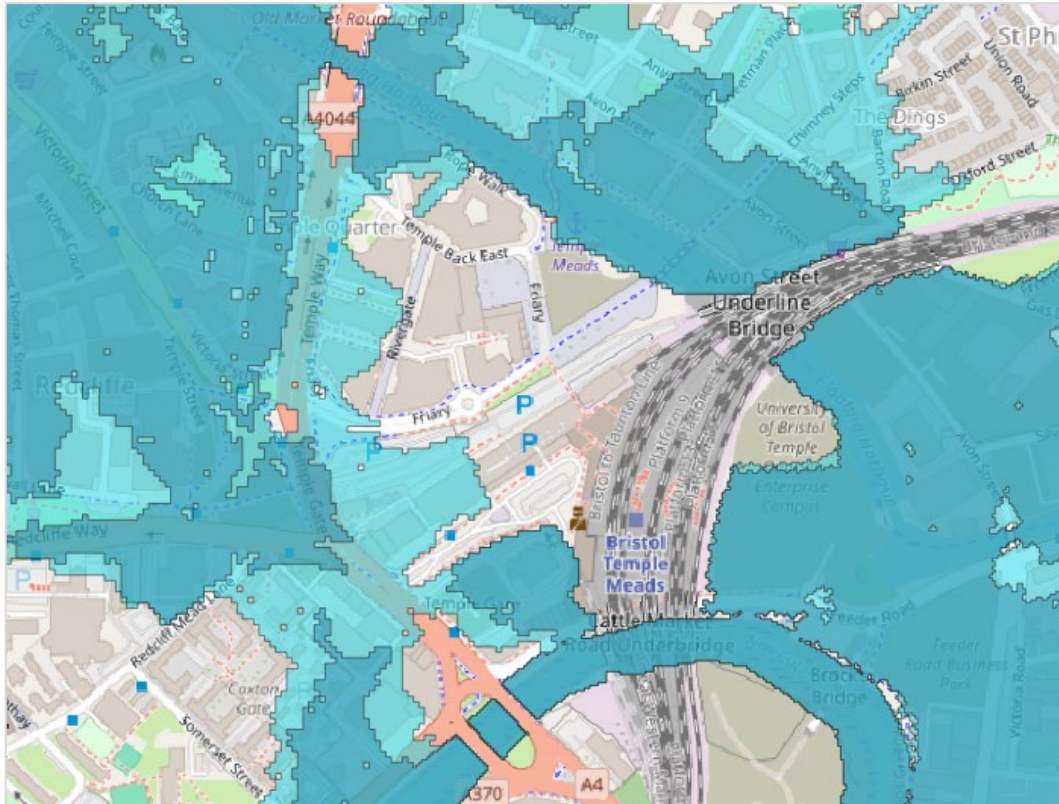


Figure 5: 2130 flood outlines (Light blue- tidal; dark blue – fluvial) at Bristol Temple Meads, showing flood mechanism impacting on passageways under station (east side of station) and isolation of the station in flood events.

Potential damages and disruption caused by the flooding of Bristol Temple Meads station were estimated using the MCM methodology on delays and monetary compensation for rail services. Flooding will cause some services to be cancelled and others to be delayed. The more severe the flooding the more severe will be the disruption and the larger the number of services cancelled.

The number of services impacted and/or the passenger journeys for the rail asset at risk from flooding shown in model results in a 24-hour period was obtained from the Office of Rail and Road Statistics²¹. Estimates were then made on the number of services affected and the disruption was quantified using the Network Rail indicative compensation and value of time methods.

The station had 11.6 million passenger exits and entries between 2019 and 2020, and 1.6 million interchanges. This gives an average of 36,304 journeys changing, entering, or exiting Bristol Temple Meads per day. Based on the past 7 years, usage is increasing at approximately 6.6% a year, and usage is anticipated to have

²¹ <https://dataportal.orr.gov.uk/statistics/usage/estimates-of-station-usage/>

reached 22 million exits and entries by 2030 according to the Adopted Joint Local Transport Plan 4²².

The “Indicative Train Service Specification” (ITSS) prepared for Bristol by Network Rail accounts for forecast passenger demand changes due to exogenous factors. This includes macro influences on the economy, and the competitiveness of alternative modes (eg fuel costs, coupled with local influences such as changes in land use in the vicinity of the station). The ITSS projects growth of up to 34 million passengers by 2043. The ITSS forecast is however dependent on additional capital expenditure beyond the immediate proposals at Bristol Temple Meads, and as such is not used in this analysis. The figure of 22 million users from the Adopted Joint Local Transport Plan is used as the basis for the benefit assessment, and is assumed constant over the appraisal period.

Table 16: Approximate value of time and type of user

	Business	Commuters	Leisure
Percentage	53%	15%	32%
Value of time (£/hr)	168.62	23.22	20.43

Using the value of time per type of user in Table 16 the cost per hour of delay was calculated to be £99.39 per hr per delay.

Table 17: Percentage of passenger services delayed or cancelled.

	Delay	Cancellation
Percentage of passenger service	40%	60%

In present day terms, delays would cost potentially £2.4 million per day of disruption.

At an estimated 216 trains per day rising to 410 trains per day by 2030, with an assumed compensation value of £3,808 (assumed high because of the high percentage of business journeys), cancellations would cost £936k per day of disruption.

The duration of disruption is assumed based on Table 6.17 of MCM 2013, subject to a minimum duration of 15 hours reflecting observed durations of flooding.

The costs associated with disruption are based on passenger numbers to 2030 (although it is likely that numbers will also increase beyond this time), and the Department for transport WebTag “Value of Time Index”. This means that the cost of a flood event increases over time from £5.4m in 2030 to £41.5m in 2130.

²² <https://travelwest.info/app/uploads/2020/05/JLTP4-Adopted-Joint-Local-Transport-Plan-4.pdf>

The combination of fluvial and tidal flood mechanisms gives the station a potential frequency of disruption of 1 in 75 years annual chance in the present day, worsening to an annual event in 2130, in both the Do Nothing and Do Minimum scenarios.

2.15 Traffic Disruption

The disruption to road users has been calculated and monitored using Department for Transport's (DfT) Transport User Benefit Appraisal (TUBA) software. The software calculates the impact of journey time changes, vehicle operating costs and other charges between reference scenario and test scenario based on the changes in traffic and travel.

The calculations have been undertaken using economics data from TAG Data Book v1.21 May 2023 (economics file v1.9.21.0) and has been calculated for a single day of distribution over a 100-year appraisal period. The model data comes from the highway assignment model of The West of England Regional Transport Model (WERTM) for the 2029 and 2042 forecast year. It has been run with a fixed demand response, as no longer-term demand impact is expected.

The monetary impacts were estimated for 10 scenarios for a range of events with varying probabilities of occurrences. These are used to find the annual average disruption over the appraisal period. Cancelled trips are multiplied by the value of a cancelled journey (£31.05), taken from rail disruption guidance (cancelled trips do not have a comparable analogue within the road transport discipline).

The disruption accrued over the proposals' lifetime is calculated in present value terms by application of the relevant annual average disruption in each epoch, discounting to present day values based on the Treasury Green Book discount rates.

2.16 Active Travel

The construction of significant linear infrastructure beside existing roads and active travel routes is an opportunity to enhance or create three existing or new active travel routes.

- **West of Temple Meads:** Chocolate Path between Cumberland Lock and Bristol Temple Meads station
- **Feeder Road:** Feeder Road to the east of Temple Meads station
- **St Phillips Greenway:** Alongside River Avon east of Temple Meads station

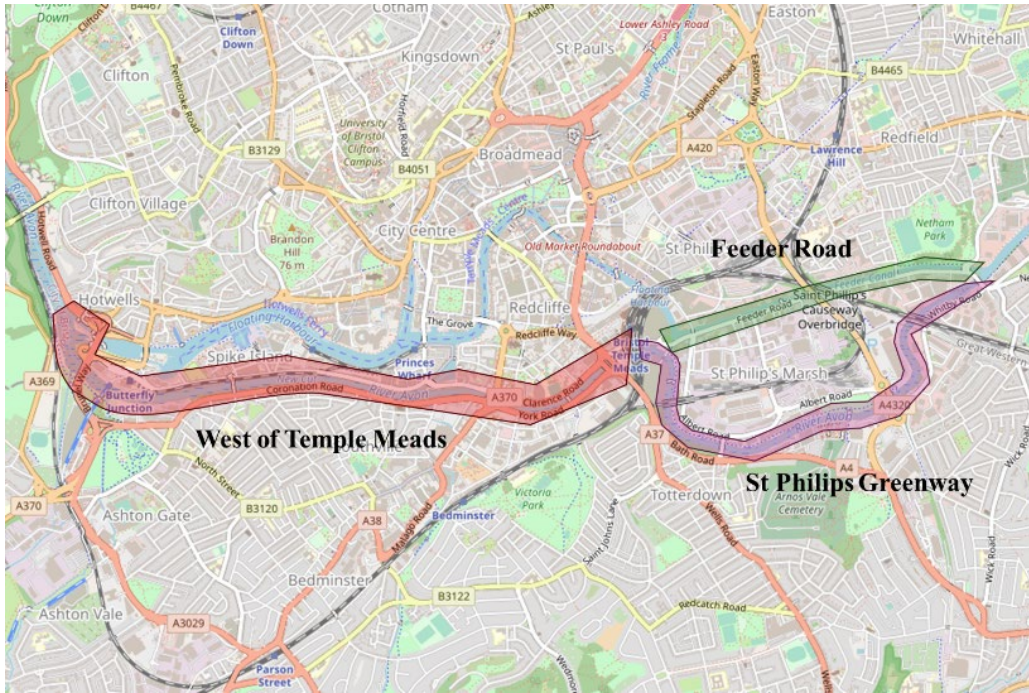


Figure 4 - Scheme Areas Map

An assessment of the benefits of these routes have been assessed using the Active Modes Appraisal Travel kit (AMAT), the full detail of which can be found in Appendix C.

Appendix C notes the costs of delivering Active Travel. These are theoretical costs if delivered as a standalone project, and the expected costs of delivering Active Travel as part of the scheme should be much lower, essentially delivered as part of reinstatement of the public realm following construction; the latter costs are built in to the costs estimate of the scheme.

The Active Travel benefits are “non-damage related benefits”. They are however <1% of the overall benefits of the scheme. Non-damages related benefits up to 20% of the overall benefits can be claimed in line with the guidance of LIT 58360. LIT 58360 also notes the validity of including benefits as a consequence of the solution to risk management.

2.17 Erosion disruption to Traffic and Active Travel

In January 2020, a 113m-long section of riparian wall on Cumberland Rd collapsed (see Picture 1). The area had been subject to long-term monitoring due from progressive movement of the road and parallel Chocolate Path. The subsidence was related to the tidal cycle and its influence on local groundwater, leading to a sudden failure. The failure led to immediate closure of the highway, heritage railway, footpath and cyclepath, with significant disruption at a local and regional level. It is understood that failure of the riparian wall is also occurring at another location today in 2024.



Picture 1: Collapse of the riparian wall on Cumberland Road in 2020

The mechanism of erosion is saturation and desaturation of the soils behind an aged arched brick revetment wall, a mechanism that is accentuated by the extremely high tidal range of the tidal Avon, leading to strain on the wall. The proposed defence construction along the road alignment would prevent failure, ensuring preservation of the road, the active travel pathway, and the Harbour Railway.

Without construction of the defence, the revetment will fail at other locations along the road, leading to firstly loss of the active travel pathway and the Harbour Railway together with closure of one lane of the Cumberland Road, and subsequently closure of the second lane of the road. The probabilistic progression of this failure has been calculated using EA Asset Deterioration guidance, based on the current condition of the revetment (CG4), and assumed condition for the loose earthfill behind it which would subsequently be exposed to erosion (also CG4). The traffic impact of closure of the Cumberland Road was assessed within the same TUBA analysis described in Section 2.15. The Active Travel impact of the loss of the Chocolate Path and closure of the Cumberland Road is calculated in the Active Travel assessment described in Section 0. The impact of the loss of the Harbour Railway was assessed as part of the assessment of the tourism industry, included in the Wider Benefits Assessment, Appendix B.

2.18 Rapid drawdown impacts on harbour walls

One of the key assumptions for the Do Nothing scenario is that the lock gates at Entrance Lock fail causing the Floating Harbour to rapidly drain. This mechanism would leave the harbour walls exposed to the same variation in saturation / desaturation that have caused the failure of the Cumberland Road revetment. These walls, unlike the Cumberland Road, have not previously been exposed to this mechanism and would be at high risk of collapse.

The Harbour Condition Surveys Serious and Critical Asset Prioritisation report²³ undertaken in 2019 by Mott MacDonald identified that 68 of the harbour walls are already in a serious or critical condition and would fail partially or fully within 5 years. Therefore, some degree of failure by 2024 is expected and given the importance of the harbour walls to the area it is likely they will be rebuilt to a good standard (EA condition grade 3) by the time the scheme starts in 2030.

An estimated year of failure was calculated using the EA Asset Deterioration guidance as proxy for rates of deterioration, from this starting point of CG3 in 2030. Table 18 outlines the estimated residual life of the harbour walls in the event of the Floating Harbour being exposed to rapidly varying tidal conditions, and the expected year of failure assuming a start year of 2030. The table also outlines the assumed maintenance regime for each scenario and the estimated rate of deterioration used. For example, the Do Nothing has an assumed maintenance regime of 1 – low/basic where no maintenance or repair works are undertaken and the fastest rate of deterioration because of this.

Table 18: Estimated residual life of harbour walls and expected year of failure.

Scenario	Maintenance regime	Estimate of deterioration used	Residual life	Year of failure
Do Nothing	1 – Low/basic	Fastest	20	2050
Do Minimum	1 – Low/basic	Medium	25	2055
Options	2 - Medium	Slowest	60	2090

A probabilistic analysis was then undertaken whereby the probability per year as rate of decay was calculated between 2030 and the year of failure. The cost of repair and refurbishment in order to get each asset back to an acceptable condition detailed in the Mott MacDonald 2019 report was then multiplied by the probability and the discount rates to calculate the Present Value Damages over the appraisal period for each scenario.

The benefit of the option is therefore calculated from the change in the timing to failure.

2.19 Rapid drawdown impacts on exposed utilities

If the harbour walls were to collapse as a result of the Floating Harbour rapidly draining, they would expose utilities that are located behind them. Each utility would then have to be diverted.

The location of each type of utility (internet, electrical, and water) was obtained from stat returns and each harbour wall asset was marked with the type of utility behind it. The proposed utility diversion was set back 5m from the harbour walls

²³ ASSET-PRIORITISATION-REPORT B01

to represent the diversion around the collapsed wall and this new calculated diversion length was multiplied by the cost per m shown in Table 19.

The cost of diversion was then run through the probabilistic analysis outlined in Section 2.17 to derive a present value diversion cost. Each diversion is however assumed to occur only once.

Table 19: Approximate cost per m for each type of utility

Type of utility	Cost per m
Electrical	£1,787.15
Internet	£3,015.81
Water	£1,898.85

2.20 Carbon

The carbon impacts of the scheme in terms of flood damages avoided and the embodied carbon of the flood strategy have been calculated using the Environment Agency Carbon Impacts Tool.

This shows that the scheme has embodied carbon of 55,000 tCO₂e, but prevents carbon release through flood damages of 1,366,000 tCO₂e.

The benefits of carbon avoided are as follows

Table 20: Carbon benefits & disbenefits (present value 2028)

	1.33% AEP SoP	1% AEP SoP	0.5% AEP SoP	Local Choice
Embodied carbon tCO ₂ e	55,569	55,569	55,569	55,569
Carbon avoided tCO ₂ e	1,355,000	1,358,000	1,367,000	1,366,000
p.v. Whole carbon costs (£m)	10.3	10.3	10.3	10.3
p.v. carbon emissions avoided (£m)	177.0	177.4	178.4	178.4
Net carbon economic benefits (£m)	166.7	167.1	168.1	168.1

3. Options

The shortlisted options for the economic assessment were as follows:

- Do Nothing
- Do Minimum
- Defend

3.1.1 Do Nothing

Background to the operation of the Harbour

Downstream of the Floating Harbour, the River Avon is tidal. At low tide, harbour water levels are maintained at a normal level of 6.1mOD by two pairs of lock gates at the Entrance Lock to Cumberland Basin, at the western end of the basin. A pair of lock gates at Junction Lock (Junction Upper Gates)) at the eastern end of Cumberland Basin act as back up to the Entrance Lock gates to ensure that water levels are maintained in the Floating Harbour. The Junction Upper Gates are also closed approximately twice a month to retain water in the Floating Harbour when Cumberland Basin is scoured at low tide to remove accumulated silt.

Fluvial flow enters the harbour from the River Avon via the Feeder Canal at Netham Lock, and from the River Frome which passes through the centre of Bristol. Flows discharge from the harbour via four culverts at Underfall Yard Sluice, located close to Junction Lock.

Spring high tides are prevented from entering the Floating Harbour by two pairs of flood-stop gates located in Junction Lock. – the 1992 and 2010 stop gates. The function of the outer pair of lock gates at Netham lock is to restrict high river flows from entering the Floating Harbour. During high tides, neither the lock gates at Cumberland Basin nor the Junction Upper Gates can be used to prevent tidal inflows because they are mitred in the opposite direction. The Cumberland Basin gates are opened when the flood stop gates close to avoid damage due to reverse loading.

When a surge tide level is predicted to exceed the normal operational level of the Floating Harbour (by Environment Agency flood forecasting models), the decision is taken to close a pair set of the Junction Lock gates, which are mechanically operated using Hydraulic Pump Units (HPU). The Harbour Authority is obliged to notify the Environment Agency Flood Incident Duty Officer that the gates have been closed. The gates are typically operated 200 times each year.

As such, the deployment of the gates on demand is dependent on: Environment Agency services, a power supply, and staff with appropriate flood-risk training and decision support. While a mobile HPU is available for back up in the event of failure to the main units, this would also need maintenance, and deployment by appropriately trained staff. In the peak of major flood events, water levels will cut off access to the lock gates for their operation.

The installation of the gates was funded by Environment Agency GiA. The Harbour Authority is paid £150 per closure by the Environment Agency for their operation.

Modelling of the Do Nothing

Under the Do Nothing scenario, the flood gate protective structures at Netham Lock and Junction Lock are no longer powered, funded, supported or maintained. In the absence of proactive management of the gates, they would not be closed on time; the lock gates managed by the Harbour Master are not constructed to hold back flooding. The lock gates / flood gates are modelled as being static and open.

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

3.1.2 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. Fluvial flood events have been noted to last for the duration of multiple tidal cycles.

However, there are several resilience concerns with regards to the locks, relating to risks of operational failure due to equipment failure, electrical failures, and traffic disruption impacting on staff availability. The Central Area Flood Risk Assessment (“CAFRA”, BCC, 2016) identified the susceptibility of the Netham Lock gates to flooding as “Moderate to High”. The Failure Mode Analysis identified a 5-20% likelihood of both gates failing open, noting a past incident (2016) where staff were unable to access the gate on time due to traffic.

Tidal surge events have been shown to tend to occur during concurrent high tides, and, at present, are not reliably forecast. Notably, the need for proactive management during a flood event requires real time response to the complex interaction of river flow volumes and tidal levels: a fluvial event may last two tidal cycles. This interplay between the two mechanisms does not allow deployment of the gates to be limited to a single operation in advance of a flood.

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. Recent incidents note that (outside of events), dumping of eScooters in the harbour has led to obstruction of the gates. The Failure Mode Effect Analysis (Arup, 2015) identified a 20-50% likelihood of vandalism or debris on the cill preventing closure of one of the Junction Lock gates, an event that is noted as having happened 3 times in 20 years, although the risk of this occurring to both sets of gates is considered “low” in a Do minimum scenario.

In flood events greater than a present day 12 year fluvial event, or a 20 year 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 (see Picture 2).

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



Picture 2: Flood flows bypassing the lock gates.

3.1.3 Defend

The construction of flood defences along the Avon and tying into the floodgate / lock structures would prevent flooding from entering the Floating Harbour up to a given standard. To promote such a strategy it is also necessary to undertake any works necessary to mitigate detrimental flood risk impacts of the proposals.

A range of standards of protection 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.

3.1.3.1 Approach to uncertainty

For the purposes of economic appraisal, defences have been modelled without freeboard but have been costed including freeboard. This approach is part of the process to ensure that appropriate conservatism is accounted for in design, but not assumed to be of benefit to the project. It is a conservative assumption: on the balance of probability, the defence height including freeboard will defend against a greater scale of flooding than designed for.

Such an effect is potentially even more conservative in a tidal context such as Bristol, where flood frequency is sensitive to small variations in water level. Nonetheless, the analysis suggests that it is of relatively low consequence for this analysis because of the low residual damages post-implementation of the strategy.

3.1.3.2 *Development of flood defence options*

Defence options have been developed around the need to address climate change through a managed adaptive approach. This reflects the likely potential for sea level rise to drive dramatic changes in the standard of protection over time.

As a starting point, scenarios have been built around the concept of constructing a strategy in 2030 on a precautionary basis, the standard of which will decline against time to meet a given standard in 2069, at which point the defence would 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 strategy life.

Figure 6 shows an example of this in action.

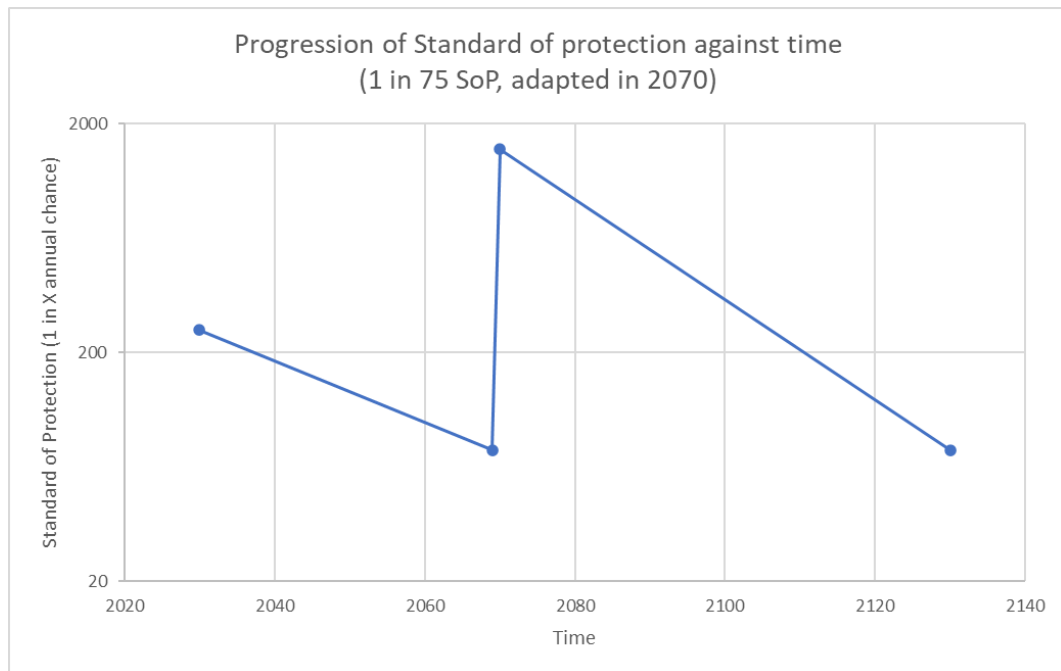


Figure 6: Progression of the standard of protection against time, for a strategy designed to a 1 in 75 annual chance, and uplifted in 2069

To provide a 75year standard of protection (SoP) on this basis (and considering only the tidal component for now), the strategy would need to be built to the equivalent of a ~250year strategy in 2030. Over time, this SoP would decline, reaching a 75year SoP in 2070. At this point in time, the strategy would be raised to what would be, in 2070, the equivalent of 1540 year standard of protection. However, over time, this too would decline to a 75 year standard of protection by the end of strategy life.

This example is a good illustration of why this adaptive approach is necessary. Had the strategy not been raised in 2070, the 75 year strategy would have continued to decline such that by 2130, it would have had a SoP equivalent to 3.5 years – 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 75year standard of protection would have meant that, when constructed, the strategy would have had a SoP equivalent to the 2030 5250year event. This would be

potentially 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 2070 and 2130 defence heights is typically 0.60m.

3.2 Treatment of climate change

Current English government guidance²⁴ on the impact of climate change is to build on the assessment of current risk, and to incorporate resilience and flexibility based on an assessment of potential future sensitivities as quoted in Table 21 and Table 22. The hydraulic model inputs to the economic model assume the Central allowance for fluvial events, and the Higher allowance for tidal events.

Table 21: Climate change guidance for fluvial events, % changes to 1961-1990 baseline

Estimates	Total potential change anticipated for the 2020s	Total potential change anticipated for the 2050s	Total potential change anticipated for the 2080s
Upper	27%	38%	71%
Higher	15%	19%	39%
Central	10%	12%	26%

Table 22: Climate change guidance for tidal events, % changes to 1981-2000 baseline

Estimates	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Upper End	7 (245)	11.4 (342)	16 (480)	18.4 (552)	1.62
Higher Central	5.8 (203)	8.8 (264)	11.7 (351)	13.1 (393)	1.21

3.3 Flood Mechanisms

Each tidal scenario was run for the 1yr, 2yr, 12yr, 20yr, 75yr, 100yr, 200yr, and 1000yr return period flood events. These events assumed generally to coincide with 1yr return period inflow, except for the 200yr event (coinciding with a 2yr flow on local water courses) and the 1,000yr event (coinciding with a 12yr flow).

Similarly, fluvial scenarios were run for the 20yr, 75yr, 100yr, 200yr, and 1000yr return period flood events. These events assumed generally to coincide with a 1 year return period tidal flood event, except for the 200yr event (coinciding with a 2yr tidal event) and the 1,000yr event (coinciding with a 12yr tidal event).

The coincident events from these mechanisms were highlighted in the Central Area Flood Risk Assessment CAFRA (“CAFRA”, BCC, 2016), and updated by Arup following a review of joint probability.

The annual average damage (AAD) for these two mechanisms were calculated separately and combined to give an estimate of the overall flood risk. A third

²⁴ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

“mechanism” was also assessed: this adjusted for potential double counting of tidal flooding within the set-up of the fluvial mechanism for the 200yr and 1000yr events. The AAD for this mechanism was subtracted from the sum of the other two AAD values.

The same process was completed for the future epoch modelling to account for climate change and produce AAD figures for the NCC, 2020s, 2050s and 2080s future epochs.

4. Overlaps

There are several overlapping initiatives and mechanisms within the Bristol Avon Flood Strategy; these are managed by adjustments within the calculation of Net Present Value.

4.1.1 River Frome flood risk / Pill flood risk

The benefit area of the Bristol Avon Flood Strategy has considerable overlap with that of the flood alleviation proposals for the Lower Frome, particularly in the more extreme flood events, and entirely overlaps the study area of the Pill SOC. It is currently understood that the proposals of these projects amount to refurbishment of existing culverts and assets from Eastville to the city centre on the Lower Frome, and the refurbishment of existing defences at Pill. Hence both projects are about preventing deterioration rather than improving the standard of protection.

The BAFS Do Nothing scenario does not model deterioration at either location, hence representing a “post scheme” scenario for the Lower Frome and Pill works as the economic baseline for the BAFS scheme. As such, it is reasonable for the BAFS to claim benefits in these locations, particularly as they act directly on the residual risk of either project. OM2 scores can also be claimed provided they move properties from one risk band to another, and the GIS datasets indicating the baseline assumptions of the BAFS project will be shared with those projects.

The Pill scheme does also consider surface water flooding from the Markham brook, but the degree of overlap between the tidal flood mechanism (the focus of interest of the BAFS works) and the Markham Brook mechanism is minimal.

4.1.2 Pluvial flood risk

The local Surface Water Management Plan, and associated surface water flood maps have been inspected to identify overlapping locations within the floodplain. The apportionment of benefits in such areas is complex as it is often the case that surface water models may replicate mechanisms that are also represented within the rivers model. In this project, the areas in Figure 7 have been identified as having potential overlaps with the benefit areas of surface water projects. For

apportionment purposes, flood damages and OM2 properties are not claimed within these areas.

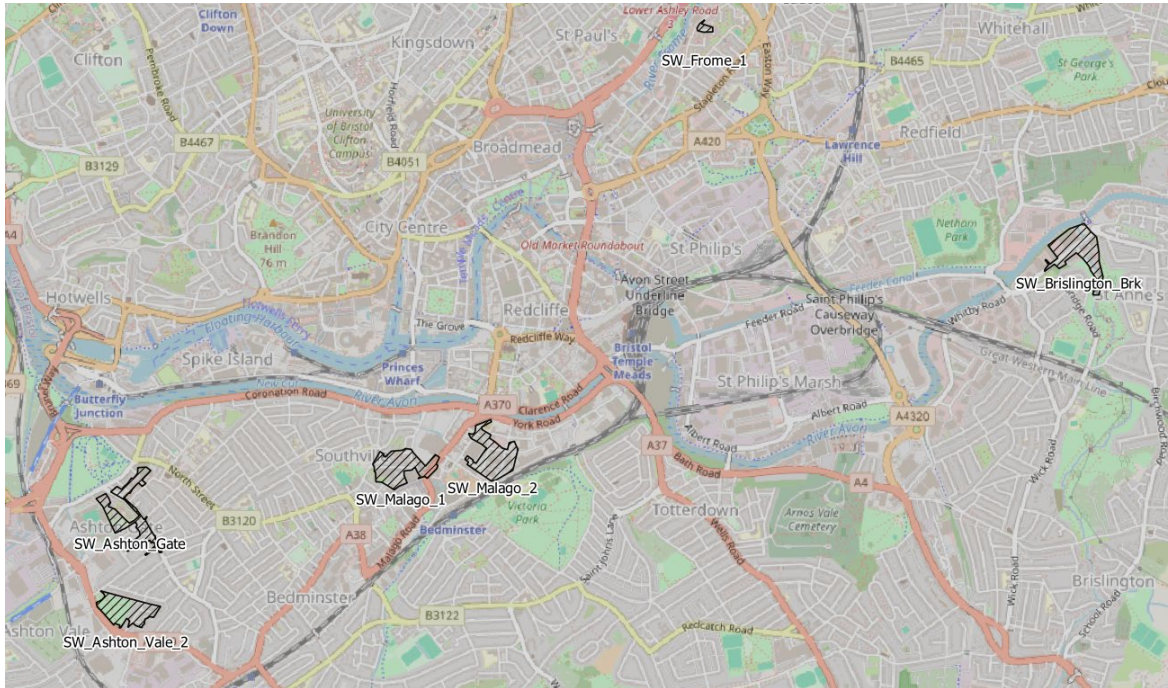


Figure 7: Surface Water hotspots for which damages are not claimed

In one location, on the northwest side of the M32 / A4320, overlap has not been accounted for, and benefits are still claimed. This is because, after review, it was considered that the flooding mechanism represented was due to a tributary of the Frome that is included in the BAFS model. As such it is subject to the same approach to managing scheme overlaps on the Frome as is identified in Section 4.1.1, above.

4.1.3 Local economy

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

For properties overlapped by proposed developments identified by BCC planning datasets, it is assumed that damages are only accrued outside of the build out timeline of the sites. This is because the imminent development of those sites will lead to replacement of the properties on those sites with National Planning Policy Framework compliant construction. Nonetheless it is acknowledged that, without an adopted Bristol Avon Flood Strategy, even allocated sites are struggling in some locations to obtain planning permission because they are contrary to national planning policies regarding flood risk.

The assumed build-out timeline for these sites is 5 years, and there is an allowance within the calculation of the impacts on the local economy for a 10% chance that the developments do not go ahead. Flood damages for properties within this outline are therefore assumed to be accrued for the first 5 years.

In some cases, it has been noted by comparison with alternate sources, or by direct information from BCC staff, that the provided polygons contain development that is subject to refurbishment, or extension, rather than full redevelopment. Where this is the case, these polygons have been updated so that those properties can still accrue damages.

For properties overlapped by Bristol's more extensive areas of growth and regeneration (Bristol Temple Quarter and St. Philip's Marsh), the timelines of the proposed development have been considered, such that damages are accrued up till the expected delivery of the development. Properties can still be written off before the delivery date if at high risk in the Do Minimum and Do Nothing scenarios. The timelines are uncertain and should be subject to review: some elements of each of these proposals may be carried out in advance; others may lag behind. Nonetheless, the assumed timelines are as presented in Table 23.

Table 23: Assumed timelines for development

Area for growth and regeneration	Bristol Temple Quarter	St. Philip's Marsh	Frome Gateway
Assumed delivery date	2035	2040	2045

The development proposals for the area of Western Harbour are noted not to include any replacement / demolition of existing properties, and because of this, no adjustment is made for them.

4.1.4 Culture & Heritage / Amenity & Recreation – Parks

The Culture and Heritage assessment draws on the DCMS Rapid Evidence Assessment Methodology and the DCMS Culture and Heritage Valuation Studies Evidence Bank. The Evidence Bank contains details of the same parks that feature in the OrVAL assessment used to assess Amenity & Recreation.

To avoid double counting, parks are only assessed against Amenity & Recreation.

4.1.5 Culture & Heritage / Tourism

The Culture and Heritage assessment draws on the DCMS Rapid Evidence Assessment Methodology and the DCMS Culture and Heritage Valuation Studies Evidence Bank.

The Evidence Bank contains details of some of the museums and festivals that are also identified in the Tourism assessment in the Wider Benefits appendix (Appendix B). However, the values used in the Tourism assessment are not claimed against Grant in Aid, nor are the values from the Culture and Heritage assessment used in the Wider Benefits numbers. As such there is no overlap between the two.

5. Impacts on the local economy

5.1 Overview

Whereas the rest of this report sets out the analysis undertaken of the *national* economic benefits of avoided flood damage, *this* section summarises the methods used, and results attained to estimate ***the benefit to Bristol and the wider West of England region*** of the flood risk management options being considered. They are covered in great detail in **Appendix B**.

The analysis considers a mixture of quantified and qualitative benefits.

The unquantified benefits are unable to draw on the level of data required to make a numerical estimate of the benefit of the flood strategy. They should not however be dismissed lightly and may well be of comparable magnitude to the quantified benefits. They are described in a Qualitative description of the case for investment in Section 2 of Appendix B to give the reader a feel for the scale of the case.

The quantified benefits draw on the approach set out in the “Frontier” methodology to set out the Gross value added (GVA) benefits associated with the flood strategy. GVA is a monetary measure of the value added by businesses to the local economy.

The quantified benefits are split in this document into “Direct” benefits, which are inextricably connected with the strategy, and “Indirect” benefits which reflect investment that is enabled as part of the strategy.

Direct benefits include avoided flood damage and disruption to businesses, and the employment benefits of constructing the strategy.

Indirect benefits are related to the removal of flood risk as a constraint to development proposals. Flood risk will not be the sole constraint to development proposals, and a wide range of enabling work may be necessary for development to happen, any of which may also point to the same set of benefits. As such, the indirect benefits are not “claimed” in this report - they are *presented*, and it is within the gift of Bristol City Council and other concerned parties to consider how the contribution of the flood strategy towards these benefits might be funded.

5.2 Approach to quantification of local economy benefits

Figure 8, extracted from the “Frontier methodology”²⁵, illustrates the areas of overlap between Flood and Coastal Erosion Risk Management benefits, and impacts to the local economy.

²⁵ Defra / EA project FD2662, “Flood and Coastal erosion risk management and the local economy,” March 2014.

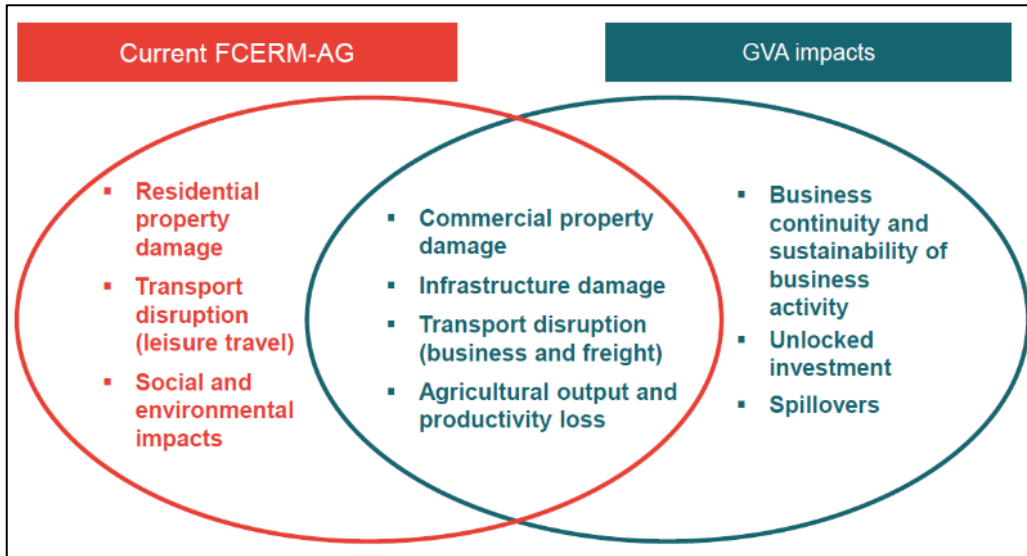


Figure 8: Overlaps between Grant in Aid eligible impacts, and impacts to the local economy

Benefits to the local economy would be generated by all the shortlisted options. They do not necessarily contribute to the calculation of FCERM Grant in Aid however, because of the principle of displacement. However, these benefits align with the HM Treasury Green Book Approach, and in order to provide a robust justification for the investment of Bristol City Council funding they are included and presented in Table 18, below.

These benefits have been calculated in-line with HM Treasury Green Book principles and the Homes and Communities Agency (HCA, now Homes England) Additionality Guidelines, as well as the Frontier methodology, as detailed in **Appendix B**. 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:

- Direct impacts on commercial property and infrastructure
- 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 flood strategy and the unlocked development.
- GVA saved through the reduced flood risk to Bristol’s tourism industry.

5.2.1 Direct impacts on commercial property and infrastructure

This is calculated using the approaches outlined elsewhere in this report. The relevant aspects are: disruption to road and rail; direct damages to non-residential properties; utility damages and indirect commercial losses.

5.2.2 GVA loss saved through reduced flood risk to existing businesses

Reducing the flood risk to existing businesses reduces losses as a result of:

- Incurring losses due to business disruption
- Incurring costs spent on adapting their properties to be flood proof
- Going out of business or moving out of the area

The approach for calculating these losses is prescribed in the “Frontier” methodology, a joint Defra/EA flood and coastal erosion risk management (FCERM) research and development programme – project FD2662. This method identifies the likelihood of the above scenarios, based on the Location Dependence and Adaptive Capacity of the business. Location Dependence and Adaptive Capacity of the business are in turn identified from the Business Type and Business Size. The economic impacts of flooding are based on the lost earnings of staff (FTE) employed by each business, multiplied by the duration of impact and the frequency of flooding.

The benefits of the intervention are calculated from the impacts avoided, and a range of different standards of protection have been assessed.

This calculation has been carried out at a high level, using available datasets, and generic assumptions of business response to flooding. Improvements in the calculations of disruption could be made using surveys of individual businesses.

5.2.3 GVA earned through the jobs created by construction

Construction jobs are created through two sources on this project

- The construction of the strategy itself
- The construction of development unlocked by the strategy.

The benefits of the created jobs have been estimated at £10m for delivery of the strategy, and £29m for construction of development unlocked by the strategy.

5.2.4 GVA saved through the reduced flood risk to Bristol’s tourism industry

The 2013 report “Bristol Floating Harbour EIA Final Report” identified annual visitor spending associated with the Floating Harbour of £14.9m through conducting surveys of a number of harbourside businesses.

The assumptions and findings of that study have been related to the latest flood modelling outputs of the Floating Harbour area to identify how different scales of flooding would impact on visitor spending.

Four different scales of flood event can be identified, impacting on variously:

- The quays and the harbour railway
- SS Great Britain
- All quays and attractions except for M Shed

- All quays and attractions, including M Shed.

Estimates of the costs and frequencies of these events have been built up by reference to visitor surveys and the modelled flood extents. This has allowed the following estimates of impact to the local economy, based on Net Present Value.

It is considered that some of these attractions are fundamentally unmoveable from their current locations; as such they would either continue to incur disruption, adapt or go out of business. Even with adaptation, flooding to the quays on a 50% (1 in 2) annual frequency (as per the Do Nothing 2069 scenario) would likely make their position untenable. As such, it is expected that a significant portion of Bristol's tourism industry in the Floating Harbour would be written off long term in the Do Nothing scenario. This scenario would have knock-on effect for other portions of the local tourism industry, unquantified in this assessment.

5.3 Summary of quantified benefits to the local economy

The quantifiable benefits to the local economy are summarised in Table 24, below.

The direct benefits are indisputably impacts of the project on the local economy, and as they are direct outcomes of flood protection, are presented here as grounds for funding by BCC, WECA and other interested bodies.

The potential indirect benefits are slightly more complex, as flood risk is not the only infrastructure issue to be resolved to enable the unlocked sites, and the benefits identified would need to be apportioned across several infrastructure investments at FBC. However, without resolving flood risk, it is true to say that these developments will only proceed with significant delay or cost. The benefits are presented here, but not "claimed" as such – the apportionment of benefits across enabling projects would need to be resolved by BCC.

Table 24: Quantified benefits to the local economy

	Local Choice strategy
	Benefit compared to Do Nothing, £m
Direct benefits	
Commercial property damage and infrastructure disruption avoided	858
Disruption to businesses avoided	360
Disruption to the tourism sector avoided	354
GVA of jobs created through construction (of flood alleviation scheme)	23
TOTAL direct benefits	1,595
Potential Indirect benefits (from unlocked sites) – based on 30yrs p.v.	
GVA Growth enabled at unlocked sites	5,307
GVA of jobs created through construction at unlocked sites	15
Net residential expenditure	1472

Net amenity benefits	101
Net Council tax receipts	137
Net Business rate receipts	13
TOTAL Potential Indirect benefits	7,045

*At lesser standards of protection, not compliant with NPPF, a flood strategy will still have some influence in enabling development to proceed to planning consent earlier, or at lesser expense, however it may be significantly reduced, and is presented here as a nominal zero value.

5.4 Unquantified benefits

The qualitative summary of unquantified effects, Table 25, below, notes the following impacts that could not be quantified within the scope of this assessment, but which nonetheless are thought to be highly significant.

Table 25: Summary of unquantified benefits

Benefit	Commentary
Ensuring the benefits of proposed works at Temple Meads station	The potential £524m benefit of investment in the station would be impacted by flood risk to the surrounding area affecting public realm appeal, footfall, and disruption to onward transport station
Ensuring the direct benefits of other transport initiatives	BCC and WECA are investing large sums of money into transport infrastructure to stimulate growth and levelling up within the Bristol and West of England economy. All these initiatives; (MetroWest (£175m), MetroBus (£200m), and a still in development mass transit system (£4bn) have a common feature in that the flood affected centre of Bristol and Temple Meads Station in particular form a central hub of the proposals.
Ensuring the economic growth benefits of other transport initiatives	While the proposals themselves may be constructed to be flood resilient, this will not possible in all locations, and flooding to the surrounding streets will impact on their integration, effectiveness and appeal, yet it is highly unlikely that this has been taken into account in their own economic case, or in their calculations of impacts on regional growth.
Avoiding blight	Write off of property is likely for properties flooded more frequently than 1 in 3 years. By 2070 this will impact much of the harbourside area, and by 2130 will impact large areas of central Bristol. What is currently one of Bristol’s most appealing features would be blighted by vacant properties, and degrading public realm. Avoiding mass property write-off is therefore important to retention of businesses and residents. While write-off is built into the calculation of GiA eligible benefits, the indirect and spiralling effects of wide-spread write-off and the moving away of local residents is not.
Ensuring the continued attractiveness of Bristol	The appeal of Bristol’s public realm, its cultural attractions and the aesthetics of the harbour area are important to the attraction of talented and creative workers, businesses, and the visitor

Benefit	Commentary
	economy. The loss of this appeal due to blight will impact Bristol's potential for economic growth.
Avoiding wider impacts on the tourist industry	Loss of the harbourside tourist industry and the general appeal of the harbour area in a post write-off scenario would impact on the wider tourist industry within Bristol and West of England. While the direct impacts of flood risk on the harbourside tourist industry have been calculated, the wider impact of its loss has not

6. Flood damages results

6.1 Present Value Damages

Capped present value damages associated with the options are shown in Table 26.

Table 26: Capped present value damages

	Do Nothing	Do Minimum	75yr SoP	100yr SoP	200yr SoP	NPPF
Residential property damages	250	248	42.3	41.7	39.9	40.1
Relocation	16.9	15.8	9.9	9.8	9.5	9.5
Mental health	42	40.3	21.4	21.1	20.3	20.4
Intangible health benefit	17.9	17.7	7.7	7.5	7.5	7.6
Vehicle damages	212.3	151.4	12.1	11.7	10.9	10.9
Risk to Life	514.8	473.8	78.3	77.2	74.7	75
Non-residential property damages	462.3	447.7	103.8	99.7	91.5	92
Indirect Commercial losses	13.3	12.9	3	2.8	2.6	2.6
Emergency Services	46.3	32.1	17.4	16.8	15.6	15.7
Transport impacts – road	194.3	160.6	87.1	86.4	85.8	85.8
Transport impacts – rail	101.9	84.7	3.6	3.6	1.6	1.6
Erosion impacts – Road / Active travel	689	689	0	0	0	0
Rapid drawdown impacts – harbour wall repairs	74.9	72.7	62.7	62.7	62.7	62.7
Rapid drawdown impacts – harbour wall utilities	14.2	13.8	11.9	11.9	11.9	11.9
Carbon of flood damages avoided		-48.9	-177.0	-177.4	-178.4	-178.4
Carbon scheme			10.2	10.2	10.2	10.2
Utilities	164.3	163.0	9.8	9.9	9.1	9.1
Education	4.5	3.1	0.0	0.0	0.0	0.0
Active Travel		0	-5.6	-5.6	-5.6	-5.6
Heritage & Cultures	78.9	36.0	3.9	3.7	3.2	3.2
Recreation & Amenity	7.9	7.6	7.5	7.5	7.5	7.5
Recreation & Amenity – Parks	6.3	6.2	6.2	6.2	6.2	6.2
Environmental benefit (EHOV)			-0.1	-0.1	-0.1	-0.1
OM1a qualifying damages	2912.0	2627.4	316.3	307.4	286.8	288.1
OM1b qualifying damages	803.9	699.0	129.4	127.3	122.9	123.4

These damages have been discounted to adjust for the construction programme of the Strategy, giving the values in Table 27, below.

Table 27: Damages and benefits.

Option	Net PV Damages (£m)	OM1a Benefits (Total Benefits, £m)	OM1b qualifying damages (£m)	OM1b Benefits (£m)
Do Nothing	2531.7	0	700.5	0
Do Minimum Blended	2284.7	247.0	609.1	91.4
75yr SoP	277.2	2254.5	112.8	587.8
100yr SoP	269.4	2262.3	110.9	589.6
200yr SoP	251.6	2280.1	107.1	59.4
NPPF scheme	252.8	2279.0	107.5	593.0

For some properties, the trend on damages is not consistent across the options (eg. the 1% AEP SoP has higher residual damages than the 1.3% AEP SoP). This is because of a mechanism whereby higher defences hold back flood waters in exceedence events. It is important to emphasise that this phenomenon **does not lead to flood risk detriment**, but it does partially offset the benefits of higher standards of protection. The affected properties are identified in Figure 9.

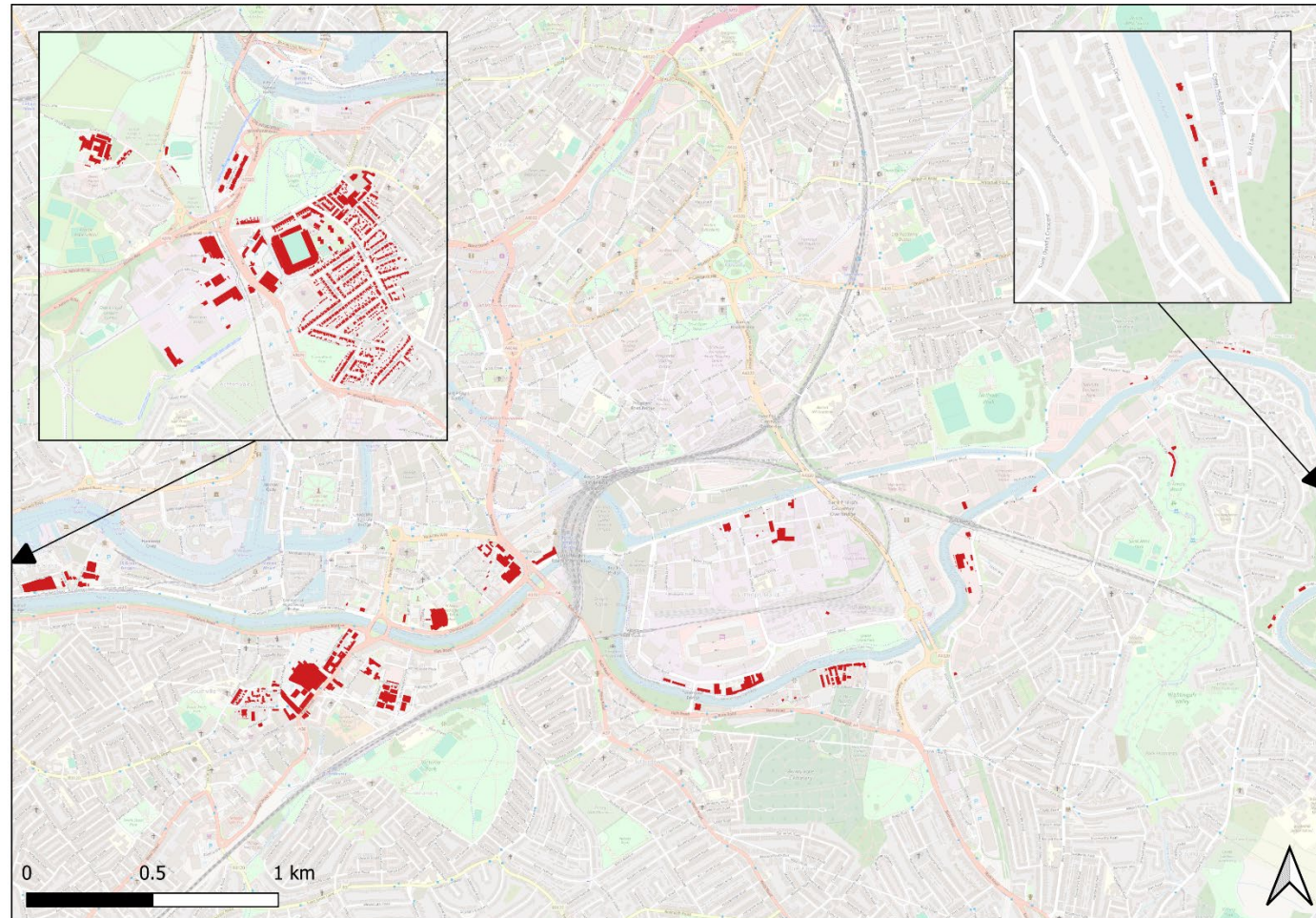


Figure 9: Properties that are subject to the phenomenon of inconsistent flood damages with increasing standard of protection.

6.2 Risks to Property

The potential increases in flood risk to property if the status quo continues is shown below in Table 28. This count does not include upper floor properties within the floodplain, or properties constructed since 2012. The distribution of these properties is shown in Figure 10 and Figure 11, overleaf.

Table 28: Property at risk in the Do Minimum scenario, assuming Floating Harbour flood gates are successfully operated.

Location	Do Minimum 2030						
	Tidal 200		Fluvial 100		Total, avoiding double counting		
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential	Sum
Central Bristol	51	186	614	396	616	426	1042
Downstream	170	26	7	0	170	26	196
Upstream to A4174	7	1	117	63	117	63	180
<i>Total</i>	<i>228</i>	<i>213</i>	<i>738</i>	<i>459</i>	<i>903</i>	<i>515</i>	<i>1418</i>
Location	Do Minimum 2130						
	Tidal 200		Fluvial 100		Total, avoiding double counting		
	Residential	Non-residential	Residential	Non-residential	Residential	Non-residential	Sum
Central Bristol	1223	997	2202	945	1483	1062	2545
Downstream	323	31	216	26	323	31	354
Upstream to A4174	73	32	234	98	117	70	187
<i>Total</i>	<i>1619</i>	<i>1060</i>	<i>2652</i>	<i>1069</i>	<i>1923</i>	<i>1163</i>	<i>3086</i>

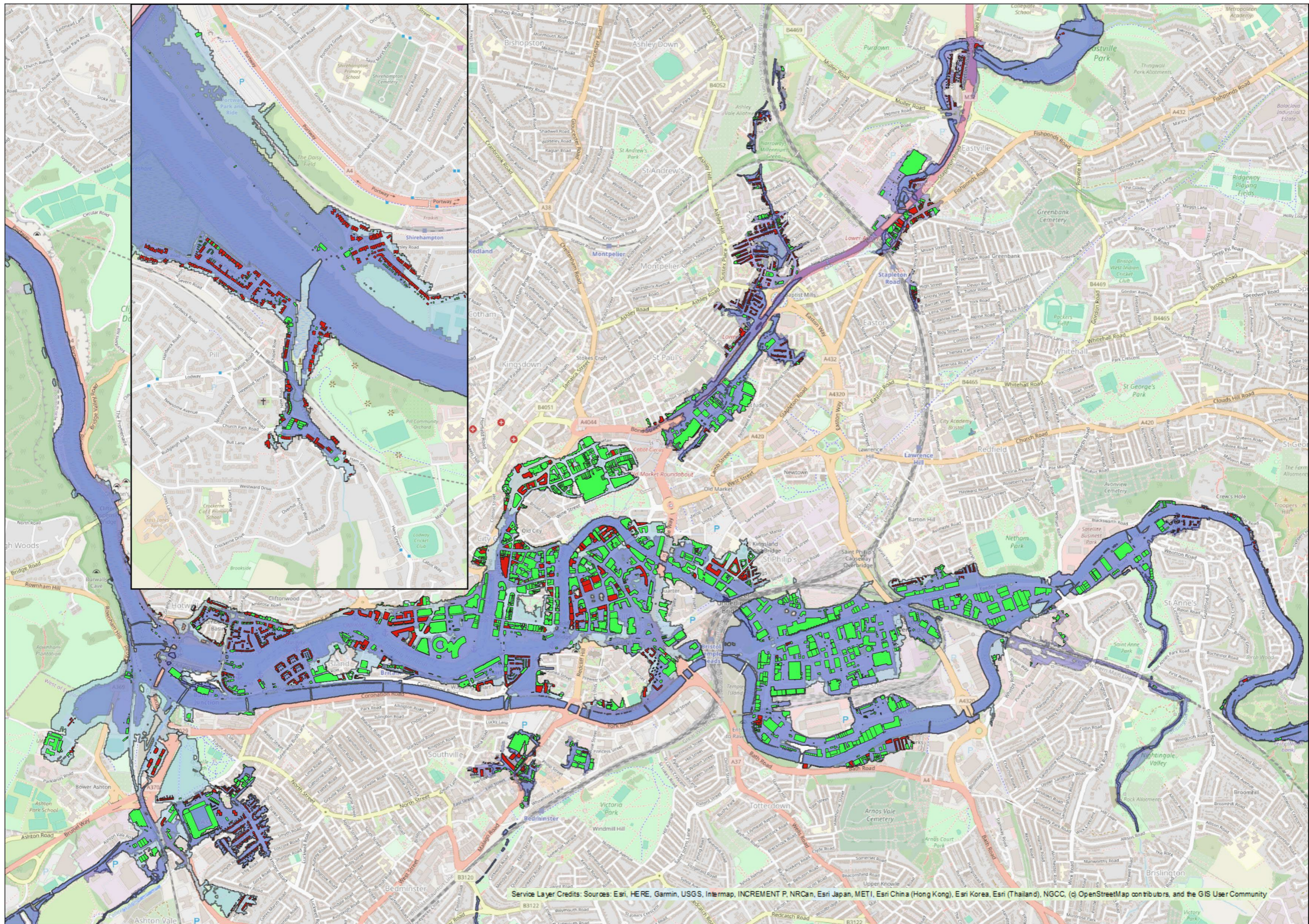


Figure 10a: Residential (red) and non-residential (green) properties within the 2130 200yr tidal (pale blue) and 100yr fluvial (dark blue) flood extents for central Bristol. Inset: Pill & Shirehampton.

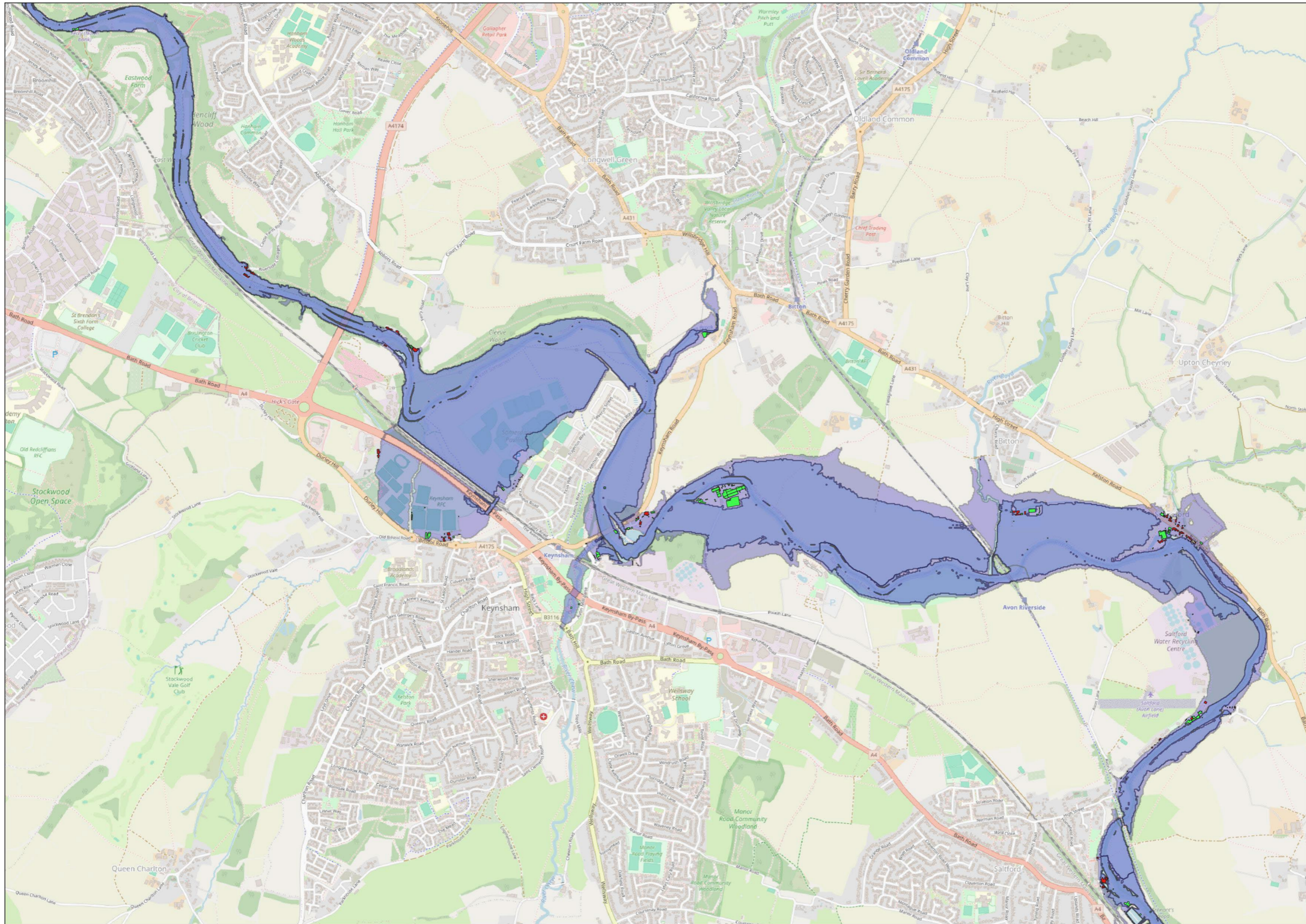


Figure 11b: Residential (red) and non-residential (green) properties within the 2130 200yr tidal (pale blue) and 100yr fluvial (dark blue) flood extents upstream of Bristol.

6.3 Critical Infrastructure

6.3.1 Electrical supply

A total of 34 electrical substations are at risk in the Do-Nothing tidal present-day scenario 1 in 100 chance event, rising to 75 by 2130 and a total of 28 electrical substations are at risk in the Do-Nothing fluvial present-day scenario, also rising to 75 by 2130. In total 111 substations are at risk in the Do Nothing scenario.

The 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.

6.3.2 Education

Several educational properties are at risk over the 100-year appraisal period for the Do-Nothing scenario. This includes 1 school and 3 nurseries.

- St. Mary Redcliffe & Temple C of E school (~8,900 pupils)
- Redcliffe Childrens Centre and Maintained Nursery School (~690 pupils)
- Becket Hall Day Nursery (~310 pupils)
- St. Philips Marsh nursery.

6.3.3 Emergency services

Emergency service centres at risk in 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)

The ambulance stations at direct flood risk may reasonably be interpreted as servicing 15- 30% of the city's ambulance capacity.

Most hospitals in Bristol are located to the north of the Avon and Floating Harbour; there would therefore be a significant increase in emergency response times for south Bristol while transport is impacted during a flood event.

There is only one ambulance station south of the Avon, located at Keynsham; at face value it therefore appears likely that there would be serious shortfalls in service during major flood events.

6.3.4 Healthcare facilities

- 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

6.3.5 Community centres at risk

- TS Adventure Sea Cadets
- Redcliffe Children's Centre
- Broad Plain and Riverside Youth Project
- Marksbury Road Library

7. Strategy costs

The costs of the Strategy have been developed across the 2 Phases of development in detail, down to the type of construction considered for each defence, and how / when each component would be designed to allow for raising to 2130 standard.

7.1.1 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, 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. 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.
- 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, 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.

7.1.2 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 adaptations 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.

7.1.3 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 will also modernise many of the harbour assets, which is expected to reduce future operations and maintenance costs.

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.

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.

Table 29: Net Present Value strategy costs (NPV to a base year of 2028)

Option	Capital works, 2029-2035 (£m)	Capital works, 2070 (£m)	Whole life maintenance costs (£m)	Total Whole Life Cost (£m)
Do Nothing	0	0	0	0
Do Minimum	14.0	0	5.0	19.0
75yr SoP	248.6	10.6	27.1	286.3
100yr SoP	249.8	10.6	27.1	287.5
200yr SoP	257.3	10.9	27.1	295.3
NPPF	255.1	10.9	27.1	293.0

8. Selection of the preferred option

8.1 Application of the Decision Rule

Capped present value damages, the net benefit of implementing each of the options, and the project costs are used to calculate the benefit cost ratios shown in Table 30 below.

Table 30: Benefit cost ratios for each phase

Option	Damages (£m)	Benefits (£m)	Costs (£m)	Benefit Cost Ratio	Incremental Benefit Cost Ratio to previous option
Do Nothing	2531.7		0	0	0
Do Minimum	2284.7	247.0	19	13.0	13.0
1.33% AEP SoP	277.2	2254.5	286.3	7.9	7.5
1% AEP SoP	269.4	2262.3	287.5	7.9	6.5
NPPF Local Choice	252.8	2279.0	293.0	7.8	3.0
0.5% AEP SoP	251.6	2280.1	295.3	7.7	0.5

From the Do Minimum, an Incremental benefit Cost Ratio (IBCR)>1 is required to progress to a subsequent option. The analysis indicates an IBCR of 7.5

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 strategy 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 in 2070.

8.2 Grant in Aid

8.2.1 Overview of the Partnership Funding Calculator

The Partnership funding calculator is populated with the following information:

Costs

The cost of the strategy, including appraisal studies to date, capital costs, allowances for the 95%ile risk and optimism bias, and future costs over the lifetime of the project. The future costs are for operation and maintenance of the strategy, and for works to increase flood defence heights (and extents) in the 2060’s. Costs do not include inflation. Values are given in present value terms, which is to say that they are discounted between when incurred, and the expected year of FBC submission (2028).

Where future costs exceed 20% of the upfront costs, applicants are required to shorten the duration of the claimed benefit period.

In this project the costs of maintenance and the uplifts to raise the scheme to a higher standard of protection at a later stage are less than 20% of the upfront costs. This allows the same funding period for the strategy to be assumed as the appraisal period, 100 years

Benefits

The benefits of the project are divided into several different types, reflecting different rates of payment, and allowing for reporting against the government’s targets for delivery of flood risk outcomes. This is why they are referred to as “Outcome measures”, or “OM’s”. All OM’s are entered for the preferred project on economic grounds, not the Local Choice option.

OM1a is the total benefit of the project, as calculated above, also given in present value terms.

OM1b is the portion of OM1 that relates to benefits to people and their personal possessions. These are: risks to life; intangible health benefits; mental health impacts; the costs of relocation; vehicle damages. Also given in present value terms.

OM2a is calculated from the number of households moved from one defined flood risk band at the start of a project to another by the end of the appraisal period. Rates of payment for OM2a are further defined by the Index of Multiple Deprivation for the Lower Super Output Area that properties are located in, with higher rates of payment for properties in more deprived communities.

OM2b. Similar to Om2a, except OM2b is calculated from the movement of households not already captured by OM2a from one defined flood risk band in the year 2040 to another by the end of the appraisal period.

OM3 is based on property numbers at risk from erosion, and does not apply here.

OM4 is a measure of environmental improvement, based on changes in habitat type and quality. The vast majority of the project is conducted in the urban environment, and OM4 benefits are nominal and not counted.

Partnership funding contributions

Money raised from funding sources other than GiA is entered in present value terms.

Outputs

The calculator presents the outputs in a range of ways, as detailed in Table 31, below.

Table 31: glossary of the PFC calculator outputs.

Term	Description
Raw PF Score	The percentage of the project that will be covered by Grant in Aid
Adjusted PF Score	The percentage of the project that will be covered by Grant in Aid + Contributions. Grant in Aid will not be paid for anything less than score of 100%.
Minimum p. contribution / saving required	The amount of present value. financial contributions required to achieve Adjusted PF Score of 100%
Pv maximum eligible FCERM GiA	An overall value of Grant in Aid for which the project is theoretically eligible, which is subsequently split into GiA towards up-front costs and future costs. Risk management Authorities (RMAs) claiming grant are not eligible for the future costs element of this, so the full value of Pv maximum eligible FCERM GiA is not what would be paid towards this project

Pv FCERM GiA up-front costs	This is the amount of funding that will actually be available to the project. Note however that some of this may be necessary to cover appraisal costs
Pv FCERM GiA future costs	This is the amount of funding available towards future costs. RMAs claiming grant are not eligible for this proportion.

8.2.2 Calculator inputs

As per Section 4, benefits and properties are not claimed for the key areas identified as being subject to Surface Water Flood Risk. The definition of baseline flood risk on the Pill and the Frome is used to avoid claiming benefits associated with local defence refurbishment projects.

OM1

The input value of Whole Life Benefits, OM1a, is £2,279m.

The input value of People relative impacts, OM1b, is £593m

OM2's

The property counts are given below in Table 32 and Table 33. These properties can be seen in Figure 12 and Figure 13, overleaf.

Table 32: Outcome measure 2a- households at risk today that are better protected against flood risk by this project

N° households in deprived areas	at risk today				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk
20% most deprived	3	0	0	0	4
21% to 40% most deprived	19	112	1	26	
60% least deprived	44	151	0	108	

N° households in deprived areas	at risk after duration of benefits				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk
20% most deprived	3	0	4	0	0
21% to 40% most deprived	138	0	20	0	0
60% least deprived	269	23	11	0	0

Table 33: Outcome measure 2b- additional households at risk in 2040 that are better protected against flood risk by this project

N° households in deprived areas	at risk from 2040				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk
20% most deprived	2	5	0	11	
21% to 40% most deprived	28	39	0	1	
60% least deprived	17	19	0	66	

N° households in deprived areas	at risk after duration of benefits				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk
20% most deprived	18	0	0	0	0
21% to 40% most deprived	68	0	0	0	0
60% least deprived	102	0	0	0	0

Section 4.5 of LIT 58360²⁶ sets out the requirements for the duration of benefits period used in correctly calculating FCERM GiA. *The duration of benefits period is critical for correctly calculating FCERM GiA. It is defined as:*

- *“for flood risk management projects - the time period over which the benefits and outcomes achieved can be relied on before a further major investment*
- *The duration of benefits period typically relates directly to the useful life of the flood or coastal asset being built or upgraded, or the time until the next major capital investment is proposed, whichever is sooner. A major investment is one that is more than 20% of the value of the investment being considered today (in today’s prices, without inflation added).”*

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.

8.2.3 Calculator outputs

The full partnership funding calculator is attached in Appendix A. The payment for outcomes from the calculator are shown in Table 34, below.

Table 34 Partnership Funding Calculator payment for outcomes, NPPF option.

OM	deprivation	Qualifying benefits	%age benefits	Payment rate	Eligible FCERM GiA	%age
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	

The future costs of the scheme comprise 11% of the total costs, and this reduces the present value FCERM Grant in Aid contributions to up-front costs that the strategy is eligible for to p.v. £197.7m, subject to p.v. £83.8m partnership contributions being secured.

With the current level of identified funding contributions (p.v. £45.8m) , the PF Scores are

Raw PF Score: 70%

Adjusted PF Score: 86%

Partnership Funding Calculators are enclosed at Appendix A1 (showing the current funding position) and A2 (assuming that the funding gap has been closed).

²⁶ Environment Agency 2023, “Calculate GiA funding for FCERM projects,” LIT 58360

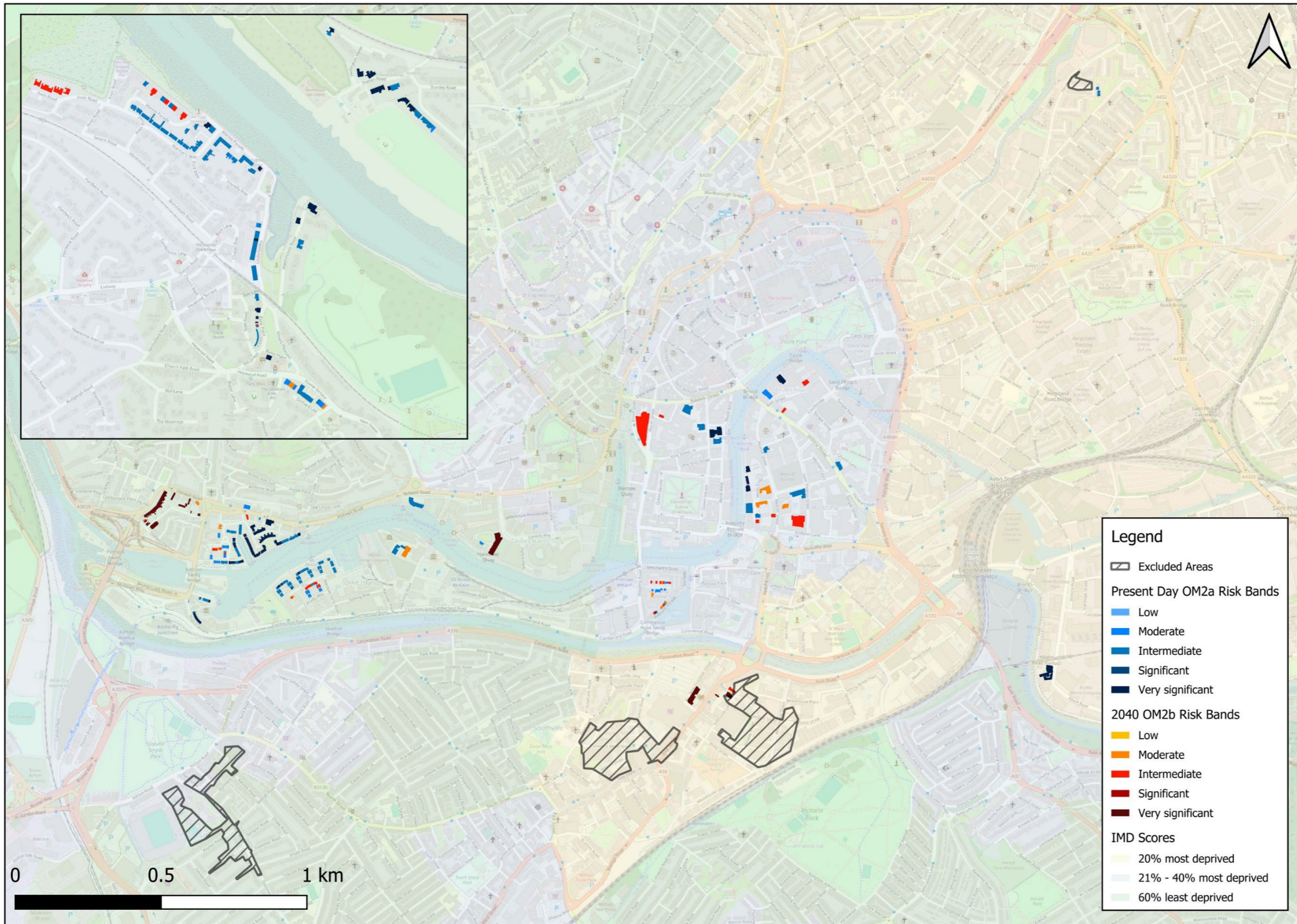


Figure 12: OM2a and OM2b before flood strategy.

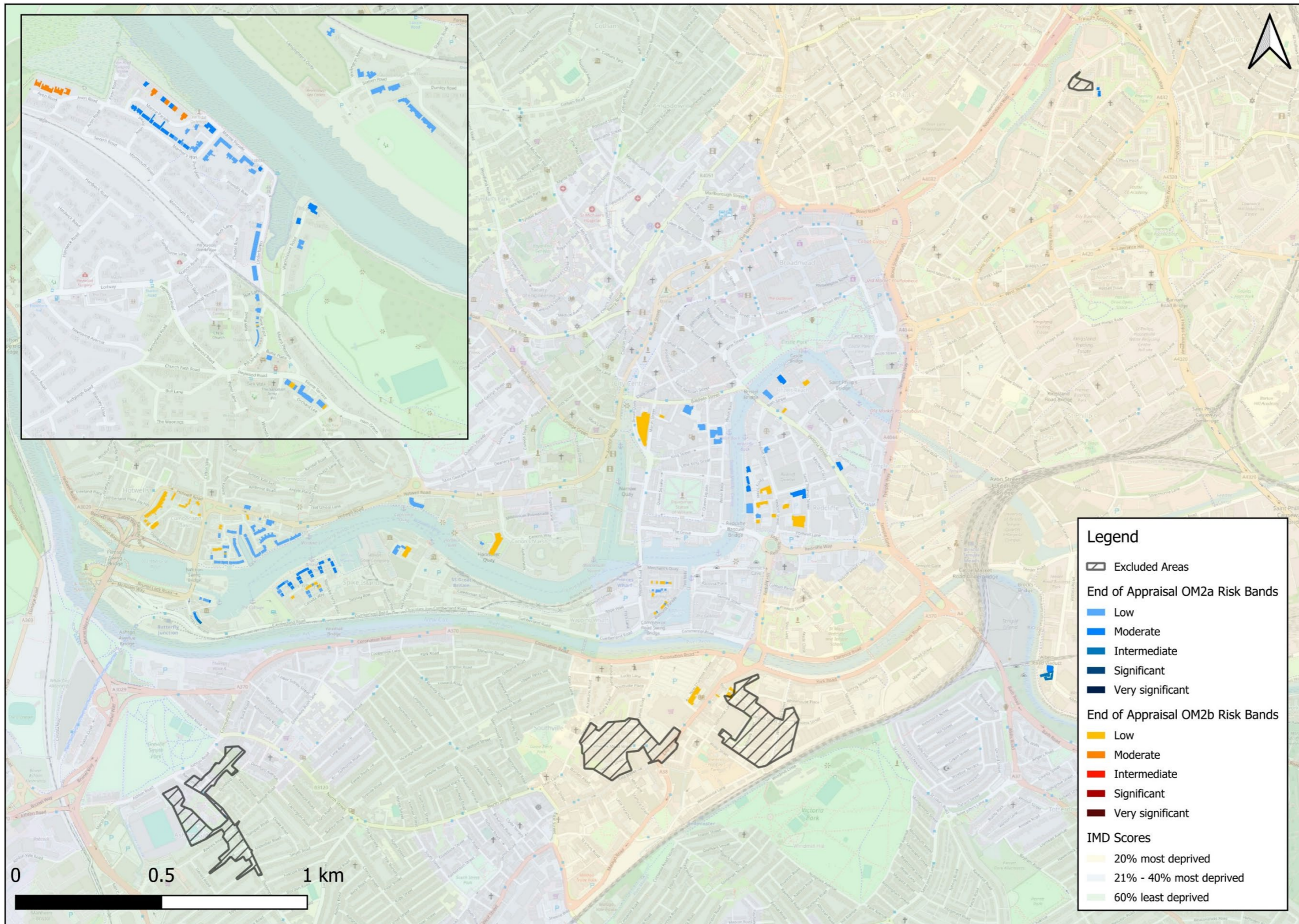


Figure 13: Distribution of OM2a and OM2b eligible properties at the end of the appraisal period, assuming implementation of 75yr Standard of Protection.

8.3 Local Choice

Bristol City Council’s ambitions for Western Harbour, Bristol Temple Quarter and St. Philip’s Marsh merit the consideration of a National Planning Policy Framework compatible standard of protection. Such a strategy would be constructed to the greater of the 1 in 100 fluvial, or 1 in 200 tidal SoP, with greater allowances made for climate change (in line with NPPF). The defences however would not need to be constructed with freeboard, because uncertainty in flood risk can be managed by development behind the defences through their own application of freeboard in their floor levels.

Comparison of such a strategy suggests that the resulting defence heights would in fact be very similar to the greater of the 1 in 100 fluvial or 1 in 200 tidal defence heights including freeboard and climate change in line with appraisal convention as per Section 3.2.

The Phase 1 capital cost would be p.v. £255.1m. This would require additional funding of approx.. £54.3m on top of the £200.8m Grant in Aid funding. Funding would also need to be secured towards maintenance of the scheme and the later costs of Phase 2.

The case for funding by Bristol City Council and other local government, as presented in Section 5, is that, in quantifiable terms, the Local Choice option provides £1,595m of direct benefits to the local economy through the avoidance of disruption and flooding to businesses and infrastructure, construction jobs created, and protection to the tourism industry.

The direct benefits are indisputably impacts of the project on the local economy, and as they are direct outcomes of flood protection, are presented here as grounds for funding by BCC, WECA and other interested bodies.

The Local Choice also aids the unlocking of developments providing an additional £7,045m in GVA and other benefits. Flood risk is not the only infrastructure issue to be resolved to enable the unlocked sites or the greenway, and these benefits would need to be apportioned across several infrastructure investments. However, without resolving flood risk, it is true to say that these developments will only proceed with significant delay or cost. The benefits are presented here, but not “claimed” as such – the apportionment of benefits across enabling projects would need to be resolved by BCC.

The strategy also has a number of other significant but unquantified benefits for Bristol and the West of England:

- Ensuring the benefits of proposed works at the Temple Mead station against flood risk effects
- Ensuring the direct and economic growth benefits of other transport initiatives (MetroWest (costing £175m), MetroBus (£200m) and the mass transit project (£4bn)) against flood risk effects
- Avoiding blight to the centre of Bristol, leading to loss of businesses and residents
- Ensuring the continuing attractiveness of Bristol to creative and talented workers, businesses and visitors.

- Protecting the wider Bristol visitor economy from the knock-on impacts of the loss of the central tourist industry

8.4 Phasing of the Scheme

8.4.1 Precautionary vs Managed Adaptive approaches.

It is proposed to deliver the scheme using a Managed Adaptive approach, in line with best practice. This means to construct Phase 1 of the scheme with climate change allowances to 2069, and uplift the scheme in 2070 to have climate change allowances to 2130. In fact, not all locations will be constructed using this principle; at a number of communities, defences will be constructed on a Precautionary basis to the 2130 standard. These locations reflect relatively low differences in flood defence height, and are typically found at areas upstream and downstream of the Floating Harbour. The full list is:

- Pill
- Shirehampton
- Sea Mills
- Bower Asthon
- Entrance Lock
- Whitby Road
- Chapel Way
- Pump House Lane
- Beeses Bar
- Riverside Cottages
- Hanham Mills
- Lock Cottage
- Keynsham
- Broadmead Lane
- Bitton
- Swineford

The Managed Adaptive approach was originally proposed in the shortlisting assessment of 2017²⁷. That report noted that, while IBCR’s of the 4 most favoured options were all very similar, the option to raise defences on a precautionary basis (i.e. to construct to the 2130 standard at the start of the project) was less cost beneficial.

Alternate phasing options could be considered however: a precautionary approach (constructing to the 2130 allowance from the start of the project), and a myopic approach (constructing to the 2069 standard in Phase 1, but without building in the potential to raise defences in 2070 – defences rebuilt from scratch to 2130 standard in 2070). These options are considered in Table 35, and it can be seen that the Managed Adaptive approach is undeniably the strongest option.

Table 35: Comparison of phasing options (Green: best; Amber: next best; Red: worst)

	Precautionary	Managed adaptive	Myopic
Cost benefit	The Managed Adaptive is already a very high standard over the duration of Phase 1. Constructing the scheme to the Phase 2 standard early will not significantly increase benefits over the Managed Adaptive approach. It will however increase pv costs by £36m (12%)	Cheapest (cost of Phase 2 is discounted 40 years into the future)	Benefits theoretically no different from Managed Adaptive approach, although risk of delays to uplift may lead to reductions in reality. By far the greatest cost.
Carbon	Given the low residual risk of the Managed Adaptive scheme, carbon avoided will not be significantly lower for the Precautionary option. Constructing early means that p.v. carbon will be worse	Best potential for reduced carbon for scheme construction by adopting technology in 40 years’ time	Given reconstruction costs, assumed the greatest carbon impact

²⁷ Aecom, 2018 “River Avon Tidal Flood Risk Management Strategy - Preferred Option Report”

	Precautionary	Managed adaptive	Myopic
Adaptability	Least adaptive approach	Most adaptive by nature, allow BCC to respond to future changes.	Generally adaptable, but risk of lost flexibility for future raising.
Environmental	Highest impact initially, but this may be offset by having only 1 construction phase	Defers full impact of project until later, but this may be offset by having 2 construction phases, not 1	Greatest impact by virtue of magnitude of Phase 2 construction effort
Placemaking	Higher defences from early on, with greater visual impact	Defers visual impact until strictly necessary	Defers visual impact until strictly necessary
Public support	Higher cost, and higher defences from the off, likely to be least supported	Best option	Higher disruption at Phase 2 makes this less favoured than the Managed Adaptive
Funding	Greater funding required up front.	Opportunities for developer to deliver through “in kind” contributions. Time available to gather partnership funding	Opportunities for developer to deliver through “in kind” contributions. Time available to gather partnership funding (but greater funding needed)

8.4.2 Sensitivity to duration of benefits period

As stated in Section 8.2.2, the proposals qualify for funding over a Duration of Benefits period of 100 years because the costs of implementing Phase 2 are significantly less than the 20% guide figure for shortening a funding period. The main body of the OBC also makes clear the commitment of BCC to the funding and construction of Phase 2.

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.

While not yet explicitly calculated, it has been possible to infer a minimum Grant in Aid value for the Phase 1 (no Phase 2) 100 year duration of benefits from a blend of the results of the “lock gates close successfully” scenario that comprises part of the Do Minimum, and the NPPF results. The make up of these benefits is shown in Table 36.

Table 36: Make up of benefits in estimate of Phase 1 (no Phase 2)

Benefit type		Approach to damage calculation
(i)	Residential property damages	For areas where adaptive approach was going to be applied, based on Do Min “lock gates close successfully” (across the full 100years) For areas where the defences are raised to the full 2130 standard from the start, based on the NPPF scheme.
	Relocation	
	Mental health	
	Intangible health benefit	
	Vehicle damages	
	Risk to Life	
	Non-residential property damages	
	Indirect Commercial losses	
	Emergency Services	
	Carbon of flood damages avoided	
(ii)	Transport impacts	

Benefit type		Approach to damage calculation
	Utilities	Based on the NPPF scheme to 2070, and then interpolated to the Do Minimum Damages in 2130
	Education	
	Heritage & Cultures	
	Recreation & Amenity	
	Environmental benefit (EHOV)	
(iii)	Rapid drawdown impacts	Based on the NPPF Scheme
	Active Travel	
	Erosion impacts – Road / Active travel	

This scenario, by not including the defences of Phase 1, will significantly under estimate the type (i) benefits of the NPPF option in the period 2030-2069 and will also show some underestimation in the period 2069-2130 for both type (i) and type (ii) benefits. It is therefore very much a **lower bound estimate of Grant in Aid**. Nonetheless, it suggests that an **absolute lower bound** estimate of the 100 year benefit of Phase 1 (no Phase 2) would be £1664m (OM1a), which with people related benefits of £403m (OM1b) would make this scenario eligible for a minimum GiA of £143m. Phase 1 therefore will still represent a healthy 8.5:1 return on GiA investment even if Phase 2 does not proceed as planned in line with BCC’s commitments.

A PFC showing this calculation can be found in Appendix A3, albeit that this is a lower bound estimate.

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

- Delivery of several defence locations to the 2130 standard on a precautionary basis (typically upstream and downstream of the Floating Harbour area).
- 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; delivery of the active travel route.
- The residual standard of protection in 2070 is still very high. While it would decline over time to a low standard by 2130, it would still deliver significant benefits over the 2070-2130 period.
- Approximately 9% of the Phase 1 capital costs (£29m cash, including Optimism bias, inflation and 95%ile risk allowance) 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 p.v. £88.2m GiA (see PFC of this estimate in Appendix A4). While Phase 2 would in theory be eligible for the remaining p.v. £109.5m GiA, it is likely that some benefits will be lost because the residual benefit of Phase 1 will 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. However 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.

9. Sensitivity Testing

9.1 Decision Rule

The choice of the preferred option on economic grounds is highly sensitive to small changes in costs or benefits. This is an artefact of very low incremental costs and incremental benefits, when considered as a percentage of the overall costs and benefits.

The cost of the Local Choice option would only have to increase by 1% for the Decision Rule to find the 1% AEP scheme as the preferred option on economic grounds. Similarly, the benefit of the Local Choice option would only have to reduce by 0.1%, or that of the 1% AEP scheme to increase by 0.1% for the 1% AEP scheme to become the preferred option.

Much as the preferred option by the Decision Rule may be sensitive, the implications for Grant in Aid are low – there is only 1.1% difference in Grant in Aid between the 1.33% AEP SoP and the Local Choice option.

10. Available partnership funding

The Grant in Aid calculator identifies a need for p.v. £83.8m partnership funding contributions to achieve Adjusted PF = 100%.

Secured sources of funding are presented below in Table 36, and currently come to p.v. £43.7m. Present values of the secured funds are inferred from a speculative distributed funding profile over the period 2029-2033. This suggests a need to secure an additional p.v. £60.6m in funding contributions, of which a number of potential sources are being considered.

Potential sources with a total value of £117m cash are being considered to close this funding gap, with further details in the Financial Case. These include:-

- Developer contributions, on the principle of beneficiary pays, or Developer “in kind” contributions
- Additional grant funding contributions from WECA or central government funding
- Additional Community Infrastructure Levy (CIL) funding.
- Public Sector land value

Table 37: identified potential sources of funding

Fund	Notes	Cash value (£m)	Present value (£m)	Status
Secured funding				
Local Levy	The costs of the SOC (£1.3m) and a portion of the costs of the OBC (£0.84m) have been funded by BCC, WECA and the Wessex Regional Flood and Coastal Committee via Local Levy	2.14	2.14	Spent
BCC	Funding of the OBC	1.064	1.064	Spent
Local Levy	Funding of £2.2m is programmed from Local levy towards the estimated £15m cost of the FBCs	2.2	2.2	Programmed
Local Enterprise Partnership (LEP) Economic Development Funding (EDF)	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.	10	9.188	Allocated
Community Infrastructure Levy (CIL)	BCC allocated £22.233m of CIL from 2029-33 towards the project	20.4	19.42	Allocated
BCC Budget reserves	The 2022/23 BCC budget earmarked £10.1m of reserves for the project	10	9.662	Allocated
TOTAL SECURED		45.8	43.7	

11. Conclusion

11.1 Preferred strategy

A preferred flood strategy has been identified for Bristol Avon. This is the “Local Choice” strategy, an NPPF compliant strategy, based on the greater of a 1 in 200 tidal and 1 in 100 fluvial design defence level, including freeboard, constructed (in Phase 1) with an allowance for climate change up to 2069, and raised in 2070 (Phase 2) to include an allowance up to 2130.

11.2 Grant in Aid eligible benefits

The Local Choice strategy is the “preferred scheme on economic grounds”, and is eligible for p.v. £197.7m Grant in Aid.

The scheme would deliver Grant in Aid eligible benefits to the nation through flood damage avoided of £2,279m. It moves some 414 residential properties at flood risk today to a lower risk band at the end of the appraisal, and an additional 188 residential properties at flood risk in 2040 to a lower risk band at the end of the appraisal.

11.3 Grant in Aid Funding

The NPPF compliant strategy has an estimated capital cost for Phase 1 of £263.3m (present value, 95% uncertainty), with project development costs of £18.2m, giving total up-front costs of £281.5m. The Grant in Aid funding identified for this strategy has been identified at a maximum of £197.7m subject to securing partnership funding of at least p.v. £83.8m. Partnership funding secured to date totals p.v. £43.7m.

Potential sources with a total value of £117m cash are being considered to close the funding gap. These include:-

- Developer contributions, on the principle of beneficiary pays
- Additional grant funding contributions from WECA or central government funding
- Additional Community Infrastructure Levy (CIL) funding.
- Public Sector land value

Maintenance costs, and the capital works to uplift the defence in Phase 2 are estimated at p.v.£37.9m, to be funded by Bristol City Council.

11.4 The case for other sources of funding

In terms of the local economy, the strategy would help deliver significant benefits through avoided damage to businesses and infrastructure (£858m), avoided disruption to local businesses (£360m) and the creation of construction jobs (£23m), and protection of the tourism industry (£354m).

There are proposed developments capable of generating an estimated (£5.3bn) GVA located in the benefitting floodplain of the strategy, and a further (£1.7bn) in other benefits – and while it’s true

to say that the progression of these developments is not solely dependent on delivery of a flood strategy (and therefore the strategy could not 'claim' all these benefits), it is also true to say that delivery of the strategy will enable these to progress to a faster timescale and lower cost.

The city's ambitions for economic growth outside of the floodplain require an effective integrated transport network linking it to the city centre, and Bristol Temple Meads rail station is seen as 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 would form a key part of making this ambition effective so that recent (£375m) and considered (£4bn) infrastructure investments can achieve their full potential both in terms of direct improvements to travel times, and the induced economic growth.

Without investment to protect the city from fluvial and tidal flood risk, properties around the harbour area risk being written-off by 2069 due to high frequency flooding. By 2130, this could apply to extensive areas of the city: Hotwells, North Redcliffe, St. Philip's Marsh and Western Harbour. This would lead to blight and degradation of the public realm at the heart of the city, impacting heavily on Bristol's ability to attract businesses, workers and visitors.

11.5 Further considerations

The costs and benefit values presented in this report are estimates based on information available prior to its preparation. Values should continue to be refined at Full Business Case stage in consultation with the Environment Agency Large Project Review Group (LPRG) to confirm the economic case for the strategy.

The build-up of costs and benefits should remain under review at FBC, and further sources of Grant in Aid eligible benefit should be explored if necessary.

Planning and development is an evolving process, and the benefit case for funding leveraged against the identified developments in the floodplain will need to evolve with those developments. It is recognised that the flood strategy is not the only component of enabling works, and the attribution of benefits / funding across different initiatives will need to be managed at a city level to avoid double counting. This may mean that the local funding element of this analysis will need to be kept up to date with this evolving situation.

Appendix A

Partnership Funding Calculators

A.1 Partnership Funding Calculator, 100year Appraisal Period, Preferred Scheme

Project teams are required to provide a copy of the PF Calculator within their business case for approval of FCERM GiA.

Flood and Coastal Erosion Risk Management (FCERM)

Partnership Funding (PF) calculator 2020 for Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM GiA)

Version 2: April 2022 (for use by projects delivering FCERM outcomes after 1 April 2021)

Key

input	selection
-------	-----------

SECTION 1: Project details

Project Name	Bristol Avon Flood Strategy
National Project number	
Date of PF Calculator	17 June 2024
Lead RMA	Bristol City Council
FCERM GiA applicant type	Local Authority

Project stage	OBC
Option reference	NPPF

Benefit:Cost ratio	7.2 to 1
Effective return to taxpayer:	n/a to 1
Effective return on contributions:	52.2 to 1

All values in £ (pound Sterling)

Figures in blue to be included in the national FCERM capital programme for the chosen option

SECTION 2: Prospect of eligibility for FCERM GiA

Confirmed strategic approach?	Yes	See guidance. Evidence provided in the business case
Raw PF Score	70%	Adjusted PF Score 86% Insufficient contributions to secure FCERM GiA
Minimum pv contribution/saving required	£ 83,830,992	pv FCERM GiA up-front costs £ -
pv maximum eligible FCERM GiA	£ 221,825,098	pv FCERM GiA future costs £ - Other RMAs are not eligible for the proportion of the pv maximum eligible FCERM GiA that is for future costs

SECTION 3: Costs and contributions for the PREFERRED OPTION (over the duration of benefits period)

Estimated project costs	Towards qualifying outcomes	Contributions proposed to date	towards pv appraisal costs		towards pv qualifying outcomes up-front		towards pv qualifying outcomes future		Contributor(s) or Fund(s)
			£		£		£		
pv appraisal costs	£ 18,203,823	pv Local Levy	£	4,340,000.00					
pv design and construction costs	£ 165,809,113	pv other public sector	£	1,064,000	£	38,273,000			
pv risk contingency	£ 97,509,131	pv private and voluntary sector							
pv costs for approval	£ 281,522,067	pv other Environment Agency							
pv future costs	£ 34,368,067	pv sub-total	£	5,404,000	£	38,273,000	£	-	
pv WLC (over duration of benefits)	£ 315,890,134	pv total contributions	£	43,677,000					

Contributions to future costs are not included in GiA calculation. Other RMAs are encouraged to secure contributions towards future costs, separately

SECTION 4: Outcome Measure 1 - economic benefits arising from FCERM

pv WLB (appraisal period)	£ 2,278,977,724	Economic summary sheet completed	Yes	4 of 4 essential data cells completed in the Economic summary; 39 of 39 other data cells completed in the Economic summary
Duration of benefits (DoB) period	100	Economic data included in business case?	Yes	
pv WLB (DoB = OM1A)	£ 2,278,977,724			
People related impacts - due to measures proposed (DoB = OM1B)	£ 593,000,000			

SECTION 5A: Outcome Measure 2A (today) - households at risk today that are better protected against flood risk by this project (over the duration of benefits period)

N° households in deprived areas	at risk today					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	3	0	0	0	4	3	-3	4	0	-4	£	159,883
21% to 40% most deprived	19	112	1	26	138	-19	-92	-1	-26		£	2,104,840
60% least deprived	44	151	0	108	269	-21	-140	0	-108		£	6,390,068

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	3	0	4	0	0					
21% to 40% most deprived	138	0	20	0	0					
60% least deprived	269	23	11	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 5B: Outcome Measure 2B (2040) - households at risk in 2040 that are better protected against flood risk by this project (over the remaining duration of benefits period)

Year when measures are ready for service - Gateway 4	2033
--	------

N° households in deprived areas	at risk from 2040					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	2	5	0	11	18	-2	-5	0	-11		£	433,638
21% to 40% most deprived	28	39	0	1	68	-28	-39	0	-1		£	334,597
60% least deprived	17	19	0	66	102	-17	-19	0	-66		£	2,534,909

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	18	0	0	0	0					
21% to 40% most deprived	68	0	0	0	0					
60% least deprived	102	0	0	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 6: Outcome Measure 3 - households better protected against coastal erosion

N° households in deprived areas	at risk today		Damages per household avoided:	pv qual. benefits	
	long-term loss	medium-term loss		£	
20% most deprived			Annual damages avoided	£ 6,800	£ 6,800
21% to 40% most deprived			Loss expected in	50	20 years
60% least deprived			Present value of Year 1 loss (i.e. first year damages, discounted based on when loss is expected)	£ 1,341	£ 3,417

Long-term loss Medium-term loss

SECTION 7: Outcome Measure 4 - environmental improvements

Type of habitat (OM4A)	'before' condition (Ha)			'after' condition at end of DoB (Ha)			pv qual. benefits	Length of river habitat enhanced (OM4B)	pv qual. benefits
	Poor	Moderate	Good	Poor	Moderate	Good			
Intertidal habitat							£ -	Comprehensive restoration <input type="text"/> kilometre(s) Partial restoration <input type="text"/> A single, major physical improvement <input type="text"/>	£ -
Woodland							£ -		£ -
Wet woodland							£ -		£ -
Wetlands/wet grassland							£ -		£ -
Grassland							£ -		
Heathland							£ -		
Ponds/lakes							£ -		
Arable land							£ -		

SECTION 8: Qualifying benefits and eligible FCERM GiA arising from project

OM	deprivation	Qualifying benefits	%age benefits	Payment rate	Eligible FCERM GiA	%age
OM1a	overall	£ 1,674,019,789	73.5%	6	£ 100,441,187	45.3%
OM1b	people related	£ 593,000,000	26.0%	20	£ 118,600,000	53.5%
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%
	ivers	£ -	0.0%	20	£ -	0.0%
Total		£ 2,278,977,724		pv max. eligible GiA	£ 221,825,098	

Example sensitivity analyses

Test	Raw score	Contributions required	%age of whole life costs
PF Calculator (above)	70%	£ 83,830,992	30%
SA1: pv WLC - Affordability	56%	£ 154,211,509	39%
SA2: OM2 - Flood risks lower than assumptions made	70%	£ 84,010,434	27%
SA3: OM3 - Erosion risks lower than assumptions made	N/A	No OM3 contribution	n/a
SA4: Duration of benefits - Option choice is conservative	70%	£ 83,830,992	27%
SA5: Duration of benefits - Option choice is optimistic	70%	£ 83,947,827	27%
SA6: Strategic considerations not demonstrated	32%	£ 192,561,083	61%
SA7: Change in environmental habitat is optimistic	N/A	No OM4 contribution	n/a

A.2 Partnership Funding Calculator, 100year Appraisal Period, Preferred Scheme, with funding gap closed

Project teams are required to provide a copy of the PF Calculator within their business case for approval of FCERM GiA.

Flood and Coastal Erosion Risk Management (FCERM)

Partnership Funding (PF) calculator 2020 for Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM GiA)

Version 2: April 2022 (for use by projects delivering FCERM outcomes after 1 April 2021)

Key	input	selection
	calculated cells	

SECTION 1: Project details

Project Name	Bristol Avon Flood Strategy
National Project number	
Date of PF Calculator	17 June 2024
Lead RMA	Bristol City Council
FCERM GiA applicant type	Local Authority

Project stage	OBC
Option reference	NPPF

Benefit:Cost ratio	7.2	to 1
Effective return to taxpayer:	11.5	to 1
Effective return on contributions:	27.2	to 1

All values in £ (pound Sterling)

Figures in blue to be included in the national FCERM capital programme for the chosen option

SECTION 2: Prospect of eligibility for FCERM GiA

Confirmed strategic approach?	Yes	See guidance. Evidence provided in the business case		
Raw PF Score	70%	Adjusted PF Score	100%	Review maturity of the risk contingency and any contributions to minimise the risk of exceeding FCERM GiA limits
Minimum pv contribution/saving required	£ 83,830,992	pv FCERM GiA up-front costs	£ 197,691,075	
pv maximum eligible FCERM GiA	£ 221,825,098	pv FCERM GiA future costs	£ -	Other RMAs are not eligible for the proportion of the pv maximum eligible FCERM GiA that is for future costs

SECTION 3: Costs and contributions for the PREFERRED OPTION (over the duration of benefits period)

Estimated project costs	Towards qualifying outcomes	Contributions proposed to date	towards pv appraisal costs		towards pv qualifying outcomes up-front		towards pv qualifying outcomes future		Contributor(s) or Fund(s)
			£		£		£		
pv appraisal costs	£ 18,203,823	pv Local Levy	£	4,340,000.00					
pv design and construction costs	£ 165,809,113	pv other public sector	£	1,064,000	£	38,273,000			
pv risk contingency	£ 97,509,131	pv private and voluntary sector							
pv costs for approval	£ 281,522,067	pv other Environment Agency			£	40,153,992			
pv future costs	£ 34,368,067	pv sub-total	£	5,404,000	£	78,426,992	£	-	
pv WLC (over duration of benefits)	£ 315,890,134	pv total contributions	£	83,830,992					

Contributions to future costs are not included in GiA calculation. Other RMAs are encouraged to secure contributions towards future costs, separately

SECTION 4: Outcome Measure 1 - economic benefits arising from FCERM

pv WLB (appraisal period)	£ 2,278,977,724	Economic summary sheet completed	Yes	4 of 4 essential data cells completed in the Economic summary; 39 of 39 other data cells completed in the Economic summary
Duration of benefits (DoB) period	100	Economic data included in business case?	Yes	
pv WLB (DoB = OM1A)	£ 2,278,977,724			
People related impacts - due to measures proposed (DoB = OM1B)	£ 593,000,000			

SECTION 5A: Outcome Measure 2A (today) - households at risk today that are better protected against flood risk by this project (over the duration of benefits period)

N° households in deprived areas	at risk today					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	3	0	0	0	4	3	-3	4	0	-4	£	159,883
21% to 40% most deprived	19	112	1	26	138	-19	-92	-1	-26		£	2,104,840
60% least deprived	44	151	0	108	269	-21	-140	0	-108		£	6,390,068

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	3	0	4	0	0					
21% to 40% most deprived	138	0	20	0	0					
60% least deprived	269	23	11	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 5B: Outcome Measure 2B (2040) - households at risk in 2040 that are better protected against flood risk by this project (over the remaining duration of benefits period)

Year when measures are ready for service - Gateway 4	2033
--	------

N° households in deprived areas	at risk from 2040					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	2	5	0	11	18	-2	-5	0	-11		£	433,638
21% to 40% most deprived	28	39	0	1	68	-28	-39	0	-1		£	334,597
60% least deprived	17	19	0	66	102	-17	-19	0	-66		£	2,534,909

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	18	0	0	0	0					
21% to 40% most deprived	68	0	0	0	0					
60% least deprived	102	0	0	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 6: Outcome Measure 3 - households better protected against coastal erosion

N° households in deprived areas	at risk today		Damages per household avoided:		pv qual. benefits	
	long-term loss	medium-term loss	Annual damages avoided	Loss expected in	£	years
20% most deprived			£ 6,800	£ 6,800	£	-
21% to 40% most deprived			50	20	£	-
60% least deprived			£ 1,341	£ 3,417	£	-

Present value of Year 1 loss (i.e. first year damages, discounted based on when loss is expected)

SECTION 7: Outcome Measure 4 - environmental improvements

Type of habitat (OM4A)	'before' condition (Ha)			'after' condition at end of DoB (Ha)			pv qual. benefits	Length of river habitat enhanced (OM4B)	pv qual. benefits
	Poor	Moderate	Good	Poor	Moderate	Good			
Intertidal habitat							£ -	Comprehensive restoration Partial restoration A single, major physical improvement	£ -
Woodland							£ -		£ -
Wet woodland							£ -		£ -
Wetlands/wet grassland							£ -		£ -
Grassland							£ -		£ -
Heathland							£ -		£ -
Ponds/lakes							£ -		£ -
Arable land							£ -	£ -	

SECTION 8: Qualifying benefits and eligible FCERM GiA arising from project

OM	deprivation	Qualifying benefits	%age benefits	Payment rate	Eligible FCERM GiA	%age
OM1a	overall	£ 1,674,019,789	73.5%	6	£ 100,441,187	45.3%
OM1b	people related	£ 593,000,000	26.0%	20	£ 118,600,000	53.5%
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%
	ivers	£ -	0.0%	20	£ -	0.0%
Total		£ 2,278,977,724			£ 221,825,098	

Example sensitivity analyses

Test	Raw score	Contributions required	%age of whole life costs
PF Calculator (above)	70%	£ 83,830,992	30%
SA1: pv WLC - Affordability	56%	£ 154,211,509	39%
SA2: OM2 - Flood risks lower than assumptions made	70%	£ 84,010,434	27%
SA3: OM3 - Erosion risks lower than assumptions made	N/A	No OM3 contribution	n/a
SA4: Duration of benefits - Option choice is conservative	70%	£ 83,830,992	27%
SA5: Duration of benefits - Option choice is optimistic	70%	£ 83,947,827	27%
SA6: Strategic considerations not demonstrated	32%	£ 192,561,083	61%
SA7: Change in environmental habitat is optimistic	N/A	No OM4 contribution	n/a

A.3 Partnership Funding Calculator, 100year Appraisal Period, Preferred Scheme Phase 1, no Phase 2 (with funding gap closed)

Flood and Coastal Erosion Risk Management (FCERM)

Partnership Funding (PF) calculator 2020 for Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM GiA)

Version 2: April 2022 (for use by projects delivering FCERM outcomes after 1 April 2021)

Key	input	selection
	calculated cells	

SECTION 1: Project details

Project Name	Bristol Avon Flood Strategy
National Project number	
Date of PF Calculator	17 June 2024
Lead RMA	Bristol City Council
FCERM GiA applicant type	Local Authority

Project stage	OBC
Option reference	Phase 1, 100yr DoB, no Ph2

Benefit:Cost ratio	5.4 to 1
Effective return to taxpayer:	11.6 to 1
Effective return on contributions:	12.0 to 1

All values in £ (pound Sterling)

Figures in blue to be included in the national FCERM capital programme for the chosen option

SECTION 2: Prospect of eligibility for FCERM GiA

Confirmed strategic approach?	Yes	See guidance. Evidence provided in the business case
Raw PF Score	51%	Adjusted PF Score: 100%
Minimum pv contribution/saving required	£ 138,544,395	pv FCERM GiA up-front costs: £ 142,977,672
pv maximum eligible FCERM GiA	£ 156,734,449	pv FCERM GiA future costs: £ -

Review maturity of the risk contingency and any contributions to minimise the risk of exceeding FCERM GiA limits

Other RMAs are not eligible for the proportion of the pv maximum eligible FCERM GiA that is for future costs

SECTION 3: Costs and contributions for the PREFERRED OPTION (over the duration of benefits period)

Estimated project costs	Towards qualifying outcomes	Contributions proposed to date	towards pv appraisal costs	towards pv qualifying outcomes up-front	towards pv qualifying outcomes future	Contributor(s) or Fund(s)
pv appraisal costs	£ 18,203,823	pv Local Levy	£ 4,340,000.00			
pv design and construction costs	£ 165,809,113	pv other public sector	£ 1,064,000	£ 38,273,000		
pv risk contingency	£ 97,509,131	pv private and voluntary sector				
pv costs for approval	£ 281,522,067	pv other Environment Agency		£ 94,867,395		
pv future costs	£ 27,087,000	pv sub-total	£ 5,404,000	£ 133,140,395	£ -	
pv WLC (over duration of benefits)	£ 308,609,067	pv total contributions	£ 138,544,395			

Contributions to future costs are not included in GiA calculation. Other RMAs are encouraged to secure contributions towards future costs, separately

SECTION 4: Outcome Measure 1 - economic benefits arising from FCERM

pv WLB (appraisal period)	£ 1,663,950,000	Economic summary sheet completed	Yes	4 of 4 essential data cells completed in the Economic summary; 39 of 39 other data cells completed in the Economic summary
Duration of benefits (DoB) period	100	Economic data included in business case?	Yes	
pv WLB (DoB = OM1A)	£ 1,663,950,000			
People related impacts - due to measures proposed (DoB = OM1B)	£ 403,400,000			

SECTION 5A: Outcome Measure 2A (today) - households at risk today that are better protected against flood risk by this project (over the duration of benefits period)

N° households in deprived areas	at risk today					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	0	0	0	0	0	0	0	0	0	0	£	-
21% to 40% most deprived	6	62	0	0	4	72	-6	-62	0	-4	£	744,952
60% least deprived	7	35	0	0	27	68	-7	-34	0	-27	£	1,591,807

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	0	0	0	0	0					
21% to 40% most deprived	72	0	0	0	0					
60% least deprived	68	0	1	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 5B: Outcome Measure 2B (2040) - households at risk in 2040 that are better protected against flood risk by this project (over the remaining duration of benefits period)

Year when measures are ready for service - Gateway 4	2033
--	------

N° households in deprived areas	at risk from 2040					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	0	0	0	0	0	0	0	0	0	0	£	-
21% to 40% most deprived	2	11	0	0	0	13	-2	-11	0	0	£	76,288
60% least deprived	3	1	0	0	0	4	-3	-1	0	0	£	10,707

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	0	0	0	0	0					
21% to 40% most deprived	13	0	0	0	0					
60% least deprived	4	0	0	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 6: Outcome Measure 3 - households better protected against coastal erosion

N° households in deprived areas	at risk today		Damages per household avoided:		pv qual. benefits	
	long-term loss	medium-term loss	Annual damages avoided	Loss expected in	£	years
20% most deprived			£ 6,800	£ 6,800	£	-
21% to 40% most deprived			50	20	£	-
60% least deprived			£ 1,341	£ 3,417	£	-

Present value of Year 1 loss (i.e. first year damages, discounted based on when loss is expected)

Long-term loss Medium-term loss

SECTION 7: Outcome Measure 4 - environmental improvements

Type of habitat (OM4A)	'before' condition (Ha)			'after' condition at end of DoB (Ha)			pv qual. benefits	Length of river habitat enhanced (OM4B)	pv qual. benefits	
	Poor	Moderate	Good	Poor	Moderate	Good				
Intertidal habitat							£ -	Comprehensive restoration	£ -	
Woodland							£ -		Partial restoration	£ -
Wet woodland							£ -		A single, major physical improvement	£ -
Wetlands/wet grassland							£ -			
Grassland							£ -			
Heathland							£ -			
Ponds/lakes							£ -			
Arable land							£ -			

SECTION 8: Qualifying benefits and eligible FCERM GiA arising from project

OM	deprivation	Qualifying benefits	%age benefits	Payment rate	Eligible FCERM GiA	%age
OM1a	overall	£ 1,258,126,246	75.6%	6	£ 75,487,575	48.2%
OM1b	people related	£ 403,400,000	24.2%	20	£ 80,680,000	51.5%
OM2	20% most	£ -	0.0%	45	£ -	0.0%
	21% to 40%	£ 821,240	0.0%	30	£ 246,372	0.2%
	60% least	£ 1,602,514	0.1%	20	£ 320,503	0.2%
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%
	ivers	£ -	0.0%	20	£ -	0.0%
Total		£ 1,663,950,000		pv max. eligible GiA	£ 156,734,449	

Example sensitivity analyses

Test	Raw score	Contributions required	%age of whole life costs
PF Calculator (above)	51%	£ 138,544,395	49%
SA1: pv WLC - Affordability	41%	£ 208,924,911	54%
SA2: OM2 - Flood risks lower than assumptions made	51%	£ 138,582,379	45%
SA3: OM3 - Erosion risks lower than assumptions made	N/A	No OM3 contribution	n/a
SA4: Duration of benefits - Option choice is conservative	51%	£ 138,544,394	45%
SA5: Duration of benefits - Option choice is optimistic	51%	£ 138,567,070	45%
SA6: Strategic considerations not demonstrated	23%	£ 217,182,114	70%
SA7: Change in environmental habitat is optimistic	N/A	No OM4 contribution	n/a

A.4 Partnership Funding Calculator, 40year Appraisal Period, Preferred Scheme

Flood and Coastal Erosion Risk Management (FCERM)

Partnership Funding (PF) calculator 2020 for Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM GiA)

Version 2: April 2022 (for use by projects delivering FCERM outcomes after 1 April 2021)

Key	input	selection
	calculated cells	

SECTION 1: Project details

Project Name	Bristol Avon Flood Strategy
National Project number	
Date of PF Calculator	17 June 2024
Lead RMA	Bristol City Council
FCERM GiA applicant type	Local Authority

Project stage	OBC
Option reference	NPPF, 40 yr DoB

Benefit:Cost ratio	3.4 to 1
Effective return to taxpayer:	11.3 to 1
Effective return on contributions:	5.1 to 1

All values in £ (pound Sterling)

Figures in blue to be included in the national FCERM capital programme for the chosen option

SECTION 2: Prospect of eligibility for FCERM GiA

Confirmed strategic approach?	Yes	See guidance. Evidence provided in the business case		
Raw PF Score	31%	Adjusted PF Score	100%	Review maturity of the risk contingency and any contributions to minimise the risk of exceeding FCERM GiA limits
Minimum pv contribution/saving required	£ 193,021,492	pv FCERM GiA up-front costs	£ 88,216,153	
pv maximum eligible FCERM GiA	£ 93,065,150	pv FCERM GiA future costs	£ -	Other RMAs are not eligible for the proportion of the pv maximum eligible FCERM GiA that is for future costs

SECTION 3: Costs and contributions for the PREFERRED OPTION (over the duration of benefits period)

Estimated project costs	Towards qualifying outcomes	Contributions proposed to date	towards pv appraisal costs		towards pv qualifying outcomes up-front		towards pv qualifying outcomes future		Contributor(s) or Fund(s)
			£		£	£	£	£	
pv appraisal costs	£ 18,203,823	pv Local Levy	£ 4,340,000.00						
pv design and construction costs	£ 165,809,113	pv other public sector	£ 1,064,000		£ 38,273,000				
pv risk contingency	£ 97,509,131	pv private and voluntary sector							
pv costs for approval	£ 281,522,067	pv other Environment Agency			£ 149,628,914				
pv future costs	£ 14,520,000	pv sub-total	£ 5,404,000		£ 187,901,914				
pv WLC (over duration of benefits)	£ 296,042,067	pv total contributions	£ 193,305,914						

Contributions to future costs are not included in GiA calculation. Other RMAs are encouraged to secure contributions towards future costs, separately

SECTION 4: Outcome Measure 1 - economic benefits arising from FCERM

pv WLB (appraisal period)	£ 2,278,977,724	Economic summary sheet completed	Yes	4 of 4 essential data cells completed in the Economic summary; 25 of 25 other data cells completed in the Economic summary
Duration of benefits (DoB) period	40	Economic data included in business case?	Yes	
pv WLB (DoB = OM1A)	£ 992,970,000			
People related impacts - due to measures proposed (DoB = OM1B)	£ 226,300,000			

SECTION 5A: Outcome Measure 2A (today) - households at risk today that are better protected against flood risk by this project (over the duration of benefits period)

N° households in deprived areas	at risk today					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	5	0	0	0	16	9	-1	8	0	-16	£ 518,642	
21% to 40% most deprived	19	112	1	28		115	25	-111	-1	-28	£ 1,719,570	
60% least deprived	44	152	0	131		155	114	-138	0	-131	£ 5,427,929	

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	9	4	8	0	0					
21% to 40% most deprived	115	44	1	0	0					
60% least deprived	155	158	14	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 5B: Outcome Measure 2B (2040) - households at risk in 2040 that are better protected against flood risk by this project (over the remaining duration of benefits period)

Year when measures are ready for service - Gateway 4	2033
--	------

N° households in deprived areas	at risk from 2040					change due to project					pv qual. benefits	
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	low risk	moderate risk	intermediate risk	significant risk	very significant risk	£	
20% most deprived	2	5	0	14		18	-2	-2	0	-14	£ 351,440	
21% to 40% most deprived	28	39	0	1		68	-28	-39	0	-1	£ 225,282	
60% least deprived	17	19	0	66		102	-17	-19	0	-66	£ 1,706,737	

N° households in deprived areas	at risk after duration of benefits					Annual damages avoided (£) compared with a household at low risk				
	low risk	moderate risk	intermediate risk	significant risk	very significant risk	0	59	294	1000	1589
20% most deprived	18	0	3	0	0					
21% to 40% most deprived	68	0	0	0	0					
60% least deprived	102	0	0	0	0					

The deprivation categories are taken from the Index of Multiple Deprivation, available through gov.uk (see guidance and version sheet for links)

SECTION 6: Outcome Measure 3 - households better protected against coastal erosion

N° households in deprived areas	at risk today		Damages per household avoided:		pv qual. benefits	
	long-term loss	medium-term loss	Annual damages avoided	Loss expected in	£	years
20% most deprived			£ 6,800	£ 6,800	£	-
21% to 40% most deprived			50	20	£	-
60% least deprived			£ 1,341	£ 3,417	£	-

Present value of Year 1 loss (i.e. first year damages, discounted based on when loss is expected)

SECTION 7: Outcome Measure 4 - environmental improvements

Type of habitat (OM4A)	'before' condition (Ha)			'after' condition at end of DoB (Ha)			pv qual. benefits	Length of river habitat enhanced (OM4B)	pv qual. benefits
	Poor	Moderate	Good	Poor	Moderate	Good			
Intertidal habitat							£ -	Comprehensive restoration Partial restoration A single, major physical improvement	£ -
Woodland							£ -		£ -
Wet woodland							£ -		£ -
Wetlands/wet grassland							£ -		£ -
Grassland							£ -		£ -
Heathland							£ -		£ -
Ponds/lakes							£ -		£ -
Arable land							£ -	£ -	

SECTION 8: Qualifying benefits and eligible FCERM GiA arising from project

OM	deprivation	Qualifying benefits	%age benefits	Payment rate	Eligible FCERM GiA	%age
OM1a	overall	£ 756,720,400	76.2%	6	£ 45,403,224	48.8%
OM1b	people related	£ 226,300,000	22.8%	20	£ 45,260,000	48.6%
OM2	20% most	£ 870,082	0.1%	45	£ 391,537	0.4%
	21% to 40%	£ 1,944,852	0.2%	30	£ 583,456	0.6%
	60% least	£ 7,134,666	0.7%	20	£ 1,426,933	1.5%
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%
	ivers	£ -	0.0%	20	£ -	0.0%
Total		£ 992,970,000			£ 93,065,150	

Example sensitivity analyses

Test	Raw score	Contributions required	%age of whole life costs
PF Calculator (above)	31%	£ 193,021,492	69%
SA1: pv WLC - Affordability	25%	£ 263,402,008	71%
SA2: OM2 - Flood risks lower than assumptions made	31%	£ 193,217,895	65%
SA3: OM3 - Erosion risks lower than assumptions made	N/A	No OM3 contribution	n/a
SA4: Duration of benefits - Option choice is conservative	32%	£ 192,829,299	65%
SA5: Duration of benefits - Option choice is optimistic	31%	£ 193,279,782	65%
SA6: Strategic considerations not demonstrated	14%	£ 241,696,808	82%
SA7: Change in environmental habitat is optimistic	N/A	No OM4 contribution	n/a

Appendix B

Wider Benefits Assessment

Bristol City Council

Bristol Avon Flood Strategy Outline Business Case

BAFS OBC Wider Benefits Appendix

Reference: 2-30-1

2.0 | 19 June 2024









This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 285982-00

Ove Arup & Partners Limited
12 Wellington Place
Leeds
LS1 4AP
United Kingdom
arup.com

Document Verification

Project title Bristol Avon Flood Strategy Outline Business Case
Document title BAFS OBC Wider Benefits Appendix
Job number 285982-00
Document ref 2-30-1
File reference 2-30-1

Revision	Date	Filename	Appendix B BAFS OBC Wider Benefits v1.0		
P01	11-01-2024	Description	Issue		
			Prepared by	Checked by	Approved by
		Name	Luke Ballantyne	Peter Spokes	Ben Spokes
		Signature			pp 
P02	19-06-2024	Filename	Appendix B BAFS OBC Wider Benefits v2.0		
		Description	Update to first order losses		
			Prepared by	Checked by	Approved by
		Name	Luke Ballantyne	Luke Ballantyne	Dave Hunt
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document



Contents

1.	Introduction	1
2.	Qualitative description of the case for investment	1
2.1	The flood risk problem	1
2.2	Socio- economic context	3
2.3	The problem	5
2.4	Qualitative benefits of the strategy	8
3.	Quantified benefits methodology	8
3.1	Overview	8
4.	First order losses to infrastructure and commercial property	10
5.	GVA loss saved through reduced flood risk to existing businesses	10
5.1	Assumptions	11
5.2	Results	13
6.	GVA earned through unlocking development	14
6.1	Overview of approach	14
6.2	Data review	15
6.3	Calculation of GVA from allocated sites	16
6.4	Bristol Local Plan Growth and Regeneration areas	18
7.	Construction jobs	25
7.1	Direct calculation	25
7.2	Costs from secondary sources	26
7.3	Estimates of Construction jobs GVA attributable to flood strategy	27
8.	GVA saved through the reduced flood risk to Bristol’s tourism industry	27
9.	Summary	31
9.1	Quantified benefits	31
9.2	Unquantified benefits	32

Tables

Table 1: First order losses to infrastructure and commercial property (£m)	10
Table 2: Annual earnings per industry sector, adjusted per location.	13
Table 3: Net Gross Value Added (in £m present value) of avoided disruption to businesses.	13
Table 4: Sensitivity testing of “Stay and Adapt” assumption.	14
Table 5: Assumptions made behind cost build up for each development.	17
Table 6: Comparison of GVA outputs of the 2019 and 2022 studies	21
Table 7: Sensitivity analysis on 30yr present value estimate of net GVA from St. Philip’s Marsh development	24
Table 8: Wider benefits of the BTQ & St. Philip’s Masterplan	24
Table 9: Assumed construction cost per m2 of internal floor space.	25
Table 10: Calculation of GVA associated with Construction Jobs.	26
Table 11: Present value GVA of Construction jobs for the BTQ Masterplan	26
Table 12: Estimates of construction jobs GVA attributable to flood strategy	27

Table 13: Build-up of economic impact of flooding on tourist facilities beside the Floating Harbour	29
Table 14: Annual Average and net present value impact on tourism due to flooding.	29
Table 15: Benefits of the scheme for protection of the tourism industry	30
Table 16: Quantified benefit of proposals	31
Table 17: Summary of unquantified benefits (with regards to protection against flood risk)	32

Figures

Figure 1: 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.	2
Figure 2: Bristol's role as a central point for transport in the West of England.	4
Figure 3: Do Nothing 50% annual chance tidal flood outline, 2069 (dark blue) and 2130 (light blue) (background mapping © OpenStreetMap).	6
Figure 4: Bristol City Council's vision for investment in public transport, with the 2130 50% AEP (1 in 2 annual chance) flood outline (blue dashed line), and Cumberland Road erosion (red cross)	7
Figure 5: Overlaps between Grant in Aid eligible impacts, and impacts to the local economy	9
Figure 6: Allocated sites in the floodplain. Red indicates sites already granted planning permission; green indicates allocated sites at flood risk.	17
Figure 7: Proposed areas for Growth and Regeneration	19
Figure 8: Temple Quarter Development Form (from BTQ Spatial Framework report)	19
Figure 9: Template Gate development sites.	23

Drawings

No table of figures entries found.

Pictures

No table of figures entries found.

Photographs

No table of figures entries found.

Attachments

No table of figures entries found.

Appendices

No table of contents entries found.

1. Introduction

1.1.1 Objective of this report

Ove Arup and Partners Limited (Arup) have undertaken an economic appraisal for the Bristol Avon Flood Strategy Outline Business Case on behalf of Bristol City Council (BCC).

While the main Economics Report sets out the analysis undertaken of the *national* economic benefits of avoided flood damage, *this* technical appendix sets out the data and methods used, and results attained to estimate **the benefit to Bristol and the wider West of England region** of the flood risk management options being considered.

1.1.2 Overview of the report

The analysis considers a mixture of quantified and qualitative benefits.

The unquantified benefits are unable to draw on the level of data required to make a numerical estimate of the benefit of the flood strategy. They should not however be dismissed lightly and may well be of comparable magnitude to the quantified benefits. They are described in the Qualitative description of the case for investment (Section 2) to give the reader a feel for the scale of the case.

The quantified benefits draw on the approach set out in the “Frontier” methodology to set out the Gross value added (GVA) benefits associated with the flood strategy. GVA is a monetary measure of the value added by businesses to the local economy.

The quantified benefits are split in this document into “Direct” benefits, which are inextricably connected with the strategy, and “Indirect” benefits which reflect investment that is enabled as part of the strategy. Direct benefits include avoided flood damage and disruption to businesses, and the employment benefits of constructing the strategy. Indirect benefits are related to the removal of flood risk as a constraint to development proposals. Flood risk will not be the sole constraint to development proposals, and a wide range of enabling work may be necessary for development to happen, any of which may also point to the same set of benefits. As such, the indirect benefits are not “claimed” in this report - they are *presented*, and it is within the gift of Bristol City Council and other concerned parties to consider how the contribution of the flood strategy towards these benefits might be funded.

2. Qualitative description of the case for investment

2.1 The flood risk problem

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.

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.

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 (Figure 1).

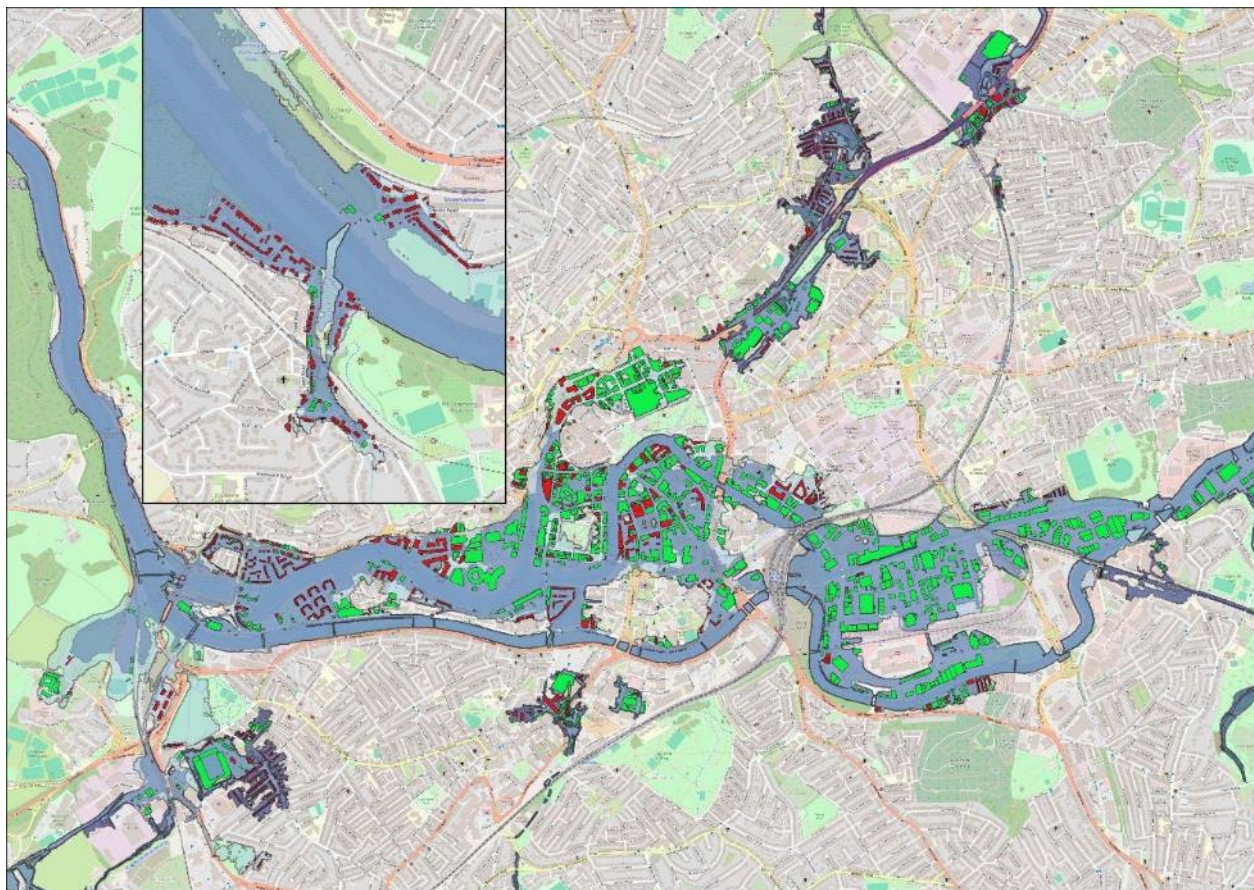


Figure 1: Residential (red) and non-residential (green) properties within the 2130 0.5% AEP tidal (pale blue) and 1% AEP fluvial (dark blue) flood extents. Inset: Pill & Shirehampton.

The Flood Strategy proposes a preferred option for a flood defence scheme to protect against the greater of the 0.5% AEP (1 in 200 annual chance) tidal flood and the 1% AEP (1 in 100) fluvial flood. The proposals will also prevent erosion to the Cumberland Road that could cause this road to be permanently closed in the future. The direct benefits *to the nation* of flooding damages avoided are quantified in the main economics report as £2.4bn.

2.2 Socio- economic context

2.2.1 Challenges facing Bristol

Bristol is an important regional centre of population, employment, education and culture, and home to over 450,000 people (over 8% over the population of the South-West). It is also a centre of employment for surrounding areas, attracting over 72,000 commuters each day.¹

Bristol faces a number of social, economic and environmental challenges, which BCC and WECA are seeking to address:

- A fast growing population¹
- Increasingly unaffordable housing¹
- Large health inequalities¹
- High crime rates¹
- High congestion² and high CO2 emissions from driving¹
- Moderately high productivity, but held back by poor transport infrastructure^{2,3}

A large number of initiatives have been identified by the West of England Economic Plan 2015-2030⁴ (amongst others) to address these issues. The ones most pertinent to this project are highlighted over the next 3 sections, covering Transport, the Attractiveness of the city and Investment in Enterprise Areas.

2.2.2 Transport initiatives

Proposals to address these issues include a wide range of transport infrastructure initiatives, as highlighted in the Economic Plan and the Joint Local Transport Plan 4.

Investment into electrification of the mainline to London is expected to deliver a 22 minute reduction in journey times from Bristol Temple Meads to London, bringing this key journey time down below the 1 hour mark, and further adding to Bristol's appeal as a location for homes and businesses. However, Burgess (2015) notes the need for improvements in the local transport network to truly deliver on the potential benefit of this step change.

The Economic Plan says “*Transport is critical to support planned economic growth in the West of England. Atkins' report “Unlocking Our Potential: The Economic Benefits of Transport Investment in the West of England” found that our programme of transport schemes will unlock 20,000 jobs and generate £1.2b in GVA per annum by 2030.*”

Notable investments in the Economic Plan include:

- MetroBus – a £200m investment across 3 routes, including an Ashton Vale – Temple Meads route.
- MetroWest – a £175m local rail investment, including electrification not only of the mainline to London, but also to the connecting suburban network.

¹ “Regional Impacts of Bristol Temple Quarter Regeneration Programme”, WECA, 2022.

² Atkins & WoE Authorities (2012) “Unlocking Our Potential: The Economic Benefits of Transport Investment in the West of England”

³ Burgess G (2015) “Understanding the barriers that exist in Bristol's regional transport system to generating maximum benefits from the electrification of the Great Western Main Line.”

⁴ West of England Strategic economic plan 2015-30 https://www.westofengland-ca.gov.uk/wp-content/uploads/2021/12/WEC063-LEP-Accessible_-FINAL.pdf

- In addition to these, ongoing studies looking into the delivery of a mass transit system for Bristol are considering schemes with construction values in excess of £3.8bn.⁵

Investment in transport is also focussed on making it more sustainable – initiatives such as the West of England Local Cycling and Walking Infrastructure Plan 2020-2036, and the City Region Sustainable Transport Settlement are intended to drive modal shift, improving air quality and delivering health benefits and great connectivity.

Investment in transport drives economic growth by increasing “static clustering” – better connecting supply chains, larger employment populations and greater geographic areas to industries by reducing travel times. This improves productivity, and the transmission of induced and indirect effects. It supports “levelling up” by spreading the induced effects of city centre economies over a wider area. The inverse of this is noted such that the communities with the greatest deprivation also suffer frequently from the lowest accessibility to public transport, and therefore stand the most to benefit from its improvement.⁶ The Centre for Cities research, which, as quoted in the Bristol Mass Transit SOC notes that sub-optimal public transport connectivity in Bristol is resulting in an annual productivity gap of £1.8bn.⁷ The investments seek to close that gap.

Figure 2 illustrates how Bristol is central to connectivity for the West of England region.

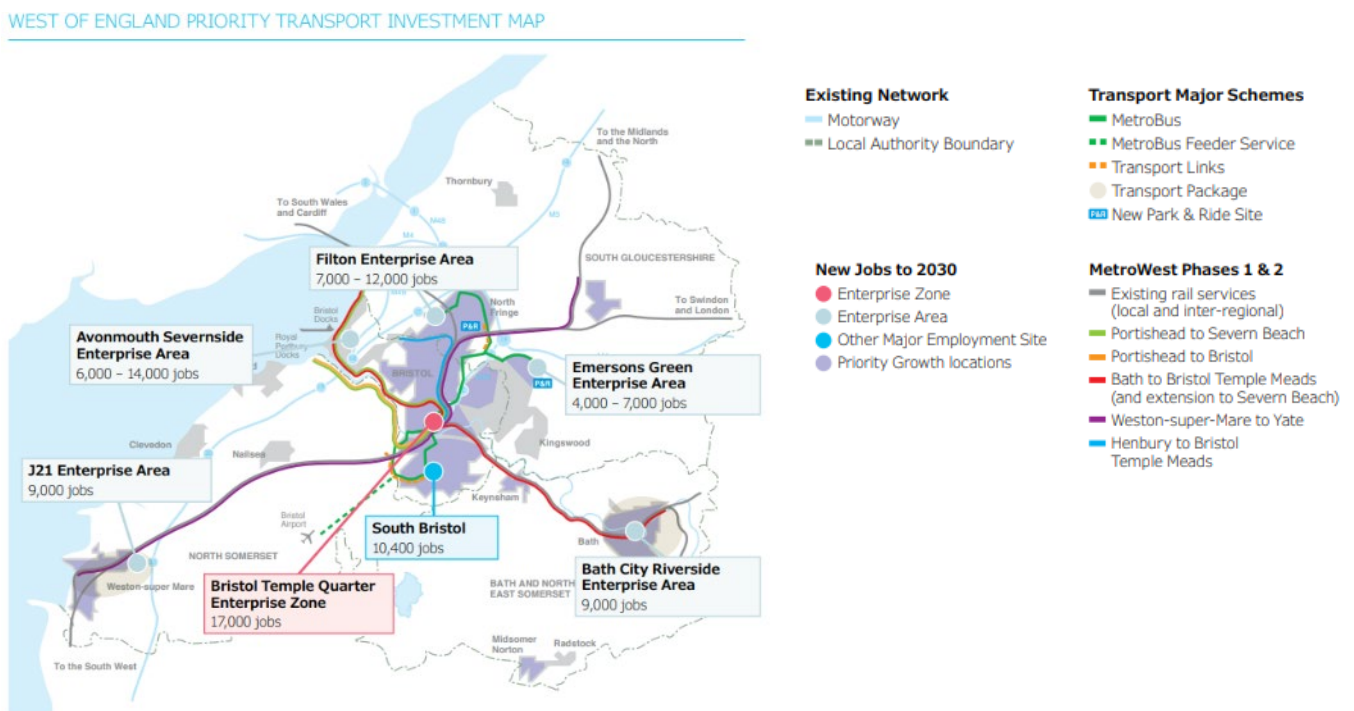


Figure 2: Bristol’s role as a central point for transport in the West of England.
Extract from the West of England Economic Plan 2015-2030

⁵ https://www.westofengland-ca.gov.uk/wp-content/uploads/2023/11/F4W_Underground-Metro-Cost-Comparison-v2-1.pdf

⁶ City Region Sustainable Transport Settlement <https://www.westofengland-ca.gov.uk/wp-content/uploads/2021/10/West-of-England-Combined-Authority-CRSTS.pdf>

⁷ Mass Transit (Future4West) SOC <https://www.westofengland-ca.gov.uk/wp-content/uploads/2023/11/Future4WEST-SOC-Final-26-Sept-2023-1.pdf>

2.2.3 Attraction

The Economic Plan also recognises the importance of the attractiveness and cultural wealth of the city as a means of attracting the best talent to work in the city, as well as for attracting visitors. *“Our vision is that by 2030, the West of England will have... Cultural attractions that are the envy of competitor city regions across Europe, making the West of England the place of choice for talented, creative workers and affluent visitors.”* As an intervention to help drive this goal, it notes a proposal for *“Bristol Arena, a large scale indoor entertainment venue of 12,000 capacity, due to be located adjacent to Temple Meads railway station.”*

The City Centre framework⁸ sets out proposals to improve movement, the public realm, and the approach to regeneration and development in Bristol City Centre, focussing on Broadmead and North Redcliffe (the area around Bristol Temple Meads Station). It notes as its goals:

- Creating a liveable, vibrant, safe and inclusive city centre for the benefit of people of all ages to live, work, learn and enjoy, both during the day and night.
- Tackling traffic congestion and improving air quality; making the city centre better connected, accessible and healthier.
- Supporting the city centre as the core retail, leisure, and cultural heart of the region, by enabling regeneration, diversifying uses and promoting the offer.
- Ensuring the sustainable development of new homes, employment space, enhancement of heritage assets, streets and public open spaces; contributing to a carbon neutral and climate resilient city

2.2.4 Investment in priority sectors and Enterprise Areas

Seven Enterprise areas are identified in the Economic Plan, of which the largest is the “Bristol Temple Quarter Enterprise Zone”. The Bristol Temple Quarter (BTQ) and St. Philip’s Marsh masterplan aims to redevelop 130ha of brownfield land, providing over 10,000 homes, and 530,000m² commercial and mixed use space, generating 12,000 net jobs.

The quantified benefits of the Bristol Temple Quarter (BTQ) & St. Philip’s Masterplan are covered in greater detail in Section 6, all of which in some way address the issues identified in 2.2.1.

2.3 The problem

There is one common feature to all these initiatives – they all focus on the Floating Harbour area of Bristol and the area around Bristol Temple Meads railway station in particular.

This leaves the delivery and/or effectiveness of all of these initiatives vulnerable to flooding. And while any of these initiatives might be designed (at a cost) to be at low direct flood risk, that will be no use if the areas they serve and connect with are at high risk.

While this may prompt the question, “should the initiatives be located elsewhere?”, there are sound reasons why these initiatives all centre on the flood zone:

- the location of the Central Business District of Bristol
- the location of key existing population centres, businesses, and cultural heritage
- existing transport infrastructure for the West of England (**Error! Reference source not found.**)
- existing transport infrastructure for Bristol (Figure 4)
- existing crossing points for the River Avon

⁸ <https://www.bristol.gov.uk/files/documents/2636-appendix-a2-city-centre-framework/file>

2.3.1 Flooding as a constraint to transport initiatives

The direct benefits to travellers of avoiding cancelled or delayed journeys due to flood risk to Temple Meads station and flood risk and erosion at Cumberland Road to the road network is assessed within the main economics report. The portion of these damages that relate to commercial traffic and commuting (and therefore relates to the local economy) is reproduced below in Section 4. However, the impacts of this disruption on economic growth and productivity are not assessed within Section 4, and as flood risk becomes more frequent, this may become a significant effect.

While the railway itself is at elevation, Temple Meads station is subject to flood disruption via flooding to its underpass, and the streets around the station. With flooding to the streets around the station, the railway network can not integrate with the road and active travel network to deliver the sustainable integrated transport network desired by the investment initiatives. The proposed investment in the station is presented in Section 6.4.5.1, but not included within the summary table in Section 9 because little of the proposed investment itself would be subject to, or constrained by flood risk. However, its effectiveness at delivering its proposed benefits is surely impacted by that ability to integrate.

In the Do Nothing scenario, all major routes of the station are flooded for tidal events in excess of the 1.33% AEP in the 2069 climate change epoch. By the end of the scheme life, all major roads to the station will be subject to flooding in a 50% AEP (1 in 2 annual chance) flood event (Figure 3). Figure 4 shows how these frequent events (and the erosion problem at Cumberland Road) would impact on Bristol City Council's vision for transport investment.

While the main economics report identifies the direct economic impacts of delays to the road and rail network, we have been unable to source references with sufficient detail to allow the identification of benefits to the West of England economy of the proposed initiatives and specifically how these might be impacted by flood risk. Nonetheless, the Economic Plan suggests £1.2bn in GVA will be unlocked by its current programme of transport initiatives. If flood risk has as little as 0.1% impact on that outcome, the strategy could be considered to generate ~ pv £36m benefit.

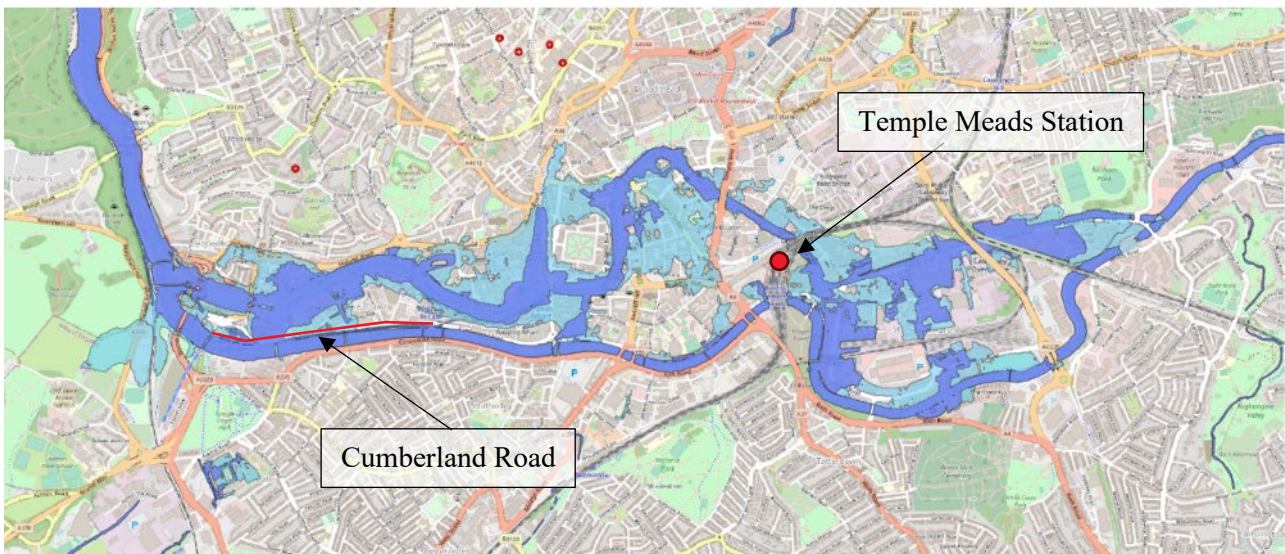


Figure 3: Do Nothing 50% annual chance tidal flood outline, 2069 (dark blue) and 2130 (light blue) (background mapping © OpenStreetMap).

Bristol public transport network vision

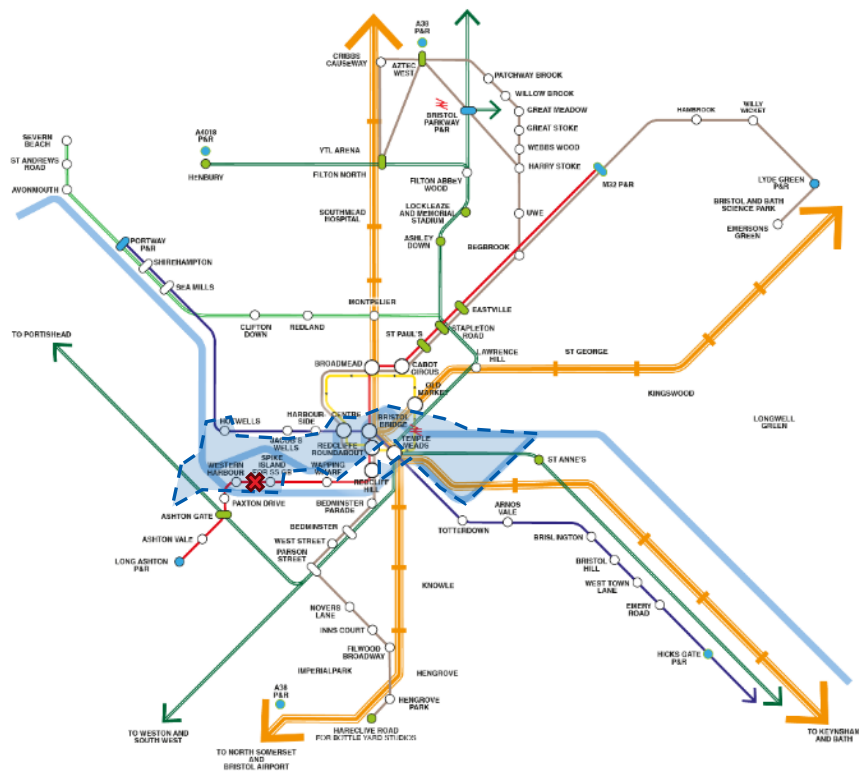
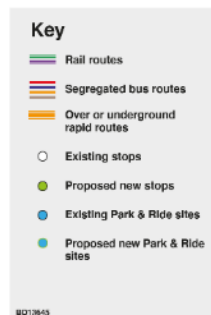


Figure 4: Bristol City Council’s vision for investment in public transport⁹, with the 2130 50% AEP (1 in 2 annual chance) flood outline (blue dashed line), and Cumberland Road erosion (red cross)

2.3.2 Flooding as a constraint to attracting talent, visitors and investment

The Multicoloured Manual¹⁰ suggests that properties subject to flooding more regularly than every 1 in 3 years will be written off. For most locations, this would result in residents and businesses moving out of the location, and buildings falling vacant.

For the location of the flood strategy, as the central business district of Bristol, the picture may be more complex. However, businesses will certainly either have to adapt, or move out of the ground floor. The public realm will either degrade, or need replacement with flood resilient features, and will regularly require clean up.

When we look at the area that this corresponds to in Figure 3, we can see that by 2069 this applies predominantly to quayside development. Quayside development is however a major part of the attraction of Bristol including harbour side restaurants & hotels, the public realm and amenity of the quays. Quayside tourist and cultural attractions include some sites that would struggle to adapt and would have to vacate.

By the end of the scheme life however (2130), write-off conditions would be present across much of the city centre. Disruption to public services would be frequent enough that (regardless of adaptation to local buildings), businesses would be more likely to move out than stay. It would be hard to argue for the attractiveness of the City if the area of North Redcliffe (as the key gateway between Temple Meads station and the shopping district of Broadmead) comprised mostly vacant properties. The public realm benefits of increased footfall and reduced crime such as are noted in the BTQ Masterplan Delivery Strategy for Temple Meads station would be reversed. With the city centre less appealing, and less businesses present, talented people will initially be deterred from moving to Bristol, limiting growth. Over time, talented people would start to move away, with corresponding loss in land value and tax receipts.

⁹ <https://www.bristol.gov.uk/files/documents/2635-bristol-public-transport-vision-map/file>

¹⁰ Flood and Hazard Research Centre 2013 “Flood and Coastal Erosion Risk Management. A manual for economic appraisal”.

This is a real threat to Bristol. What does a city look like if its historic centre is written off?

While business responses to flooding, including adaptation, or moving away, are assessed in Section 5 in line with the Frontier methodology, the Frontier methodology does not include the concept of write-off in its coding. The induced and indirect impacts of this happening on a large scale, with implications for supply chains is unknown, but undoubtedly significant. The impacts of population movement as a response to business closures is unknown but is the inverse of the agglomeration effects that the transport initiatives are invested to create.

The impacts of direct flood damage on the tourism industry are assessed in Section 8, both in terms of its direct, and induced and indirect impacts. Nonetheless, this assessment cannot take full account of the impacts of a general loss of attractiveness of the harbourside area, nor again can it take full account of the indirect effects on the wider West of England visitor economy when one significant location encompassing several sights is lost completely.

2.3.3 Flooding as a constraint to development

Where development lies within the 0.5% AEP (1 in 200 annual chance) tidal or the 1% AEP (1 in 100) fluvial floodplain, it is subject to planning restrictions under the National Planning Policy Framework, and required to, at the very least, adapt its form to avoid being at flood risk or increasing flood risk to other locations. For sites subject to the highest levels of flood risk, or covering large enough areas, this may not be economically viable, and so development can not proceed.

The benefits for the local economy of addressing this constraint are the benefits of the development proceeding. These are identified in Section 6 of this report, although as noted above, they are not “claimed”.

2.4 Qualitative benefits of the strategy

The qualitative benefits of the flood strategy are quite simply, the avoidance of the above effects. The city centre and harbourside area remain protected from write-off, and benefit from increased protection against flood risk. Transport disruption is reduced to a minimum, and initiatives for transport investment to induce economic growth for both Bristol and the West of England economy are successful. Bristol remains an attractive location for businesses, visitors, and residents.

3. Quantified benefits methodology

3.1 Overview

The Environment Agency / Defra Flood and Coastal Erosion Risk Management Grant in Aid (GiA) fund 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 considered in such an assessment, and these effects are set out in this report.

, extracted from the “Frontier methodology”¹¹, illustrates the areas of overlap between Flood and Coastal Erosion Risk Management benefits, and impacts to the local economy.

The unit of impact is a monetary measure of the value added by businesses to the local economy termed Gross Value Added, GVA.

¹¹ Defra / EA project FD2662, “Flood and Coastal erosion risk management and the local economy,” March 2014.

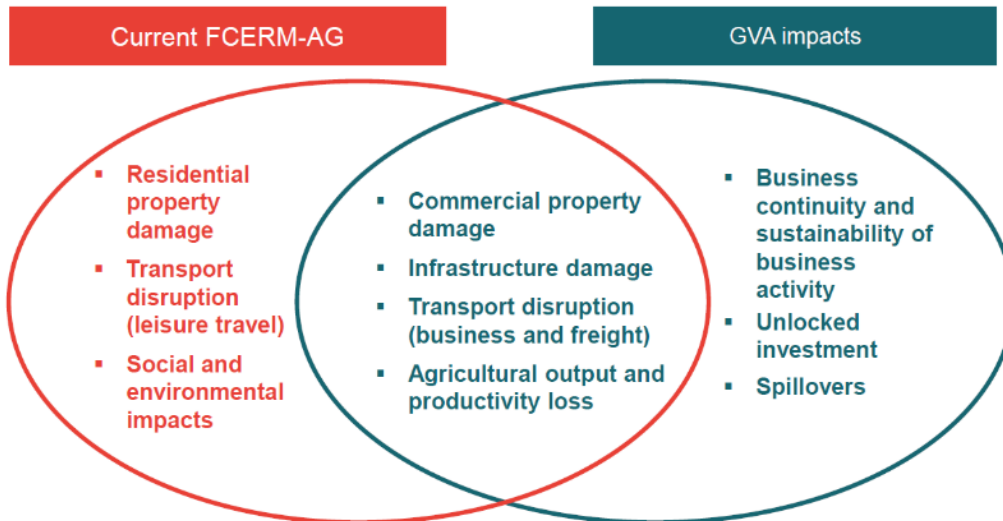


Figure 5: Overlaps between Grant in Aid eligible impacts, and impacts to the local economy

This report presents an assessment of the Gross Value Added (GVA) impacts, presented in the right-hand circle of Figure 1.

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

These benefits have been calculated in-line with HM Treasury Green Book principles and the Homes and Communities Agency (HCA, now Homes England) Additionality Guidelines, as well as the “Frontier methodology”, as detailed in Section 3.

The net economic gain to Bristol as a result of land use changes from the sites potentially unlocked by the reduced flood risk through this strategy is captured by adjusting the gross impacts for additionality, that is “the net, rather than the gross impact of an intervention after making allowances for what would have happened in the absence of the intervention”. The assessment therefore adjusts the gross impacts by considering the following additionality assumptions:

- **Deadweight:** the level of economic activity that would have occurred without the intervention.
- **Leakage:** the level of benefits (i.e. jobs on these sites) that are likely to go to residents outside of Bristol who commute in.
- **Displacement:** the proportion of economic benefits that are displaced from elsewhere in the region
- **Multiplier impacts:** additional impacts within the economy from supply linkages due to purchases made as a result of the intervention and further purchases with linked firms along the supply chain (indirect effects) and income effects associated with local expenditure as a

result of those who derive incomes from the direct and supply linkage impacts (induced effects).

4. First order losses to infrastructure and commercial property

First order losses have been taken from the direct damage calculations presented in the main body of the report, as shown here in Table 1.

Table 1: First order losses to infrastructure and commercial property (£m)

	Do Nothing	Do Minimum	1.33% AEP SoP	1% AEP SoP	0.5% AEP SoP	Preferred Scheme
Non-residential properties	402.7	389.9	90.4	86.8	79.7	80.1
Indirect Commercial losses	11.6	11.2	2.6	2.4	2.3	2.3
Utilities (flooding)	143.1	142.0	8.5	8.6	8.0	8.0
Utilities (diversion)	12.4	12.0	10.4	10.4	10.4	10.4
Traffic disruption (flooding)*	81.2	67.1	36.4	36.1	35.9	35.9
Traffic disruption (erosion)*	288.1	288.1	0.0	0.0	0.0	0.0
Rail Disruption*	56.8	47.2	2.0	2.0	0.9	0.9
Total 1st order Losses	995.9	957.5	150.3	146.4	137.0	137.5
1st order Benefits		38.3	845.6	849.5	858.9	858.4

*Commercial traffic disruption estimated at 48% of overall disruption based on ratio of “Car, Other” damages to the total damages. Commercial rail disruption taken as 64% of overall disruption, based on Do Minimum demand figures for the Bristol Temple Meads proposed development.¹² Commercial traffic component of Active travel ignored

5. GVA loss saved through reduced flood risk to existing businesses

Reducing the flood risk to existing businesses reduces losses as a result of:

- Incurring losses due to business disruption
- Incurring costs spent on adapting their properties to be flood proof
- Going out of business or moving out of the area

The approach for calculating these losses is prescribed in the “Frontier” methodology, a joint Defra/EA flood and coastal erosion risk management (FCERM) research and development

¹² “Bristol Temple Quarter Masterplan Delivery Strategy”, 394007-MML-00-ST-RP-DEL-001_B-Delivery-Strategy, Mott MacDonald Limited, June 2020.

programme – project FD2662. This method identifies the likelihood of the above scenarios, based on the *Location Dependence* and *Adaptive Capacity* of the business.

Location Dependence and *Adaptive Capacity* of the business are in turn identified from the *Business Type* (from National Receptor Dataset) and *Business Size* (determined from building area in OS Mastermap Data). The economic impacts of flooding are based on the lost earnings of staff (FTE) employed by each business, multiplied by the duration of impact and the frequency of flooding.

The benefits of the intervention are calculated from the impacts avoided, and a range of different standards of protection have been assessed.

This calculation has been carried out at a high level, using available datasets, and generic assumptions of business response to flooding. Improvements in the calculations of disruption could be made using surveys of individual businesses.

5.1 Assumptions

Average duration of disruption:

20 weeks (directly flooded properties). Source: Frontier methodology

3 weeks (disrupted properties). Source: Frontier methodology “with FCERM”

Displacement, Leakage, Multiplier

The Frontier methodology (and the worked examples embedded in the guidance) makes little to no reference to the economic concepts of displacement, leakage or multipliers. Indeed, it notes “*There is little evidence available on the degree of business displacement and additionality. This refers to the fact that new investment facilitated by FCERM could be a net addition to the national economy, as well as the local economy, or it could just be the latter.*” Notwithstanding this statement, it is considered that these effects should apply to assessment of Gross Value Added from FCERM benefits just the same as they would to any other economic analyses.

- 1) *Leakage* represents the degree to which the benefits of an intervention are felt outside the study area, and typically reflects how far a workforce may travel to get to its place of employment. This concept remains, regardless of the effect being assessed. The magnitude of leakage tends to reflect the specialism of a role, and how well rewarded it is. *Leakage* has been assumed at 25%.
- 2) *Displacement* has been assumed as 25%, reflecting the Regional Level “all observations median” for displacement from the “Research to Improve the Assessment of Additionality.”
- 3) *Multipliers* represent the indirect and induced impact on the local economy. The assumed multipliers are: Retail, Leisure: 1.3; Financial services, Specialist manufacturing: 1.7; others: 1.5.

Assumed percentages of potential business responses

“Move away or Shut Down”: 3% (Range from Frontier = 1.5 – 5%)

“Stay and Adapt”: 50% (Range from Frontier = 25 – 75%)

Persistence of benefits: 10 years.

Decay (% per annum): 0. The economic benefits are directly attributable to flood risk to existing properties calculated as a probabilistic effect; they do not decay against time due to declining influence of the intervention.

Years over which benefits build: 0. The economic benefits are to existing properties but calculated as a probabilistic effect; they do not build against time.

Percentage vacant: 3% of buildings are assumed to be vacant at any one time.

Deadweight: Deadweight is calculated explicitly, by using a baseline scenario based on the current level of flood risk.

5.1.1 Calculation of assumed earnings per sector

There are 5 key sectors used to define staff earnings: Industry, Retail, Office, Other, and Mixed Business. Annual pay for these sectors has been extracted from “ONS (2022) Earnings and hours worked, industry by two-digit SIC: ASHE Table 5.7a Annual Pay – Gross”.¹³

These figures have in turn been weighted by the ratio between the 2021 mean wage in the South West (£27,253), and the 2021 mean wage in the Bristol West (£35,254) and Bristol South (£24,907) electoral wards¹⁴. All figures were uplifted to take account of the GDP deflator to 2028 (a factor of 1.172).

In part however the wage uplifts for electoral wards are due to the make-up of jobs in these areas – for instance, a higher percentage of finance jobs in a given area will increase the average earnings of that area, without necessarily meaning that those jobs are better paid in that area than elsewhere.

The weighted ratios of industry sectors in the electoral wards have been used to find how much impact this effect has, and adjust for it. This data was compiled from the Middle Super Output Areas in each electoral ward, finding that, based on the make-up of industry sectors, Bristol West should have an average wage 7.8% greater than that of the South West region. Bristol South should have an average wage 0.1% lower than that of South West region, and Bristol City should have an average wage 5.6% greater than the South West¹⁵. Therefore, the overall impacts of geographic area are a 20% uplift for Bristol West, a -9% uplift for Bristol South, and an 8% uplift for Bristol City.

The total uplift factors applied to South West annual earnings are therefore 1.42 for Bristol West, and 1.083 for Bristol South. This resulted in the assumed annual earnings presented in Table 2.

¹³<https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/datasets/industry2digitsicashetable4>

¹⁴ ONS “Annual survey of hours and earnings – workplace analysis” (accessed from Nomis Sept 2023)

¹⁵ ONS 2021 Business Register and Employment Survey: open access (accessed from Nomis June 2023)

Table 2: Annual earnings per industry sector, adjusted per location.

SIC Code	SIC DESC	South West Mean pay, 2022 (£)	Bristol West (£) 2028	Bristol South (£) 2028
A	Agriculture, forestry and fishing	23,046	32,416	24,713
B	Mining and quarrying	47,730	67,136	51,182
C	Manufacturing	35,206	49,520	37,752
D	Electricity, gas, steam and air conditioning supply	51,949	73,070	55,706
E	Water Supply; Sewerage, Waste Management and Remediation Activities	35,333	49,698	37,889
F	Construction	35,204	49,517	37,750
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	24,389	34,305	26,153
H	Transportation and storage	30,034	42,245	32,206
I	Accommodation and Food Service Activities	17,247	24,259	18,494
J	Information and communication	40,700	57,247	43,644
K	Financial and Insurance Activities	42,659	60,003	45,744
L	Real estate activities	30,071	42,297	32,246
M	Professional, scientific and technical activities	35,794	50,347	38,383
N	Administrative and support service activities	28,240	39,722	30,283
O	Public administration and defence; compulsory social security	31,676	44,554	33,967
P	Education	28,675	40,333	30,749
Q	Human health and social work activities	25,598	36,005	27,449
R	Arts, Entertainment and Recreation	20,600	28,975	22,090
S	Other service activities	25,745	36,212	27,607
T	Activities of households as employers; undifferentiated goods- and services- providing activities	10,661	14,995	11,432
U	Activities of extraterritorial organisations and bodies	-	-	-
	Mean	29,709	41,788	31,858

5.2 Results

Table 3: Net Gross Value Added (in £m present value) of avoided disruption to businesses.

Option	Lost Net Gross Value Added (£m NPV)	Benefit (£m NPV)
Do Nothing	372.8	-
Do Minimum	278.3	94.5
1.3% AEP SoP	13.0	359.7
1% AEP SoP	13.0	359.8
0.5% AEP SoP	12.8	360.0
Preferred Scheme	12.8	360.0

5.2.1 Sensitivity testing

Bristol city centre has a high number of heritage buildings to which there may be particular constraints to adaptation. In contrast to this, it also has a number of buildings that would be considered the national or regional headquarters of financial organisations, and these would be considered to have high capacity to adapt.

Sensitivity testing has therefore been undertaken on the assumed percentages of businesses taking up the “Stay and Adapt” strategy (higher percentages of “Stay and Adapt” will conversely result in lower percentages of “Stay and Do Nothing”)

Table 4: Sensitivity testing of “Stay and Adapt” assumption.

Option	Benefit Net Gross Value Added (£m NPV)		
	Stay and Adapt = 25%	Stay and Adapt = 50%	Stay and Adapt = 75%
Do Minimum	124.4	94.5	64.6
Preferred Scheme	418.4	360.0	301.5

6. GVA earned through unlocking development

6.1 Overview of approach

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. At present, and without an adopted Bristol Avon Flood Strategy, in practice this can be impossible to achieve in some locations, including on some sites already allocated for development in the local plan. In such circumstances planning applications will be recommended for refusal because they would be contrary to national planning policies regarding flood risk, or may be delayed or incur additional cost to comply with those policies.

The adoption of the Local Choice strategy, which provides a National Planning Policy Framework compatible standard of protection, would therefore be an influence in unlocking development within the floodplain – both through expansion with existing sites, and development of brownfield sites. For lesser standards of protection, this benefit would not accrue.

The method used to assess unlocked development considers:

- Estimate the internal floor area associated with a development
- Identify the proposed uses
- Estimate the gross number of FTE jobs created from the internal floor area, the proposed use, and assumed occupancy rates
- Create an assumed time profile of construction, occupancy, and decaying benefits to understand how the numbers of jobs are created against time
- Apply leakage, displacement and multipliers to calculate net FTE
- Use assumed values of GVA / FTE based on the proposed usage

Where possible, existing data from specific assessments relating to individual sites has been used.

6.2 Data review

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.

The spatial datasets provided include:

- AllSites2022
- DevelopmentAllocations
- Economic Development Needs Assessment (EDNA)
- FullTrajectory2014_110615

Non-spatial data sources include:

- The West of England Employment Land Spatial Needs Assessment
- Bristol Employment land Review
- BDS2022.xlsx
- Bristol Business Development Survey Report 2022 (pdf)
- Extract from employment land topic paper

There are areas of overlap between datasets, and grossly different levels of detail. Assessments have been carried out as part of this study to identify potential volumes of development, and areas of overlap have been identified and resolved where necessary.

AllSites2022

This is the most recent dataset, but data contained within is limited to the construction / planning status of the developments, and a BDS reference number. It can however be cross-referenced to BDS2022.xlsx by the planning reference number to link to changes in land use.

DevelopmentAllocations

Contains a BDA planning reference, capacity (in housing units), Site type (Allocation or draft allocation) and area in Ha. As housing focused, not deemed of explicit relevance to this analysis.

Economic Development Needs Assessment (EDNA)

Contains the planning status of commercial developments (which we were able to updated through consultation with BCC planning and development officers), the nature of the development (allowing, say, refurbishment and extension projects to be treated differently to new build analyses) and gross footprints of usage within each development (needed for understanding the quantum of GVA unlocked by development).

Superseded by the ELSNA assessment, but the lack of spatial data from ELSNA makes EDNA of more use to this project, if supplemented by other datasets.

FullTrajectory2014_110615

Gives planning status of residential developments, including projected build out against time. As housing focused, not deemed of explicit relevance to this analysis. The key data (pre- or post-2012 development of residential property) is picked up elsewhere in the flood damages assessment.

The West of England Employment Land Spatial Needs Assessment (Atkins, June 2021)

While a thorough assessment at a regional level of the employment needs and supply for the West of England, the data in the ELSNA report is too aggregated for the purposes of this study.

Bristol Employment land Review (Working draft)

Market intelligence and development consultancy advice in relation to the supply and demand of employment land and floorspace in Bristol. Most of the information contained within this document is collated data and can not be related to specific sites. A portion of the report relates to the potential contribution of additional workspace coming forward across a number of specified industrial sites; it however does not quantify the impacts on employment numbers or type or developable area, and its speculative status makes it difficult to make use of this data.

BDS2022.xlsx

A list of development sites, with construction / planning status, and changes in land use. Can be linked to AllSites2022 for enriched data. Properties whose planning status is “Not Started” may be of relevance to this analysis.

Bristol Business Development Survey Report 2022

A report of the annual survey of planning permissions for business development, and how their build out is progressing. As such, this very much captures development that is not being influenced by the implementation of BAFS and has not been used.

Extract from employment land topic paper

Provided as an insight into a number of industrial sites with development potential. Mostly focused on the BTQ and St. Philips Marsh areas, where this study has made use of the more detailed documentation discussed in Section 6.4.

6.3 Calculation of GVA from allocated sites

While the Economic Development Needs Assessment (EDNA) dataset has been to some degree superseded by later datasets and assessments (eg. ELSNA), it has the advantage over those datasets in that it contains:

- the planning status of developments (updated through consultation with BCC planning and development officers)
- the nature of the development (allowing, say, refurbishment and extension projects to be treated differently to new build analyses)
- gross footprints of usage within each development (needed for understanding the quantum of GVA unlocked by development). These have been converted to internal floor area by a) an allowance of 15% to convert from external to internal floor area, and b) assumptions regarding the number of floors to each development

The dataset has been supplemented by information from BDS2022.xlsx and AllSites2022 for those sites that have not yet started.

The compiled dataset has been filtered to identify properties within the future climate 1% annual change fluvial and 0.5% annual chance tidal flood outline, that have not yet been granted planning permission. This amounts to 20 sites (Figure 2), with capacity for approx. 13,600 FTE staff.

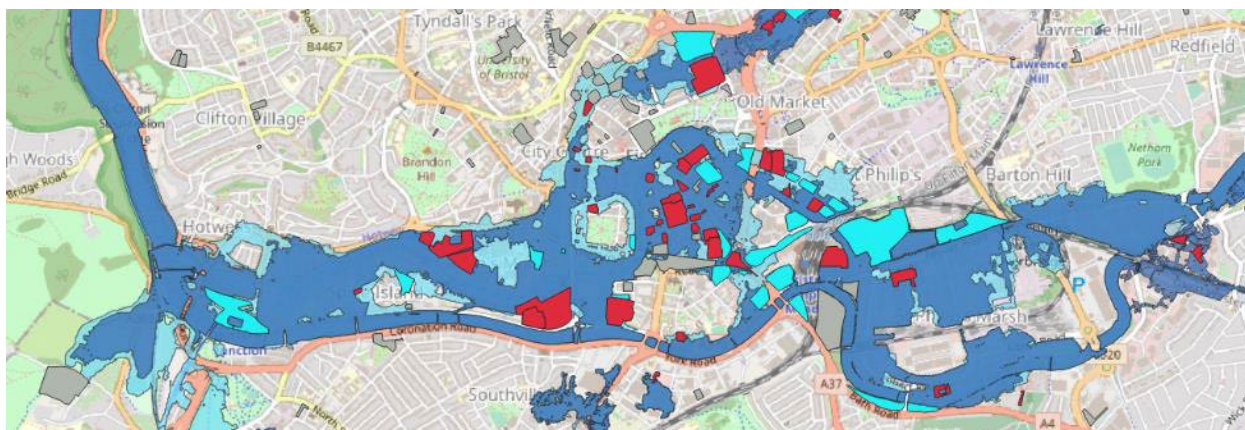


Figure 6: Allocated sites in the floodplain. Red indicates sites already granted planning permission; green indicates allocated sites at flood risk.

In some cases, it has been noted by comparison with alternate sources, or by direct information from BCC staff, that the provided polygons of the EDNA site encompass properties that will in fact be retained. These polygons have been updated so that those properties can still accrue damages, and this is reflected in Figure 2.

The following assumptions have been made for each development type:

Table 5: Assumptions made behind cost build up for each development.

	Industry	Office	Other	Retail	Mixed Businesses
Multiplier	1.7	1.5	1.3	1.2	1.3
m2 / FTE	36	12	90	19	90
Average earnings / FTE (£)	49,520	49,430	41,788	34,305	41,788
Gross/ net floorspace adjustment	0.85	0.85	0.85	0.85	0.85
Assumed number of floors	1	3	2	1.5	2

The average earnings have been calculated based on the calculated earnings in Table 2. “Other”, and “Mixed Businesses” are based on the regional average earnings; “Office” is based on a weighted average of SIC Codes J, K, L, M, N, & O.

An allowance of 10% was made for developments that do not progress (for reasons other than flood risk).

Construction of the proposals is expected to build linearly over a 5-year period from approval of the strategy: i.e. all development will be 100% complete in 2033. The estimated GVA associated with filling the developments was discounted against time using Treasury Green Book rates (3.5%). The assumed duration of benefits is 10 years, as per Frontier methodology guidance.

It is assumed that any of these developments require a flood strategy to be in place to go ahead. This is not the same as saying that they are only dependent on a flood strategy to proceed; they may all be subject to other infrastructure requirements.

The calculated Gross NPV GVA benefit of unlocking these developments would be £1,860m. An alternate way to look at this might be to consider the value of any delay to those developments, which would amount to approx. £63m / year.

The associated net construction value of the developments is estimated at £434m.

6.4 Bristol Local Plan Growth and Regeneration areas

6.4.1 Locations of Local Plan Growth and Regeneration areas

The following key developments, shown in Figure 7 below, are noted:

- **Western Harbour**
- **Temple Quarter**
- **St. Philips Marsh**
- **Frome Gateway**

These polygons represent the areas of the corresponding Masterplans, minus areas of the Temple Quarter and St. Philip's Marsh where we are aware that existing buildings will be retained, from reference to the Bristol Temple Quarter Spatial Framework¹⁶ (Figure 4) and the draft Bristol Temple Quarter Masterplan Delivery Strategy¹⁷.

In addition to these developments, we are aware of **Bedminster Green**, however this development has planning approval in principle, subject to CIL funded works to address flood risk¹⁸: this site is therefore excluded from the assessment of benefits.

¹⁶ Bristol Temple Quarter Spatial Framework, <https://www.bristoltemplequarter.com/key-projects/spatial-framework/> Bristol City Council 2016.

¹⁷ Draft Bristol Temple Quarter Masterplan Delivery Strategy, Bristol City Council, 2020

¹⁸ <https://democracy.bristol.gov.uk/ieDecisionDetails.aspx?AllId=15476>

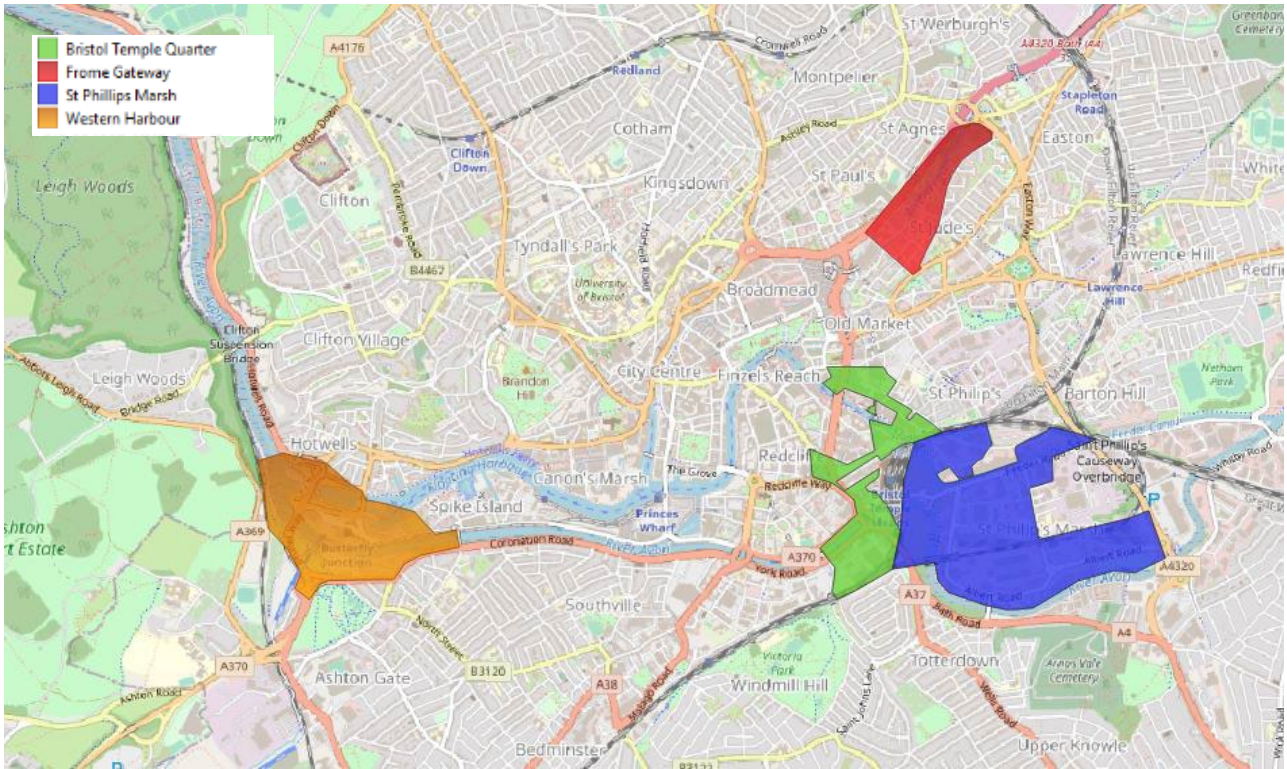


Figure 7: Proposed areas for Growth and Regeneration

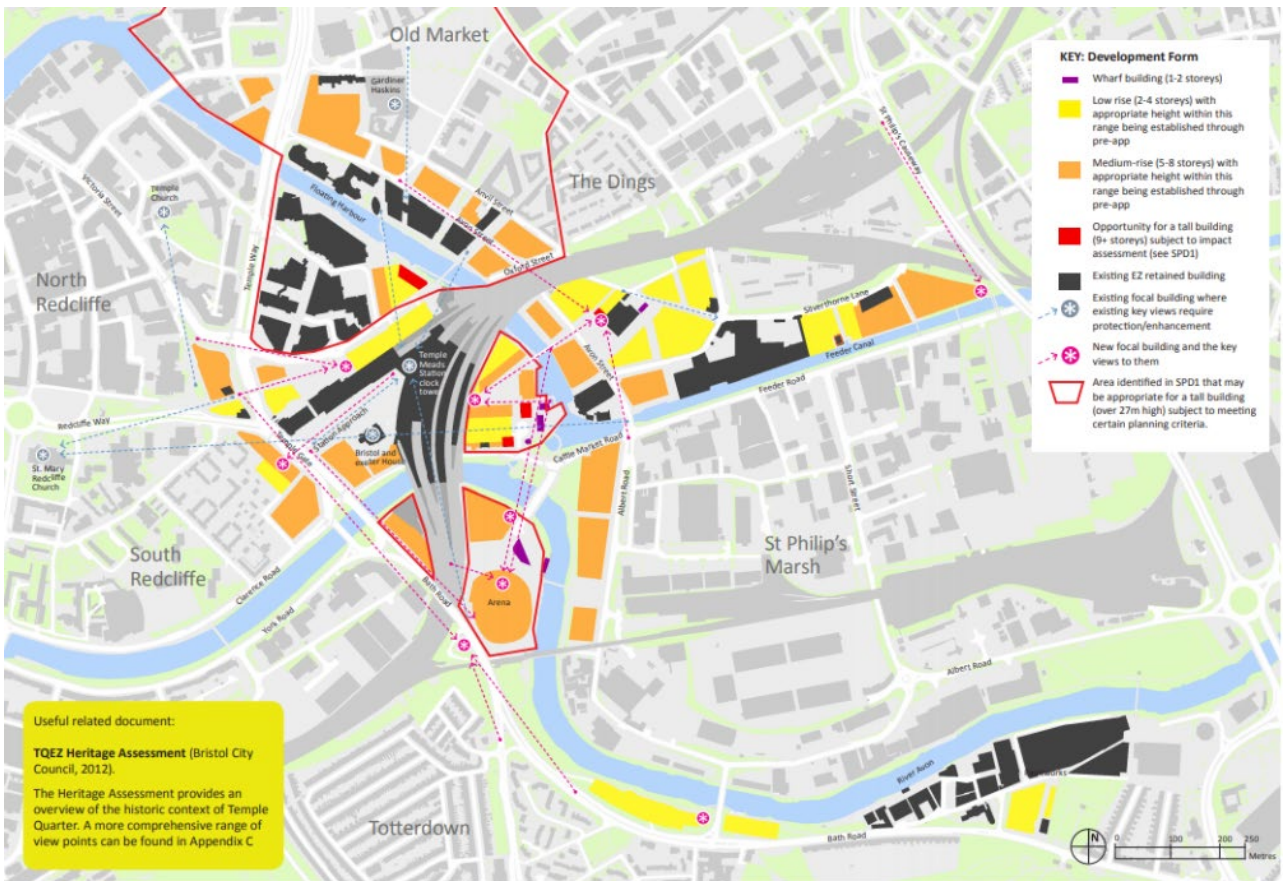


Figure 8: Temple Quarter Development Form (from BTQ Spatial Framework report)

6.4.2 Assessment of potential Gross Value Added from Growth and Regeneration areas

The plans behind these areas have evolved over different time frames, and because of this, some plans have a greater level of supporting data than others. It is also notable that the definition of the outlines of these areas and underlying data continues to evolve. Therefore, the estimates below are snapshots based on “best available” data at the time of writing and should be subject to sensitivity testing.

It is important to note that the flood strategy is not the only initiative enabling the development of these areas. A range of additional enabling infrastructure (amongst other investments) is necessary for these sites to progress and will also be trying to raise funding based on the outcomes presented below. It will be necessary at a city level to resolve any double counting that this might result in.

6.4.3 Frome Gateway

The Strategy benefits the area of growth and regeneration identified as the Frome Gateway by reducing extreme harbour water levels which help convey River Frome flows and reduce peak water levels. Proposals are at a very early scoping stages and a masterplan for the area has yet to be developed, with no information on GVA benefits available. Significant reduction in extreme tidal flood risk in the Lower Frome is predicted. However, flood risk to the area during extreme fluvial events remains significant and further flood risk management measures are likely to be required. On this basis, GVA gain for the area has been excluded from this assessment.

6.4.4 Western Harbour

The Strategy benefits the area of growth and regeneration identified as Western Harbour by containing flood risk from the River Avon and reducing extreme harbour water levels.

The Cumberland Basin area, for example, already includes an allocation for development through the Bristol Central Area Plan and was included in the Economic Development Needs Assessment polygon. As such the GVA benefit of this development is embedded in the EDNA calculation covered in Section 4.1.

However, the council’s proposals for regeneration of the Western Harbour would reveal additional areas of development land through the reconfiguration of existing road infrastructure. This represents an additional source of potential above and beyond the capacity identified by this study. Proposals are at a very early scoping stages and a masterplan for the area has yet to be developed, with no information on GVA benefits available. On this basis, GVA gain for the area should be considered to be zero as a conservative estimate.

6.4.5 Temple Quarter & St. Philip’s Marsh

Two sources of data are available for analysis of the Temple Quarter and St. Philip’s Marsh proposals. These are:

- The 2019 draft Bristol Temple Quarter Masterplan Delivery Strategy¹⁹, and
- The 2022 WECA Regional Impacts of the Bristol Temple Quarter Regeneration Programme²⁰.

¹⁹ “Bristol Temple Quarter Masterplan Delivery Strategy”, 394007-MML-00-ST-RP-DEL-001_B-Delivery-Strategy, Mott MacDonald Limited, June 2020.

²⁰ “Regional Impacts of the Bristol Temple Quarter Regeneration Programme”, Metro Dynamics Ltd for the West of England Combined Authority, Nov 2022

Of the two documents, the BTQ Delivery Strategy is more detailed in terms of plot-level detail and programming of works, whereas the WECA study provides a wider range of value in terms of technical scope. Given the wide range of subjectivity applicable to economics, their overall estimates of GVA are broadly comparable, albeit that in comparable prices, the 2019 study appears more optimistic:

Table 6: Comparison of GVA outputs of the 2019 and 2022 studies

Study	GVA p.a. of all sites (minus Silverthorne) (£m)	GVA p.a. in 2022 prices:
2019 Delivery Strategy	685	756
2022 WECA Regional Impacts study	620	620

Review suggests that the core differences relate to the assumed additionality factors, and very significant differences in the assumed levels of development, for instance the 2022 study uses only 75% of the commercial area for St Philips reported in the 2019 study. These differences are masked to some degree by what appear to be high assumed GVA rates in the WECA assessment.

The WECA assessment is also self contradictory regarding the programme of build out for St. Philips, identifying that enabling works will take 5-20 years to implement, but suggesting an optimistic programme of 2030-2040 for the implementation of the masterplan development. The 2019 study is more conservative on this point, suggesting a build out programme of 2039-2051 for implementation.

Notably the WECA study assessment of construction GVA produces higher gross values than are actually invested into construction; because of the apparent counter-intuitiveness of this outcome, the 2019 Delivery Strategy numbers are favoured for these calculations.

Taking into account its more recent date, and therefore that its updated numbers *should* reflect updates to the development proposals, the 2022 WECA study is used by preference, albeit with caution, and supplemented by the 2019 Delivery Strategy where the 2022 study is lacking in information or deemed unreliable.

The areas discussed below are the elements of the BTQ / St. Philips masterplans believed to benefit by from the flood risk alleviation provided by the Strategy.

6.4.5.1 Bristol Temple Meads station development

The 2019 Delivery Strategy is relied upon for data regarding the Bristol Temple Meads station development.

The development comprises £218m of works (2019 prices) to improve circulations and transport links to the station, including transport interchanges, retail, and car parking.

The proposals were assessed as providing £347m (2010 prices) Present Value benefit (based on a 60-year appraisal period). This benefit, calculated using the Government Transport Appraisal Guidance (TAG), derives from:

- Changes in end-to-end journey times and costs
- Time savings for users accessing the station by foot, car and bus
- Modal shift impacts, reducing traffic accidents, greenhouse gas emissions

- Station quality and urban realm improvements

The benefit can be translated to 2028 prices using the GDP Deflator (a factor of 1.51), which brings it to £524m.

A sensitivity test considered the use of the “Indicative Train Service Specification” (ITSS) prepared for Bristol by Network Rail. The ITSS accounts for forecast passenger demand changes due to exogenous factors. This includes macro influences on the economy, and the competitiveness of alternative modes (eg fuel costs, coupled with local influences such as changes in land use in the vicinity of the station. The ITSS projected growth of up to 34 million passengers by 2043, which increased the benefits of the station works to £1,663m (2010 prices). The ITSS forecast is however dependent on additional capital expenditure beyond the immediate proposals at Bristol Temple Meads, and as such was not put forward in the Value for Money statement and is not used in the conclusions of this report.

Wider Economic Impacts associated with the impacts of these changes on the Bristol City Region’s economy were not calculated.

The station itself is at elevation, and therefore it may initially be considered that efficiency improvements within the station and increased station capacity are not greatly impacted by mitigation of flood risk (notwithstanding the direct flood risk impacts presented in the main economics report of *this* study).

Nonetheless, the £524m benefits identified above are unlikely to be fully realised if access routes to the station are regularly cut-off by flooding. In the Do Nothing scenario, all major routes of the station are flooded for tidal events in excess of the 1.33% AEP in the 2069 climate change epoch. By the end of the scheme life, this will occur on average more than once a year.

Similarly, while the wider economic benefits on the Bristol City Region were not calculated in this Masterplan Delivery Strategy, such benefits will also be impacted by the station being cut-off.

6.4.5.2 City Gateway / Friary North and Temple Gate, Mead St.

Whilst the majority of these development areas are at low flood risk, plots G, N, O, P, Q, R & S of Temple Gate lie within either the 2025 1% AEP fluvial or 0.5% AEP tidal flood outline, and indeed the Temple Quarter Development Framework²¹ notes that “*Further work is required to establish the degree of flood measures required to enable development in this area*”, and, “*New buildings around Chatterton Street...*” (O, P, R & S) “*...are likely to require defences to individual properties*”.

It is therefore reasonable to assume that they may therefore experience some difficulty or delay achieving planning consent or will need to incur costs through changing the development form to meet flood risk requirements. Properties J & K lie outside the floodplain but are residential buildings and therefore do not impact on GVA calculations.

²¹ Mott MacDonald “Temple Quarter Development Framework”, April 2023

<https://democracy.bristol.gov.uk/documents/b31982/Temple%20Quarter%20Update%2002nd-May-2023%2016.00%20Cabinet.pdf?T=9>

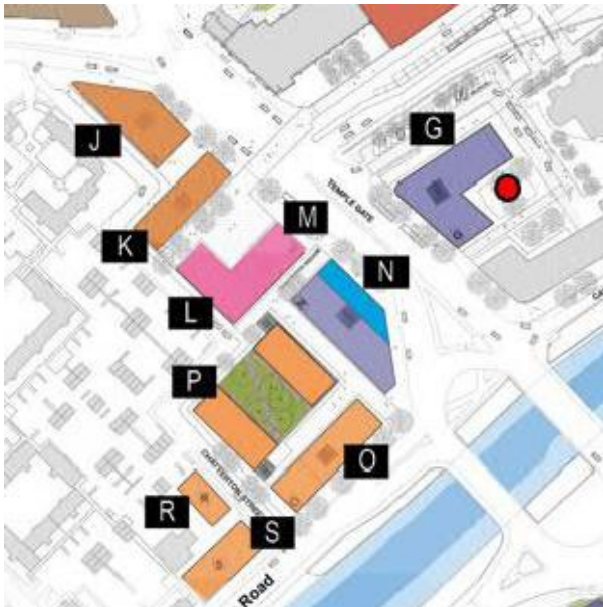


Figure 9: Template Gate development sites.

The Net additional jobs associated with plots G, and J-S is given as 520 jobs, with an additional 145 indirect jobs and 151 induced jobs. This amounts to £43.35m GVA per annum by the 2022 estimates of GVA per job used in the WECA analysis. Updating this to 2028 estimates using the GDP Deflator gives £50.1m GVA p.a.

By reference to the 2023 Temple Quarter Delivery Framework, all these jobs are located in plot N, which is scheduled for construction in 2022-26. If dependent on the Flood Strategy as suggested by the Delivery framework, construction of plot N might be delayed at least as far as 2028. Over the 30 year period 2028-2057, present value GVA of the site is assessed as £867m.

6.4.5.3 St. Philip's Marsh

BCC, working in partnership with WECA, Network Rail and Homes England are currently working on a long-term plan to guide how Temple Quarter and St Philip's Marsh develop in the future. Delivery of the plan is constrained, both physically and by the needs of multiple landowners. Regeneration is therefore planned over several decades.

The 2023 Temple Quarter Delivery Framework notes that *“A range of enabling works are required within the St. Philip's Marsh area as a prerequisite for significant redevelopment and introduction of residential uses, including flood resilience measures.”*, and *“The transformation of St Philip's Marsh set out in this Development Framework will be dependent on significant investment in new infrastructure, particularly relating to flood risk.”*

At full build-out, the 2022 WECA study suggests the St. Philip's Marsh masterplan would achieve an uplift of £191m net GVA per annum at full build-out. Updating this to a 2028 figure using the GDP Deflator gives a value of £224m GVA p.a.

Coupling this figure of £224m with the timeline from the WECA report over the period 2028-2057 gives pv GVA of £3.0bn. The longer assessment period is used due to the development timeline of the proposals.

The timeline of the WECA report is faster than that presented in the Delivery Strategy, but consistent with that presented in the Delivery Framework. However, considered against the timeline for the Flood Strategy, the report's timescale appears 5-10 years fast. A sensitivity test on the programme of development has been used to test the estimate of pv GVA (Table 7). We have

considered it more suitable to use the “5 years delay” scenario in our estimates of GVA from this analysis.

Table 7: Sensitivity analysis on 30yr present value estimate of net GVA from St. Philip’s Marsh development

	Timeline consistent with WECA report	5 years delay	10 years delay
Present Value GVA (£m)	2,961	2,580	2,172

6.4.5.4 Wider benefits of the BTQ & St. Philips Masterplan

The 2022 WECA report also notes the following benefits for delivery of the BTQ and St. Philips Marsh Masterplans:

Table 8: Wider benefits of the BTQ & St. Philip’s Masterplan

Benefit	Overall masterplan (2022 prices)	Quantum benefitting from the scheme (2028 prices)
Housing		
Net additional housing units delivered	8,058 (of which 2,448 are affordable)	5,266
Net land value uplift	£232m	£178m
Net Council tax receipts	£15m p.a.	£11.5m p.a. (£137m pv)
Net resident expenditure	£160 m p.a.	£123m p.a. (£1,472m pv)
Net induced jobs created by resident expenditure	297	194
House price increases	CBRE research suggests residential house prices within 750m of major regeneration scheme can increase by 1.5% per annum over general growth, and by up to 3.6% when scheme established.	
Commercial		
Net land value uplift	£75.2m	£32.3m
Business rate receipts	£2.4m p.a.	£1.1m p.a. (£13.2m pv)
Placemaking		
Amenity benefits	£14.4m	£8.4m p.a. (£101m pv)
Crime reduction	£0.28m p.a.	£0.16m p.a. (£2m pv)
Environmental		
65% increased energy efficiency of housing stock		
Min 10% Biodiversity net gain increase		
New blue/green space created		

6.4.5.5 Apportionment of enabling works funding

The development of the BTQ site may be limited if a city-wide flood risk management strategy is not approved and implemented. At St. Philip's Marsh, resolving flood risk is recognised as being a key part of making the development viable. Precautionary planning assessments of residual flood risk, considering the risk of defence/gate failure, also led to an emerging concept of a raised Resilient Access Network.

However, flood risk infrastructure is only part of making the development work. An additional £191.5m of enabling infrastructure (2019 price of £148m, updated to 2028) is also identified as being necessary, and therefore flood risk may only be able to claim a component of this. For comparison, the cost estimate for Phase 1 defences associated with St. Philip's Marsh comes to £38.4m; approx. 20% of the overall infrastructure investment.

7. Construction jobs

7.1 Direct calculation

The construction of the flood strategy, and of the development that it unlocks, creates jobs that will generate GVA. These can be calculated from the cost of the strategy and the developments, as shown in Table 10, below.

The cost of the strategy has been taken directly from the cost estimates for this project. Construction costs of Allocated Sites have been estimated from the assumed floor area of development calculated in Section 4 and multiplied by the rates in Table 9.

Table 9: Assumed construction cost per m2 of internal floor space.

	Industry	Office	Other	Retail	Mixed Business
Cost per m ² (£)	1,768	2,809	2,599	2,389	2,599

The construction costs in Table 9 are based on prices from Uniclass Building En Entities - October 2022 - v1.26, updated to 2028 using the GDP Deflator.

Table 10: Calculation of GVA associated with Construction Jobs.

	Flood Alleviation Scheme	Construction of developments
Capital works	£494,671,964	£433,987,638
% of cost spent on salaries	29%	29%
Salary expenditure	£ 143,454,870	£ 125,856,415
Average mean salary	£ 49,517	£ 49,517
Direct job years supported	2,897	2,542
1 FTE = 10 employment years	10	10
Direct jobs supported	289.7	254.2
Leakage	25%	25%
Net direct FTEs	217	191
Composite multiplier	1.29	1.29
Indirect & induced jobs	168	148
Total net jobs supported	386	338
Average GVA per construction worker	£ 59,077	£ 59,077
Total GVA supported	£ 22,787,179	£ 19,991,741

7.2 Costs from secondary sources

The draft Bristol Temple Quarter Masterplan Delivery Strategy presents economic impacts associated with the construction of the Masterplan, as shown in Table 11 (figures updated from 2019 to 2028 using the GDP Deflator).

Table 11: Present value GVA of Construction jobs for the BTQ Masterplan

Area	Present Value GVA from construction jobs (£m)
City Gateway / Friary North / Temple Gate & Mead Street	23.0
St. Philip's Marsh	41.2 ²²

²² Value adjusted from source material to avoid double counting of construction GVA associated with the Flood Defence works.

7.3 Estimates of Construction jobs GVA attributable to flood strategy

The indicative contribution of the flood strategy to the value and likelihood of progression of these individual projects allows approximate percentages of the construction job estimates to be claimed. As per 5.3, it will be necessary at a city level to resolve any potential double counting between different projects ‘laying claim’ to these benefits.

Table 12: Estimates of construction jobs GVA attributable to flood strategy

Area	Present Value GVA from construction jobs (£m)	% attributable to flood strategy	GVA of Construction jobs attributable to flood strategy (£m)
Direct benefits			
Flood Strategy	22.8	100%	22.8
Indirect benefits			
Allocated sites	20.0	20%	4.0
City Gateway / Friary North / Temple Gate & Mead Street	23.0	10%	2.3
St. Philip’s Marsh	41.2	20%	8.2
TOTAL	119.0		37.3

8. GVA saved through the reduced flood risk to Bristol’s tourism industry

The 2013 report “Bristol Floating Harbour EIA Final Report”²³ identifies annual visitor spending associated with the Floating Harbour of £14.9m.

However, the 2013 study is notably conservative in some of its assumptions, and its scope. It adjusted for double counting of visitors by assuming that they attend 3 attractions a day, and this adjustment is particularly conservative given that 1) shorter visits comprise a high proportion of overall visitor numbers 2) one of these visits was assumed to be for lunch, but without capturing the vast majority of harbourside restaurants. It was therefore assumed that visitors attend 2 attractions a day.

Statistics from VisitWest²⁴ allow the inference of the spend per visit in the West of England in 2019:

²³ “Economic Impact of Bristol’s Floating Harbour”, Bristol City Council, 2013.

²⁴ <https://www.visitwest.co.uk/about-the-regional-visitor-economy/research>

	No. of visits	2019 spend (£)	Spend per day per visit (£) (2019)	Spend per day, uplifted to 2028 (£)
Day visits	13,657,000	563,096,000	41.23	53.34
Staying visits	2,503,000	578,171,000	77.00 (assumes 3 day visit)	99.61
Other spend		32,730,000		
Total	16,160,000	1,173,997,000		

This allows update of the 2013 analysis as follows (note that the original visitor numbers of the 2013 study are not uplifted):

Source of visitors	No of visitors (apportioned)	No of adult visitors	Spend (£)	Dwell time adjusted spend (£)	Total spend (£)
Bristol	762,314	508,209	53.3	27	13,554,022
South West	291,186	194,124	53.3	27	5,177,317
Further afield, UK	274,612	183,075	99.6	50	9,118,027
International	114,684	76,456	99.6	50	3,807,888
Sub total	1,442,796	961,864			31,657,254
Festival	200,000	133,333	53.3	27	3,556,021
Total, incl festival	1,642,796	1,095,197			35,213,275

Noting that VisitWest reports that Bristol attracts 50% of the visitor spend, this implies that the harbour attractions comprise only 4.6% of the visitor spend in Bristol, which feels like a conservative underestimate, however, as noted below, a factor of 2.78 can be applied to this spend to account for indirect and induced GVA.

Key harbour attractions include:

- The Harbour Railway – 25,000 visitors (BCC Senior Curator, 2015)
- SS Great Britain– 236,500 visitors (SS Great Britain trust, 2018/19)
- M Shed – 555,000 visitors (www.alva.org.uk, 2014)

Statistics for these sites are not all readily or consistently available, and data in recent years is distorted by the impact of Covid-19.

If these attractions account for a 1/2 of a visitor day each, their approximate contribution to the Floating Harbour visitor numbers can be apportioned as follows:

- The Harbour Railway – 0.6%
- SS Great Britain – 5.5%
- M Shed – 12.8%

It can be assumed that for any attraction directly flooded, they may suffer 20 week's disruption to business (based on the data of the Frontier methodology). In some major events, M Shed is not flooded directly, but it is considered that disruption to the local environs, and access might still induce 3 weeks disruption / loss of income (as per Frontier methodology). For general flooding to the quays, 1 week's disruption is assumed for all attractions.

In addition to these, the Bristol Harbour festival is associated with approximately £3.25m annual spend. It is assumed that the festival will be cancelled if the quays are flooded 1 week before the date of the festival, or if most major attractions are flooded 20 weeks before the festival, and this is factored into the probability of event cancellation. A factor of 20% is allowed for displacement of lost revenue within Bristol.

This information can be used in conjunction with flood risk to the quays to build up an estimate of flood impacts as follows:

Table 13: Build-up of economic impact of flooding on tourist facilities beside the Floating Harbour

	Percentage of tourism earnings lost for a given duration.			Allowance for displacement	Economic impact per event
	1 week	3 weeks	20 weeks	(%)	(£m)
Minor events (quays, Harbour railway)	99.2%		0.8%	50	0.3
SS Great Britain directly flooded	92%		8%	30	0.8
All attractions except M Shed flooded		16.9%	83.1%	20	6.0
All attractions directly flooded			100%	10	7.9
Do Nothing – in future climate events, flooding reaches the 2 year return period, leading to year – round loss of Harbourside tourism. However it is assumed that a high level of displacement would occur				50	7.7

The UK tourism economy delivers a £58bn GVA direct contribution to the UK economy. However, the direct, induced and indirect impact of the tourism economy is £161bn²⁵, meaning that a multiplier of 2.78 can be applied to direct impacts.

Coupling this data with observed flood risk from the modelling allows us to build up an assessment of the annual average disruption per option. These can in turn be built into a Net Present Value, as shown in Table 14:

Table 14: Annual Average and net present value impact on tourism due to flooding.

Option	Annual Average Damages (£m)				Net Present Value (£m)	
	2030	2069	2070	2130	10yrs	100yrs
Do Nothing	3.63	18.85	19.97	20.02	50.7	364.0
Do Minimum	2.11	3.75	3.95	12.33	21.5	113.9
1.3% AEP SoP	1.30	1.51	1.54	1.66	12.3	42.7
1% AEP SoP	0.74	0.82	0.74	0.82	7.0	22.9
0.5% AEP SoP	0.18	0.40	0.50	0.54	1.9	9.8
Preferred Scheme	0.18	0.40	0.50	0.54	1.9	9.8

²⁵ Deloitte, with Oxford Economics, for VisitBritain, “Tourism: jobs & growth. The economic contribution of the tourism economy in the UK”, Nov 2013
<https://www.visitbritain.org/media/1835/download?attachment>

The benefits of the scheme can therefore be inferred as follows (Table 15).

Table 15: Benefits of the scheme for protection of the tourism industry

	Benefit compared to Do Nothing (£m)	Benefit compared to Do Minimum (£m)
1.3% AEP SoP	321.3	71.2
1% AEP SoP	341.1	91.1
0.5% AEP SoP	354.2	104.1
Preferred Scheme	354.2	104.1

While this section of the report focusses on the direct impacts of flooding to the tourism industry, it has to be acknowledged that if the cultural and aesthetic centre of Bristol were to be subject to frequent flooding, effectively leading to the loss of this industry, it would have significant impacts on the rest of Bristol's tourism industry as well, and this is not quantified by this assessment.

9. Summary

9.1 Quantified benefits

The potential local benefits of the Local Choice “NPPF-Compliant” strategy are compared with other standards of protection in Table 16, below. Clearly the bulk of these benefits are associated with the growth enabled at unlocked sites, associated with an NPPF complaint strategy.

Table 16: Quantified benefit of proposals

	Local Choice NPPF Compliant strategy		Other standards of protection	
	Benefit compared to Do Nothing	Benefit compared to Do Minimum	Minimum Benefit compared to Do Nothing	Minimum Benefit compared to Do Minimum
Direct benefits to the local economy				
Commercial property damage and infrastructure disruption avoided	858	820	846	807
Disruption to businesses avoided	360	266	360	265
Disruption to the tourism sector avoided	354	104	321	71
GVA of jobs created through construction (of flood alleviation scheme)	23	23	23	23
TOTAL direct benefits	1,595	1,213	1,550	1,166
Potential Indirect benefits to the local economy (unlocked potential)				
Note: With exception of construction jobs, all values are based on present value over a 30 year period				
Allocated sites				
GVA Growth enabled at unlocked sites	1,860	1,860	-	-
GVA of jobs created through construction	4	4	-	-
Temple Gate & St. Philips Marsh				
GVA Growth enabled at unlocked sites	3,447	3,447	-	-
GVA of jobs created through construction	11	11	-	-
Net residential expenditure	1472	1472	-	-
Net amenity benefits	101	101	-	-
Net Council tax receipts	137	137	-	-
Net Business rate receipts	13	13	-	-
TOTAL Potential Indirect benefits	7,045	7,045	-	-

At lesser standards of protection, not compliant with NPPF, a flood strategy will still have some influence in enabling development to proceed to planning consent earlier, or at lesser expense, however it may be much reduced. Nonetheless, because they would have that influence, the overall benefits presented above for “Other standards of Protection” are a minimum.

It is important to recognise that identification of the potential indirect local benefit of the strategy is not the same as claiming all these benefits toward a funding application. Flood risk is not the only infrastructure issue to be resolved to enable the unlocked sites, and the benefits identified above would need to be apportioned across several infrastructure investments at FBC; a process on which BCC would have to take the lead. However, without resolving flood risk, it is true to say that these developments will only proceed with significant delay or cost.

9.2 Unquantified benefits

As identified in Section 2, not all benefits and effects can have a number put to them. Identified unquantified benefits are presented in Table 17, below.

Table 17: Summary of unquantified benefits (with regards to protection against flood risk)

Benefit	Commentary
Ensuring the benefits of proposed works at the Temple Mead station	The potential £524m benefit of investment in the station would be impacted by flood risk to the surrounding area affecting public realm appeal, footfall, and disruption to onward transport
Ensuring the direct benefits of other transport initiatives	Proposals for investment in initiatives such as Metrobus (£200m), MetroWest (£175m) and the Future4West mass transit initiative (£4bn) will have made / make claims for their benefit without taking account of flood risk, and its impact on integration / forward travel.
Ensuring the economic growth benefits of other transport initiatives	Improvements to transport infrastructure are proposed in the WECA Economic Plan with a view to driving growth in the economy – and improvements as high as £1.2bn are projected for works to be implemented by 2030. However, the benefit of these initiatives will not be a great with flood risk taken into account.
Ensuring the continued attractiveness of Bristol	The appeal of Bristol’s public realm, its cultural attractions and the aesthetics of the harbour area are important to the attraction of talented and creative workers, businesses, and the visitor economy
Avoiding blight	Avoiding mass property write-off is important to retention of businesses and residents
Avoiding wider impacts on the tourist industry	Loss of the harbourside tourist industry and the general appeal of the harbour area in a post write-off scenario would impact on the wider tourist industry within Bristol and West of England.

Appendix C

Active travel Assessment

Bristol City Council

Bristol Avon Flood Strategy

Active Travel Corridor - Economic Appraisal

Click or tap here to enter text.

| 17 October 2023



This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 285982-07

Arup Limited
Rose Wharf, 78 East Street
Leeds
LS9 8EE
United Kingdom
arup.com

Document Verification

Project title Bristol Avon Flood Strategy
Document title Active Travel Corridor - Economic Appraisal DRAFT
Job number 285982-07
File reference Bristol Avon Flood Strategy Active Travel Economic Appraisal Report DRAFT FOR ISSUE 210829

Revision	Date	Filename	Bristol Avon Flood Strategy Active Travel Economic Appraisal Report DRAFT FOR ISSUE 210829		
1.00	30 September 2023	Description	Draft Economic Appraisal Report including AMAT results		
			Prepared by	Checked by	Approved by
		Name	OA, HS	MJ	
		Signature			
1.1	16 October 2023	Filename			
		Description	Updated draft Economic Appraisal Report including AMAT results		
			Prepared by	Checked by	Approved by
		Name	OA, HS		
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document

Contents

1.	Introduction	1
2.	Scheme Context	1
3.	Economic Appraisal	3
3.1	Active Modes Appraisal Toolkit (AMAT)	3
3.2	Scheme Design	3
3.3	Appraisal Methodology	4
3.4	Scheme Costs	7
3.5	Active Modes Appraisal Results	8

Tables

Figure 1 - Outline timeline for the Bristol Avon Flood Strategy	1
Figure 2 - West of Temple Meads proposed Flood Defences	2
Figure 3 - Feeder Road & St Phillips Greenway proposed Flood Defences	2
Figure 4 - Scheme Areas Map	5
Figure 5 - Bristol City Council Pinpoint Local Information Map	5
Table 1 - Scheme Specification	3
Table 2 - AMAT Count Inputs	7
Table 3 – Costs by Option (2024 Prices)	8
Table 4 - Appraisal Summary Table	8
Table 5 - Benefits and Costs by Infrastructure Section (2024 Prices)	10
Table 6 - Alternative Scenarios Appraisal Results	11

1. Introduction

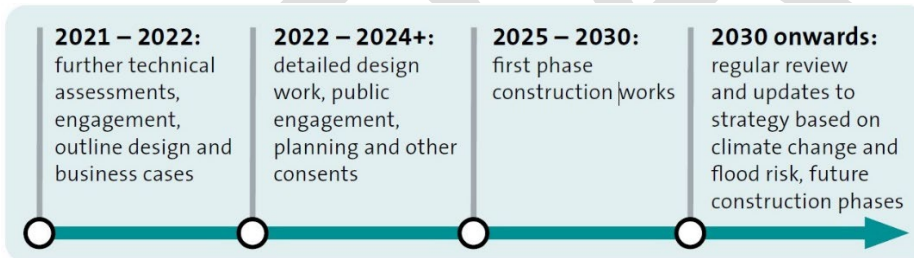
The Bristol Avon Flood Strategy (BAFS) is a key document produced by Bristol City Council (BCC) to deliver strategies to manage flood risk around the city. The Central Area Flood Risk Assessment report published in November 2013 provided confirmation that whilst, at the time of writing, the standard of protection for much of the City centre is around 0.5% AEP, indicating a 0.5% chance of flooding in one year, the St Phillips Marsh area is at much higher risk. Additionally, the threat posed by climate change and sea level rise is deemed as such that for the 50-year and 100-year epochs, the flood risk in the centre is likely to be very significant. As a riverfront city, there is an understanding that whilst all floods cannot be prevented, a long-term strategy to manage risk is essential. The BAFS, endorsed by the council cabinet in March 2021 following a public consultation, sets the ground for the development of numerous Outline Business Cases and the securing of funds to deliver the first phase of long term flood defences across the city and its neighbouring communities.

As part of this, Arup has been commissioned by Bristol City Council (BCC) to undertake an economic impact assessment of the proposed integration of cycling and walking infrastructure into future flood defences alongside the Avon river. This economic appraisal report sets out the methodology for appraising the expected impacts and the results of the appraisal of the proposed scheme. This will enable the submission of an Outline Business Case (OBC)

2. Scheme Context

The proposed scheme is part of the wider Bristol Avon Flood Strategy which sets out a strategic long term plan for managing flood risks from the River Avon to Bristol and its neighbouring communities. The Strategy, approved by the cabinet in 2021, aims to deliver the first phase of construction works in 2025-2030, with regular review and updates from 2030 onwards.

Figure 1 - Outline timeline for the Bristol Avon Flood Strategy



The strategic objectives are to:

1. Future proof the city and neighbouring communities,
2. Enable a greener and more active city,
3. Unlock Bristol’s potential.

The proposed flood defences encompass the area demarcated in bold in Figure 2 and Figure 3. The Flood Strategy works are further enhanced through improvements to the active travel infrastructure along the Avon River and the flood defence area. This directly aligns with the strategic objective of a “greener and more active city” and will enhance the flood defences as a positive contribution to their adjacent communities and public realm.

Figure 2 - West of Temple Meads proposed Flood Defences

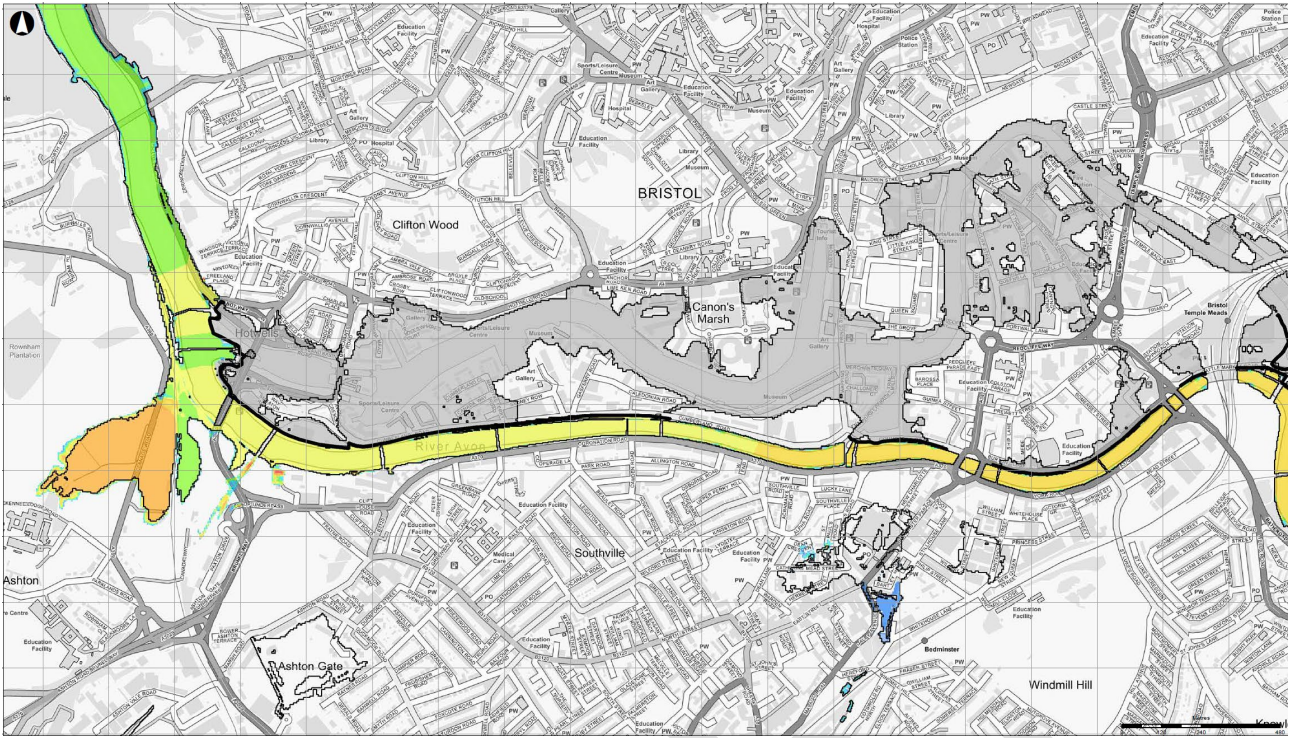
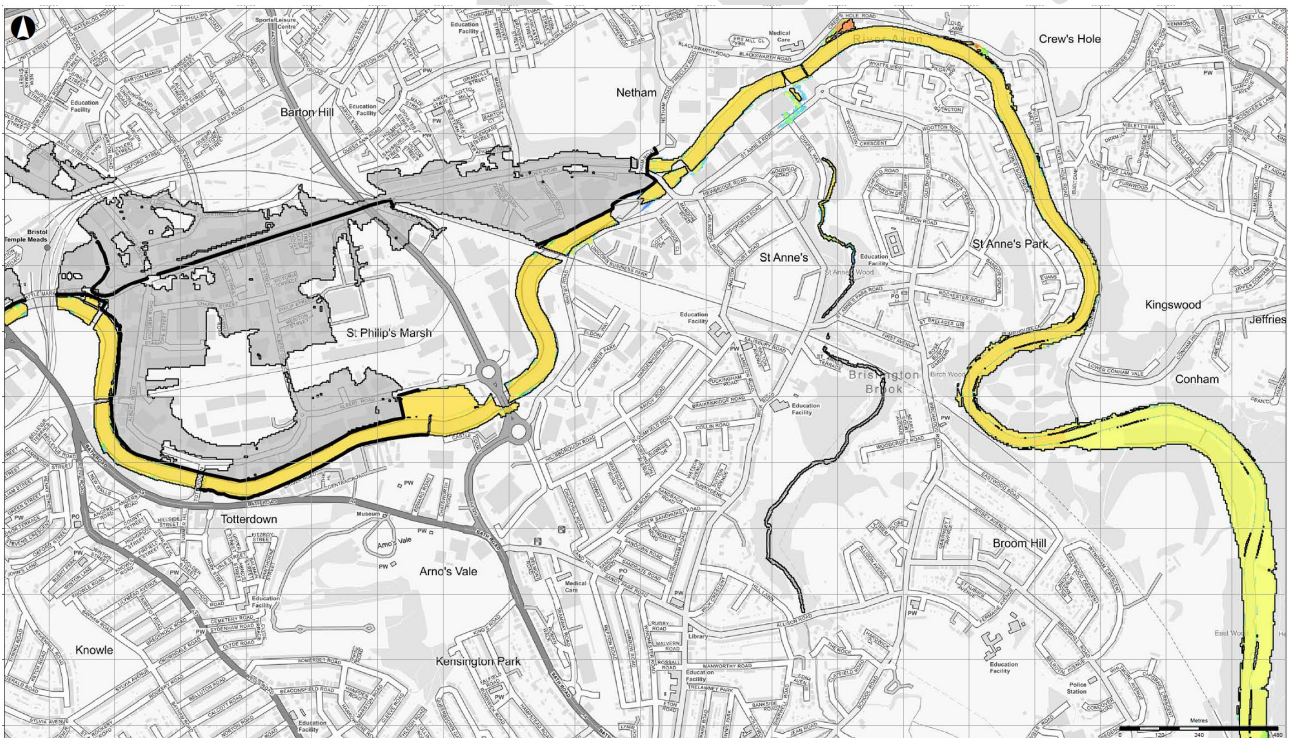


Figure 3 - Feeder Road & St Phillips Greenway proposed Flood Defences



3. Economic Appraisal

This section summarises the HM Treasury Green Book compliance approach to the economic appraisal of the active travel elements of the proposed works comprising the Bristol Flood Alleviation Strategy.

The purpose of the economic appraisal is to determine the value for money (VfM) of the proposed interventions. It will involve the quantification and comparison of the various costs and benefits in order to evaluate whether the project represents an efficient allocation of resources.

As established within the ASR, the methodology for the calculation of this value for money utilises the Active Mode Appraisal Toolkit (AMAT) to determine the scale of these expected benefits.

3.1 Active Modes Appraisal Toolkit (AMAT)

The Active Modes Appraisal Toolkit (AMAT) is a spreadsheet-based model used to quantify a range of benefits resulting from walking and cycling interventions. Through the input of trips before and after the scheme delivery and the specification of the scheme itself, the tool quantifies the:

- Health improvements from increased levels of physical activity in terms of reduced mortality risk and lower work absenteeism;
- Improvements to journey quality as a result of providing the perception of a safer or pleasant journey whilst using walking and cycling infrastructure; and
- Impacts associated with modal shift away from cars and taxis including improvements in traffic congestion, greenhouse gas emissions, air quality, noise, accidents, infrastructure maintenance, and changes to indirect tax revenues as a result of a reduction in distance travelled by these modes.

3.2 Scheme Design

In developing the scheme specification, the “Typical Costs of Cycling Interventions” report produced by Transport for Quality of Life for the Department for Transport in 2017 was used. The scheme drawings were reviewed and prospective interventions were designed which were sensitive to the existing infrastructure and physical constraints. The prospective interventions all met LTN 1/20 standards which means they meet the DfT’s Cycle Infrastructure Design (June 2020) guidelines.

Table 1 - Scheme Specification

Location	Infrastructure Type	
West of Temple Meads	Cumberland Lock northside	Resurfaced Cycle Route
	Cumberland Lock bridge (north)	Cycle Bridge (upgrade)
	Cumberland Lock Swing Bridge (south)	Cycle Bridge (upgrade)
	Brunel Lock Road to Ashton Avenue Bridge	Resurfaced Cycle Route
	Chocolate Path from Ashton Avenue Bridge to Gaol Ferry Bridge	Resurfaced Cycle Route
	Gaol Ferry Bridge to Bedminster Bridge Roundabout	Resurfaced Cycle Route
	Bedminster Bridge Roundabout	Remodelled major junction
	Bedminster Bridge Roundabout to Bath Bridge Roundabout	Resurfaced Cycle Route

Feeder Road	Cattle Market Road to Feeder Road	Resurfaced Cycle Route
	Feeder Road to Cole Road	Cycle Superhighway [Physically Segregated]
St Philips Greenway	St Philips Greenway to Sparke Evans Park	Resurfaced Cycle Route

The descriptions of these infrastructure types as taken from the DfT report is presented below.

Resurfaced Cycle Route: A track resurfaced over a significant distance to create a new strategic cycle route e.g. a towpath improved from rough track to tarmac, so it becomes an everyday cycle commuting option.

Cycle Bridge: A new or upgraded bridge to enable cyclists to cross a major obstacle e.g. a cycle bridge over a river, railway line or busy dual carriageway road.

Remodelled major junction: A large busy road junction that was an obstacle to cycling reengineered as a junction suitable to a cyclist-friendly route.

Cycle Superhighway (Physically Segregated): An extended cycle route that enables direct, rapid, safe cycle trips largely segregated from traffic along an arterial route e.g. a 10km route following an A-road from outer suburbs to a city centre.

Journey quality and reductions in likelihood of accidents are key benefits within the subsequent active travel appraisal. The differing levels of segregation and infrastructure quality will therefore have an impact on these benefits in line with the scale of intervention.

3.3 Appraisal Methodology

When conducting a cost benefit analysis, a base case must be articulated, with which to compare the project case. It represents the scenario in which the interventions are not put in place and thus can be referred to as the ‘do nothing’ scenario.

The economic appraisal will therefore compare the value for money of the scheme to the ‘do nothing’ scenario through appraising the ‘do something’, where the active travel interventions are enacted alongside the flood defences.

For ease of appraisal, the scheme area is separated in to three interventions:

- **West of Temple Meads:** Chocolate Path between Cumberland Lock and Bristol Temple Meads station
- **Feeder Road:** Feeder Road to the east of Temple Meads station
- **St Phillips Greenway:** Alongside River Avon east of Temple Meads station

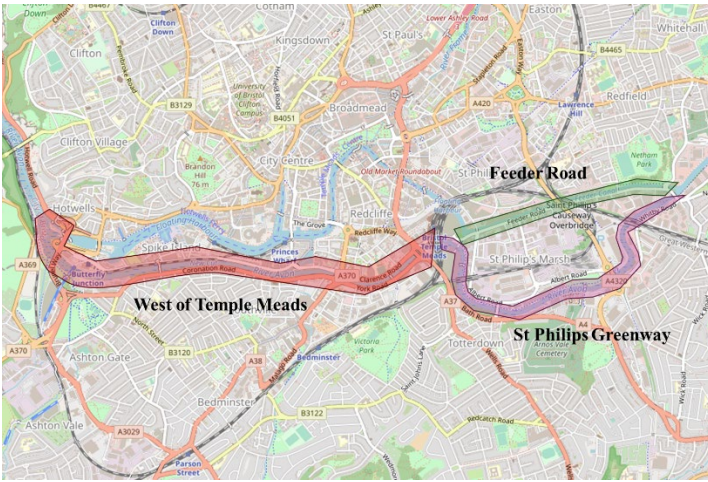


Figure 4 - Scheme Areas Map

As established above, the active mode impacts are appraised using AMAT. This primarily considers the difference between the number of trips (cycling and pedestrian) with and without the proposed intervention. Thus, the following inputs have been collected in order to utilise these tools:

- a) The current number of cycle and walk trips in the scheme area; and
- b) The expected number of extra trips, split by (i) completely new trips and (ii) reassigned trips (those that were being made on a nearby route that have switched to the new infrastructure).

Existing walking and cycling trip counts are taken from the ‘Pinpoint Local Information’ map available through Bristol City Council.

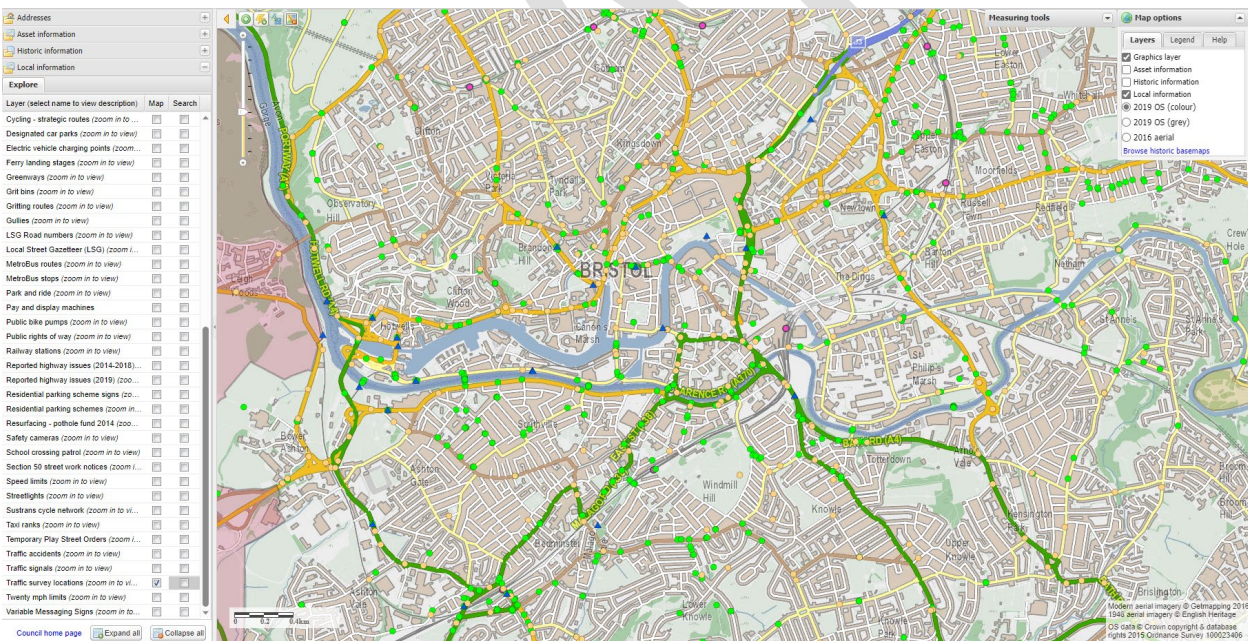


Figure 5 - Bristol City Council Pinpoint Local Information Map

Counts alongside the proposed floodworks have been taken and additional factors have been applied to ensure comparability between count locations. The following counts have been used:

- Cumberland Road/Mardyke Ferry Road
- Bathurst Basin Swing Bride
- Common Road/Clarence Road
- Clarence Road

- Cattlemarket Road
- Feeder Road

All counts used were conducted in 2019 and range between:

- automatic traffic counts – pneumatic loop count using axle spacing to determine vehicle type
- manual traffic counts – human counted traffic survey and classification of vehicle type
- junction turning counts – manual count of vehicle movements on all arms of a junction
- commissioned pedestrian and cyclist counts – manual count specifically focusing on pedestrian and cyclist movements

Expansion factors taken from the Transport Infrastructure Ireland ‘Expansion Factors for Short Period’ (October 2016) report have been used to approximate a pedestrian/cyclists ‘per day’ value for input in to the AMAT.

The expansion process is as follows:

1. Date of each count has been identified
2. A ‘Weekly Average Daily Trip’ Weekly Average Daily Trip’ factor has been applied to account for the specific day of the week of each count. This accounts for any day to day variation in traffic flows.
3. An ‘Annual Average Daily Trip’ factor has subsequently been applied to account for the month of the year in which the counts took place. This accounts for monthly variations in traffic flows, usually influenced by seasonality, public holidays and school holidays.
4. If needed, an expansion factor has been applied to create full 24 hour counts where the original counts were only 12 hour (7am to 7pm)

Expected number of trips consists of two streams:

- exogenous background growth (caused by general trends in the levels of walking and cycling) and,
- endogenous growth (growth in walking and cycling levels as a result of the proposed interventions)

This exogenous background growth is calculated within the AMAT tool.

The endogenous growth resulting from the interventions is determined through the use of the Capital Uplift tool. The Capital Uplift Tool estimates the anticipated uplift based off the monetary value of the investment in infrastructure of the scheme and uses previous case studies, infrastructure type and existing counts to estimate a resultant increase in cyclists.

This method was chosen as it relies on case studies of similar real-world schemes to determine a likely percentage uplift in cycling and walking.

Lastly, other mandatory inputs that are necessary to undertake the active modes appraisal within the AMAT tool include the scheme opening year. This will be determined by the scheme programme and the expected date for completion of the proposed interventions.

The baseline and forecast daily counts are presented in Table 1 below.

Table 2 - AMAT Count Inputs

Pedestrian Counts						
	Feeder Road		St Phillips Greenway		West of Temple Meads	
	Low	High	Low	High	Low	High
Base	620	620	413	413	1064	1064
Forecast (Uplift)	717	742	433	440	1256	1324
Cyclist Counts						
	Feeder Road		St Phillips Greenway		West of Temple Meads	
	Low	High	Low	High	Low	High
Base	766	766	1081	1081	1037	1037
Forecast (Uplift)	823	838	1093	1097	1150	1190

For the Cyclist Counts:

- **West of Temple Meads** is taken as average of four count sites along this area.
- **St Phillips Greenway** is taken as the difference between the westmost Feeder Road count and the Cattle Market Road count
- **Feeder Road** is taken as the average of the two Feeder Road counts

For the Pedestrian Counts:

- **West of Temple Meads** is taken as average of two pedestrian count sites
- **St Phillips Greenway** as the only local pedestrian count is on Cattle Market road, we assume the same split of journeys from Cattle Market Road as seen with cyclists (60%).
- **Feeder Road** as above, we assume same split of journeys from Cattle Market Road as seen with cyclists (40%)

3.4 Scheme Costs

High level capital costs for the scheme have been developed through the use of the “Typical Costs of Cycling Interventions” report produced by Transport for Quality of Life for the Department for Transport in 2017. This report details the typical costs of cycling interventions and the factors that affect them and is drawn from expenditure during delivery of Phase 1 of the Cycle City Ambition (CCA) programme.

To provide a means of comparison, two scheme options were developed, Scheme Option A and Scheme Option B. Option A based scheme costs on the low cost per km for each intervention type whilst Option B used the high cost per km. Prices were then adjusted to reflect 2024 prices through the use of the webTAG databook GDP deflator values. Table 2 below shows the cost of each option in 2024 prices.

Table 3 – Costs by Option (2024 Prices)

	Option A	Option B
Area 1 (West of Temple Meads)	£2,422,342.54	£3,278,801.61
Area 2 (Feeder Road)	£1,366,731.64	£1,588,054.50
Area 3 (St Phillips Greenway)	£254,700	£345,664.29
Total	£3,932,774.19	£5,212,520.40

Total maintenance costs of 10% of capital expenditure are applied each 5 years to the scheme. This value was chosen as it reflects the low-medium level of maintenance expected for a scheme of minimal complexity. As the scheme design progresses and designs take shape, a more accurate assumption regarding expected operating costs will be developed.

An optimism bias (OB) of 23% has been applied within AMAT. This reflects the appropriate level of OB for an active travel intervention as part of a Stage 2 (Outline Business Case) as per the DfT TAG Unit A1.2 Scheme Costs. The selection of this OB is supported by the expectation that the majority of construction risk will be borne by the delivery of the flood defences which, by virtue of being at Stage 2, will have reasonably well developed construction delivery risks which will have been accounted for within the flood defence cost development.

These costs are adjusted before use within the economic appraisal to ensure that the final economic costs are compliant with the DfT's TAG guidance. As the Flood Defences business case is planned for a 2024 submission, benefits and costs are also presented in 2024 values, again through the use of the webTAG databook GDP deflator.

3.5 Active Modes Appraisal Results

The AMAT compares the two scenarios with and without the scheme and reports the benefits as the differences between the scenarios. Hence, below, Option A reflects the benefits of the Lower Cost option relative to no intervention and Option B reflects the benefits of the Higher Cost option relative to no intervention. The outcomes of these AMAT appraisals are set out in Table 4 below. The Present Value of Costs and Present Value of Benefits are presented in £'000s and cover the 40 year appraisal period in line with DfT LTN 1/20 appraisal guidance. The Present Values are subject to discounting, using Green Book discount rates to account for the preference for current consumption over future consumption.

For each benefit category below, the AMAT considers the change in benefit resulting from the future number of walkers and cyclists in comparison to the existing number.

Table 4 - Appraisal Summary Table

£1000s	Option A [Lower Cost] (2024)	Option B [Higher Cost] (2024)
Congestion benefit	337.0	446.2
Infrastructure maintenance	1.6	2.2
Accident	55.5	73.5
Local air quality	2.3	3.1
Noise	3.7	4.9
Greenhouse gases	19.9	26.4
Reduced risk of premature death	4097.0	5424.2
Absenteeism	659.6	873.2
Journey ambience	5.7	5.7

Indirect taxation	1.1	1.5
Investment costs	3494.8	4632.4
Operating costs	789.7	1046.7
Private contributions	0.0	0.0
PVB	5181.9	6858.8
PVC	4282.9	5676.9
BCR	1.21	1.21

3.5.1 Quantified/Monetised Benefits

The quantifiable benefits of the proposed cycling interventions are presented below in 2024 prices for both Option A (Lower Cost) and Option B (Higher Cost).

The Congestion benefit refers to the monetised benefits resulting from a mode shift from car to active travel. For Option A this totals £248,115 whilst for Option B it is £328,510.

The Infrastructure Maintenance benefit refers to the benefits resulting from reduced infrastructure of the highway as a result of the mode shift induced reduction in vehicle kilometres. For Option A it amounts to £1,204. For Option B it is £1,595.

The Accident benefit refers to the benefits resulting from the expected change in collisions driven by the reduced in the likelihood of slight, serious and fatal collisions as a result of the interventions and the reduced likelihood of collisions of as a result of a modal shift away from cars. This benefit amounts to £ £40,890 for Option A and £54,139 for Option B.

Air Quality benefits refers to the benefit arising from the anticipated reduction in vehicle flows and the associated reduction in emissions such as NOx and particulate matter from tyre abrasion. As air pollution can lead to serious respiratory health impacts, particularly for vulnerable members of the local population, reducing vehicle traffic and the associated emissions contributes positively to the environmental impact of the scheme. For Option A, this benefit amounts to £ £1,706 and for Option B, £2,259.

Noise benefits refers to the benefits arising from the anticipated reduction in vehicle flows and speeds and the associated reduction in engine and tyre noise. This is expected to benefit local residents through contributing to a less noisy and thus more enjoyable environment. For Option A, this benefit amounts to £ £2,726 and for Option B, £3,609.

Greenhouse Gases refers to the benefits arising from the reduction in vehicle flows and the associated reduction in emissions of CO2. This is expected to contribute positively to climate change outcomes and the wider environmental impacts of the scheme. This benefit amounts to £ £14,660 for Option A and to £19,410 for Option B.

The health benefits of the scheme are the benefits arising from:

- The reduced risk of premature death resulting from the increase in physical activity encouraged by the new infrastructure and,
- The reduction in absenteeism (sick days from work) as a result of the improved health of those using the infrastructure and the associated productivity impacts to the economy.

The reduced risk of premature death benefits amount to £3,016,053 for Option A and £3,993,106 for Option B.

The expected reduction in absenteeism leads to a benefit of £485,559 for Option A and £642,821 for Option B.

The journey ambience benefits refer to the benefits arising from the improvements in quality of infrastructure and the positive benefit this has for people travelling by both foot and bike on the new intervention.

These benefits amount to £4,185 for Option A and £4,225 for Option B.

Indirect taxation refers to the change in fuel duty resulting from the change in vehicle kilometres driven. It amounts to a benefit of £814 for Option A and a benefit of £1,077 for Option B.

The larger benefits for Option B relative to Option A reflect the larger expected change in the number of walkers and cyclists resulting from the better quality infrastructure with Option B. As the driver for the majority of these benefits is the number of individuals impacted by it, as this increases, so does the scale of benefits.

The monetised benefits and costs are summarised by infrastructure section in Table 4 whilst Table 5 breaks this down by infrastructure section.

Table 5 - Benefits and Costs by Infrastructure Section (2024 Prices)

£'000s	Feeder Road		St Philips Greenway		West of Temple Meads	
	Low Cost	High Cost	Low Cost	High Cost	Low Cost	High Cost
PVB	£1,628.37	£2,051.79	£338.70	£453.91	£3,214.83	£4,353.07
PVC	£1,367.44	£1,729.80	£277.03	£376.76	£2,638.44	£3,570.37
BCR	1.19	1.19	1.22	1.20	1.22	1.22

As can be seen in Table 4, both Option A and Option B have BCRs of 1.21 indicating that there are £1.2 worth of societal benefits for each £1 of public expenditure. The identical BCRs for the options reflects the fact that the benefits are driven by the forecast uplift in walkers and cyclists and the associated benefits accrued by them. As this uplift is determined using the aforementioned Capital Uplift Tool which calculates an uplift based on scheme costs, the PVB and PVC will be highly linked within this appraisal.

3.5.2 Non-Monetised Benefits

A key non-monetised benefit to consider is the benefits arising from delivering the active travel scheme **in concurrence** with the flood defence delivery scheme.

The construction of each intervention is likely to lead to substantial temporary disruption to the highway, pedestrian and cycle network in the vicinity, increasing congestion and its associated disbenefits (noise, air quality, greenhouse gases etc.).

Additionally, each intervention will require the delivery and submission of a business case and funding application to the WECA Assurance team and associated decision makers.

By coordinating the delivery of the individual interventions, the combined delivery costs are unlikely to amount to the sum of the individual intervention costs.

3.5.3 Alternative Scenario

An additional set of appraisals have been undertaken to investigate the hypothetical scenario in which the proposed flood defences are not built and flooding leads to the erosion of Cumberland Road and the adjacent Chocolate Path. As a result, the shared use path would be unusable and the number of walking and cycling trips is expected to fall.

As it is difficult to accurately predict the scale of the fall in cycle and walk trips, two scenarios have been considered where:

- The number of walking and cycling trips falls to zero
- The number of walking and cycling trips falls to 50% of the existing number of trips

The disbenefits arising from these two scenarios are presented below in Table 6.

Table 6 - Alternative Scenarios Appraisal Results

£1000s	Scenario 1 (50% reduction in users)	Scenario 2 (100% reduction in users)
Congestion benefit	-628.49	-1257.97
Infrastructure maintenance	-3.05	-6.11
Accident	-103.58	-207.32
Local air quality	-4.32	-8.65
Noise	-6.91	-13.82
Greenhouse gases	-37.13	-74.33
Reduced risk of premature death	-7199.61	-14409.04
Absenteeism	-1089.04	-2179.31
Journey ambience	-2045.22	-1363.13
Indirect taxation	-2.06	-4.12
Investment costs	0.00	0.00
Operating costs	0.00	0.00
Private contributions	0.00	0.00
PVB	-11116.36	-19517.68

As can be seen in Table 6 above, the expected reduction in walking and cycling trips as a result of the loss of the Chocolate Path infrastructure leads to a substantial negative impact as appraised by the AMAT. The reduction in walkers and cyclists would likely lead to additional congestion on the highway network as a proportion of previous active travellers switch to private car and public transport. This is expected to contribute negatively to air quality, noise levels and greenhouse gas emissions. Additionally, the likelihood of accidents and resultant injury are expected to increase as car trips rise. In addition to this, as active travel levels falls, the beneficial health aspects such as reduced risk of premature death and reductions in absenteeism will also fall. Lastly, the benefits associated with the improved journey quality of dedicated cycling and walking infrastructure will fall as walkers and cyclists have to use diversionary routes with inferior or absent dedicated infrastructure.

Appendix D

D.1 WTP Values and use / non-use numbers for heritage valuation

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
Bristol_Festivals_3	British Harbour Festival	8.79	250,000	£2,198,459	4.40	254,900	£1,122,271	£3,320,729
Bristol_Festivals_4	Cinema Rediscovered	85.68	5,127	£439,281	22.49	33,046	£743,238	£1,182,519
Bristol_Festivals_5	Bristol Wing Festival	24.10	10,000	£240,975	24.10	33,046	£796,326	£1,037,301
Bristol_Festivals_6	Bristol Cider & Cheese Festival at The Cider Box	8.79	5,000	£43,969	4.40	33,046	£145,495	£189,464
Bristol_Festivals_7	Bristol Shakespeare Festival	16.07	5,000	£80,325	10.71	33,046	£353,923	£434,248
Bristol_Museums_2678	M Shed	14.67	687,932	£10,092,024	7.34	254,900	£1,870,451	£11,962,475
Bristol_Museums_2679	Archives	287.64	3,120	£897,432	214.27	33,046	£7,080,734	£7,978,166
Bristol_Museums_2680	SS GB	23.56	236,500	£5,572,413	10.71	254,900	£2,729,979	£8,302,392
Bristol_Museums_2681	Being Brunel	0.00	-	£0	0.00	-	£0	£0
Bristol_Museums_2682	Maritime Heritage Museum	0.00	-	£0	0.00	-	£0	£0
Bristol_Museums_2683	Spike Island	23.47	22,398	£525,676	1056.67	33,046	£34,918,687	£35,444,364
Bristol_Museums_2684	New Room	14.67	25,000	£366,752	7.34	33,046	£242,491	£609,243
Bristol_Museums_2685	We the curious	15.53	304,000	£4,720,968	7.50	254,900	£1,910,985	£6,631,953
Bristol_Museums_2686	Create Centre	11.91	14,000	£166,795	6.85	33,046	£226,389	£393,185
Bristol_Museums_2687	Arnolfini	23.47	600,000	£14,081,877	11.74	254,900	£2,992,722	£17,074,599
Bristol_Museums_2688	Royal Photographic Society	23.47	22,398	£525,676	11.74	33,046	£387,985	£913,662
Bristol_Museums_2689	Martin Parr Foundation	14.67	22,398	£328,581	7.34	33,046	£242,491	£571,072
Bristol_Museums_2690	Underfall Yard	14.67	72,000	£1,056,246	7.34	33,046	£242,491	£1,298,737
Bristol_Museums_2691	DesignWest	14.67	30,594	£448,817	7.34	33,046	£242,491	£691,308
ListedBuildings15132	OLD POLICE STATION	15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings15142	BEDMINSTER LIBRARY	15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings17378	KENNEL LODGE AND ATTACHED WALLS	15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings17413		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings17423		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings17432		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings17996		15.35	-	£0	10.11	652	£6,591	£6,591
ListedBuildings19377		15.35	-	£0	10.11	882	£8,916	£8,916
ListedBuildings19411		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings19414		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings19456		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings19472		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings22843	REGENT HOUSE	15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings22855	WILLS NUMBER 1 FACTORY	15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings22872	NATIONAL WESTMINSTER BANK AND ATTACHED FRONT RAILINGS	15.35	-	£0	10.11	777	£7,855	£7,855

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings22887	ST MARY REDCLIFFE AND TEMPLE SCHOOL HOUSE AND ATTACHED WALLS AND RAILINGS	15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings22899	50 AND 52, BEDMINSTER PARADE	15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings22938		15.35	-	£0	10.11	796	£8,047	£8,047
ListedBuildings22943		15.35	-	£0	10.11	796	£8,047	£8,047
ListedBuildings23088		15.35	-	£0	10.11	796	£8,047	£8,047
ListedBuildings23090		15.35	-	£0	10.11	796	£8,047	£8,047
ListedBuildings23925		15.35	-	£0	10.11	893	£9,022	£9,022
ListedBuildings23988		15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings23997		15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings24004		15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings24078		15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings24083		15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings24089		15.35	-	£0	10.11	777	£7,855	£7,855
ListedBuildings24988		15.35	-	£0	10.11	893	£9,022	£9,022
ListedBuildings26005		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings26093		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings26447		15.35	-	£0	10.11	928	£9,376	£9,376
ListedBuildings26698		15.35	-	£0	10.11	992	£10,028	£10,028
ListedBuildings26730		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings26737		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings26809		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings31783		15.35	-	£0	10.11	796	£8,047	£8,047
ListedBuildings36533	BOWER COTTAGE DOUBLE HOUSE	15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings36934		15.35	-	£0	10.11	652	£6,591	£6,591
ListedBuildings37258		15.35	-	£0	10.11	910	£9,194	£9,194
ListedBuildings41832		15.35	-	£0	10.11	1,028	£10,392	£10,392
ListedBuildings55283	RIVERSIDE	15.35	-	£0	10.11	855	£8,643	£8,643
ListedBuildings61730	RETORT HOUSE AT ST 5797 7251 EAST OF GASFERRY ROAD	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings85027	RINGER'S TOBACCO FACTORY	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings86034		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings86708	SHELDON BUSH AND PATENT SHOT COMPANY LIMITED	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings86883	22, 23 AND 24, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings87003	FORMER HARDWARE WAREHOUSE	15.35	-	£0	10.11	1,036	£10,468	£10,468

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings87003	FORMER HARDWARE WAREHOUSE	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings87008	FORMER TRAMWAY GENERATING STATION	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings87159	NEW HALL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings87159	NEW HALL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings87159	NEW HALL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings87159	NEW HALL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings87159	NEW HALL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings87580	FORMER GARDINERS OFFICES	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings89304	DOWRY PARADE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89306	DOWRY PARADE AND ATTACHED FRONT BASEMENT AREA RAILINGS AND PIERS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89307	DOWRY PARADE AND ATTACHED FRONT BASEMENT AREA RAILINGS AND GATES	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89314	HABERFIELD HOUSE AND ATTACHED BALUSTRADES AND ENCLOSING WALLS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89320		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89321	CHapel Row AND ATTACHED FRONT AREA WALLS, PIERS AND RAILINGS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89322	CHapel Row AND ATTACHED FRONT AREA WALLS, PIERS AND RAILINGS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89348		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89353		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89362		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89365	FREELAND COURT	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89382		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89416		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89418		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89420		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89421		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89422		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89423		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89429		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89435		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89455	ROCK HOUSE AND ATTACHED FRONT PAVEMENT AND BASEMENT AREA RAILINGS AND GATES	15.35	-	£0	10.11	768	£7,759	£7,759

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings89542	NUMBERS 1 TO 6 INCLUDING ROSE OF DENMARK PUBLIC HOUSE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89547	311-319, HOTWELL ROAD	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings89573		15.35	-	£0	10.11	768	£7,759	£7,759
ListedBuildings89575		15.35	-	£0	10.11	768	£7,759	£7,759
ListedBuildings89856		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89860		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89877		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89879		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89882		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89886		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89911		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89923		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings89931		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings90657	128 St George's Road, the former women's and children's dispensary, known as The Read Dispensary	15.35	-	£0	10.11	1,179	£11,913	£11,913
ListedBuildings90668		15.35	-	£0	10.11	600	£6,060	£6,060
ListedBuildings90669		15.35	-	£0	10.11	600	£6,060	£6,060
ListedBuildings90818	THE BEAR PUBLIC HOUSE (263) AND ATTACHED RAMPED WALLS AND STEPS TO NUMBER 265	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings90820	DOWRY PARADE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings90846	Flats 11-15 Trinity Place	15.35	-	£0	10.11	1,192	£12,050	£12,050
ListedBuildings90847	CHURCH OF HOLY TRINITY	13.23	-	£0	7.18	843	£6,052	£6,052
ListedBuildings90901		15.35	-	£0	10.11	1,192	£12,050	£12,050
ListedBuildings91019	YORK HOUSE AND ATTACHED FRONT AREA RAILINGS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91021	NUMBERS 14 AND 15 AND ATTACHED FRONT AREA RAILINGS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91024	NUMBER 13 AND ATTACHED FRONT AREA RAILINGS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91025		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91053		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91057		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91059		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91060		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91081		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings91118		15.35	-	£0	10.11	882	£8,916	£8,916

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings91213	129, CUMBERLAND ROAD	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91276	THE GEORGIAN HOUSE	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91279		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91323	PREMISES OCCUPIED BY WICKHAM AND MORRIS (TIMBER IMPORTERS)	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91376	Block C: former salvage store and pattern-maker's workshop and boundary wall, Underfall Yard	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91378	FORMER SHIPWRIGHT'S SHOP	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91388	NUMBERS 6 AND 7 AND ATTACHED GARDEN WALLS AND PIERS NUMBERS 9 TO 25 AND ATTACHED GARDEN WALLS AND PIERS	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91399	Block J: Cartshed, Underfall Yard	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91402	HYDRAULIC ENGINE HOUSE	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91403	Block K: Stables, Underfall Yard	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91404	Block K: Stables, Underfall Yard	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91412	Avon Crescent Substation	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91414	NUMBERS 1 AND 2 AND ATTACHED FRONT GARDEN WALLS AND PIERS	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91416	NUMBERS 1A AND 2A AND ATTACHED FRONT GARDEN WALLS AND PIERS	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91418	OLD DOCK COTTAGES	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91423	OLD DOCK COTTAGES	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91665	THE PUMP HOUSE PUBLIC HOUSE	15.35	-	£0	10.11	1,192	£12,050	£12,050
ListedBuildings91807	FORMER PATTERN MAKER'S SHOP AND STORES	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings91856	NOVA SCOTIA HOTEL PUBLIC HOUSE	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings92108		15.35	-	£0	10.11	793	£8,016	£8,016
ListedBuildings92125		15.35	-	£0	10.11	793	£8,016	£8,016
ListedBuildings92126		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92168		15.35	-	£0	10.11	793	£8,016	£8,016
ListedBuildings92320		15.35	-	£0	10.11	793	£8,016	£8,016
ListedBuildings92397		15.35	-	£0	10.11	793	£8,016	£8,016
ListedBuildings92419		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92428		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92430		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92437		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92446		15.35	-	£0	10.11	713	£7,203	£7,203

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings92447		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92518		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92521		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92557		15.35	-	£0	10.11	713	£7,203	£7,203
ListedBuildings92568		15.35	-	£0	10.11	793	£8,016	£8,016
ListedBuildings92795		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92796		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92797		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92798		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92798		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92798		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92802	REDBRICK HOUSE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92803	21, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92805	15, CLARE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92806	13, CLARE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92819	GLASS CHAMBERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92820	ABBEY CHAMBERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92821	12, CLARE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92823	CHURCH OF ST STEPHEN	13.23	-	£0	7.18	2,608	£18,720	£18,720
ListedBuildings92825	17 AND 19, CLARE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92830		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92833		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92833		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92834		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92836		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92837		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92839		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92839		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92841		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92842		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92844	25 AND 27, CLARE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92848	28, CLARE STREET (See details for further address information)	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92850	CARLTON CHAMBERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92861	30, CLARE STREET (See details for further address information)	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92862	25 AND 27, ST STEPHENS STREET (See details for further address information)	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92865	39-45, ST NICHOLAS STREET (See details for further address information)	15.35	-	£0	10.11	2,608	£26,359	£26,359

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings92868	31, BALDWIN STREET (See details for further address information)	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92873		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92875		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92879		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92882		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92883		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92886	FISH MARKET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92892		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92894		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92898	59, 61 AND 63, BALDWIN STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92899		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92908		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92914		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92919		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92921	BRISTOL BRIDGE INN	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92922	Church of St Nicholas	13.23	-	£0	7.18	2,608	£18,720	£18,720
ListedBuildings92925	WEST INDIA HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92927	19 AND 20, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92928	18, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92929	17, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92932	9 AND 10, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92935	22, 23 AND 24, DENMARK STREET (See details for further address information)	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92937	1-7, DENMARK STREET	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92940	5 AND 6, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92943	3 AND 4, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92950	9, MARSH STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92954	1, 2 AND 3, BROAD QUAY	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92962	4, BROAD QUAY	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92967	5 AND 6, BROAD QUAY	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92968	7, BROAD QUAY	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92974	NOVA HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings92993	44-47, COLLEGE GREEN	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings92996	TRANSIT SHED E	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93007	MERCHANT VENTURER'S ALMSHOUSES	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93008	THE OLD LIBRARY AND ATTACHED FRONT AREA, WALL PIER AND RAILINGS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93011	31, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings93012	32, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93013	33, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93014	34, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93015	35, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93016	36, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93017	THE THEATRE ROYAL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93026	ST NICHOLAS' ALMSHOUSES	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93027	14 AND 15, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93030	7 AND 8, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93031	NUMBER 6 AND ATTACHED RAILINGS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93033	LLANDOGER TROW PUBLIC HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93035	THE OLD DUKE PUBLIC HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93038	TRANSIT SHED W	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93051	NUMBERS 59 TO 62 AND ATTACHED RAILINGS AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93052	58, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93053	57, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93054	56, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93055	3, MIDDLE AVENUE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93059	69-72, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93059	69-72, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93062	16, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93069	WAREHOUSE TO THE BACK OF NUMBER 3 QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93074	1-9, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93082	10 AND 12, QUEEN SQUARE (See details for further address information)	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93083	NUMBER 61 AND ATTACHED FRONT AREA WALL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93084	59, QUEEN CHARLOTTE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93086	57, QUEEN CHARLOTTE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93087	55, QUEEN CHARLOTTE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93088	53, QUEEN CHARLOTTE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93089	THE GRANARY AND ATTACHED AREA WALLS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93106	Buchanans Wharf	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings93114	55, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93115	NUMBER 54 AND ATTACHED RAILINGS AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93117	52 AND 53, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings93117	52 AND 53, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93120	PHOENIX HOUSE AND ATTACHED RAILINGS AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93123	49 AND 50, QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93125	NUMBER 48 AND ATTACHED RAILINGS AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93127	NUMBERS 46 AND 47 AND ATTACHED RAILINGS AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93128	QUEEN SQUARE HOUSE AND ATTACHED FRONT AREA WALLS AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93128	QUEEN SQUARE HOUSE AND ATTACHED FRONT AREA WALLS AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93142	FORMER YEO VALLEY FARMS WAREHOUSE	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings93143	DOMINIONS HOUSE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93157	CORKERS PUBLIC HOUSE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93163	17, KING STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93173		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93175	CANON'S MARSH GOODS SHED	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93178	FORMER LEADWORKS AND ATTACHED CHIMNEY AND WALL	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93179		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93180	CATHEDRAL SCHOOL	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93181		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93192		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93195		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93203		15.35	-	£0	10.11	1,179	£11,913	£11,913
ListedBuildings93211		15.35	-	£0	10.11	1,179	£11,913	£11,913
ListedBuildings93219	38, COLLEGE GREEN	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93220	THE COLLEGE TAVERN	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93233		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93235		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93238		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93251	8-11, DENMARK STREET	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93254		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93263		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93264		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93266		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93267		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93269		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93274		15.35	-	£0	10.11	1,744	£17,630	£17,630

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings93275		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93279		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93282		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93283		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93284		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93288		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93303		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93304	Former Swallow Hotel and attached front entrance balustrades	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93310		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93352		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93353		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93360		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93397	7, 8 AND 9, BATHURST PARADE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93400	2-6, BATHURST PARADE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93403	THE LOUISIANA PUBLIC HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93406	1-4, WAPPING ROAD	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93418	SEVERN SHED	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93420	29 Queen Square	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93423	27 and 28 Queen Square	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93435		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93447		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93454	66, PRINCE STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93455	THE SHAKESPEARE PUBLIC HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93457	BUSH HOUSE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93463		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93473	NUMBER 1 INCLUDING THE BRISTOL CLIPPER PUBLIC HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93477	Nos. 36, 37 and 38 QUEEN SQUARE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93492	PRINCE STREET BRIDGE ENGINE HOUSE AND ACCUMULATOR TOWER	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93526	ROBINSON'S WAREHOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93596	THE OSTRICH INN	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93715		15.35	-	£0	10.11	924	£9,341	£9,341
ListedBuildings93720		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings93723		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings93726		15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings93763	Canon's House	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93792	THE SUGAR LOAF PUBLIC HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings93795	ST BARTHOLOMEW'S HOSPITAL	15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93807		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93821		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93823		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93824		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93825		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93826		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93827		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93829		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93831		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93832		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93846		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93848		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93851		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93856		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93858		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93859		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93865		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93872	11, SMALL STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93874	QUAY HEAD HOUSE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93875	1,3 AND 5, ST STEPHENS STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93877	CONCORDE HOUSE INCLUDING RAILINGS AND LAMPS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93878	13, ST STEPHENS STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93880	15 AND 17, ST STEPHENS STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93882		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93883		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93893		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93894		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93895		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings93917		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93923		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93923		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93924		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93933		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93936		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93941		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93943	FORMER SUGAR REFINERY	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93944		15.35	-	£0	10.11	2,608	£26,359	£26,359

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings93945	WEST GATE	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93947		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93948		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93949		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93950		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93951		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93952		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93954		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93956		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93957		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93958		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93960		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93963		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93964	20, CHRISTMAS STEPS	15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings93977	CHURCH OF ST JOHN THE BAPTIST AND ST JOHN'S GATE	13.23	-	£0	7.18	2,730	£19,600	£19,600
ListedBuildings93982		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93988		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93998		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings93999		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94001		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94001		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94005		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94009		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94011		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94014		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94020	EMPLOYMENT EXCHANGE	15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94054	CENTRAL POLICE STATION	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94055	MAGISTRATES COURT PETTY SESSIONS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94056	7, BRIDEWELL STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94059	BRISTOL POLICE HEADQUARTERS FIRE STATION	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94080	WALSALL CONDUITS SITE	15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94081	UNITARIAN CHAPEL	15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94109		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94131	SUNDAY SCHOOL OF UNITARIAN CHAPEL AND TOWER HOUSE	15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94146		15.35	-	£0	10.11	1,795	£18,145	£18,145
ListedBuildings94147		15.35	-	£0	10.11	1,795	£18,145	£18,145

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings94147		15.35	-	£0	10.11	1,795	£18,145	£18,145
ListedBuildings94154		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94156		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94160		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94167		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94168		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94168		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings94174		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94174		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings94200	STATUE OF SAMUEL MORLEY	15.35	-	£0	10.11	1,795	£18,145	£18,145
ListedBuildings95840	NUMBER 4 AND AREA RAILINGS	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings95842	GARDINER'S WAREHOUSE, FORMER SOAP WORKS	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings95843		15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings95870	NUMBER 3 AND AREA RAILINGS	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings95873	WCA WAREHOUSE	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95882	SHAKESPEARE INN	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95896	THE SEVEN STARS PUBLIC HOUSE	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95903	25-31, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95906	CHURCH OF ST THOMAS INCLUDING WALL, GATES AND GATEWAY	13.23	-	£0	7.18	1,110	£7,966	£7,966
ListedBuildings95911	66, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95912	64, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95913	62, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95914	KINGS HEAD INN	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95915	58, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95936	4 AND 6, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95940	THE CORNUBIA PUBLIC HOUSE	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings95975	3-10, BATH STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings96000	PERIMETER WALL 3 METRES NORTH OF NUMBER 97 REDCLIFF STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings96002	84 AND 86, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings96002	84 AND 86, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings96152		15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings96155		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings96345		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96347		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96362		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96488		15.35	-	£0	10.11	997	£10,073	£10,073

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings96488		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96492		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96501		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96510		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96518	1-8, PRITCHARD STREET	15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96521		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96524		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96525		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96538		15.35	-	£0	10.11	997	£10,073	£10,073
ListedBuildings96545		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings96559		15.35	-	£0	10.11	1,369	£13,834	£13,834
ListedBuildings96809	MERCHANT TAYLORS' ALMSHOUSES	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings96841	Church of St Philip and St Jacob	13.23	-	£0	7.18	2,608	£18,720	£18,720
ListedBuildings96848		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings96856	THE NEW ROOM	15.35	-	£0	10.11	1,795	£18,145	£18,145
ListedBuildings96885	THE GREYHOUND HOTEL	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings96893	LOWER ARCADE	15.35	-	£0	10.11	1,795	£18,145	£18,145
ListedBuildings97119	ST AGNES' SUNDAY SCHOOL	15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97120	CHURCH OF ST AGNES WITH ST SIMON	13.23	-	£0	7.18	1,204	£8,641	£8,641
ListedBuildings97296		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97299		15.35	-	£0	10.11	1,269	£12,828	£12,828
ListedBuildings97300		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97303		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97304		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97310		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97312		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97314		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97382		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97387		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings97769		15.35	-	£0	10.11	971	£9,811	£9,811
ListedBuildings98498	ST VINCENT'S WORKS AND ATTACHED FRONT AREA RAILINGS	15.35	-	£0	10.11	944	£9,538	£9,538
ListedBuildings99384		15.35	-	£0	10.11	1,260	£12,732	£12,732
ListedBuildings99385		15.35	-	£0	10.11	1,369	£13,834	£13,834
ListedBuildings100355		15.35	-	£0	10.11	937	£9,467	£9,467
ListedBuildings101065	FORMER CHURCH OF ST MARK	13.23	-	£0	7.18	1,168	£8,386	£8,386
ListedBuildings101150		15.35	-	£0	10.11	1,241	£12,545	£12,545
ListedBuildings101157		15.35	-	£0	10.11	1,241	£12,545	£12,545
ListedBuildings101159		15.35	-	£0	10.11	1,241	£12,545	£12,545

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings101159		15.35	-	£0	10.11	1,241	£12,545	£12,545
ListedBuildings101507		15.35	-	£0	10.11	1,241	£12,545	£12,545
ListedBuildings101645	12-18, JUBILEE ROAD	15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings102412	LOCK KEEPER'S HOUSE AT NETHAM LOCKS LOCK KEEPER'S TOLL HOUSE AT NETHAM LOCKS	15.35	-	£0	10.11	1,053	£10,640	£10,640
ListedBuildings103743		15.35	-	£0	10.11	1,071	£10,821	£10,821
ListedBuildings104077		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings104078		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings104079		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings104093		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings104094		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings104116		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings104117		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings104145		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings106072	WATCH HOUSE, RETAINING WALLS TO THE RIVER AND GARAGE	15.35	-	£0	10.11	932	£9,416	£9,416
ListedBuildings106074	MULBERRY HOLUSE AND MULBERRY COTTAGE	15.35	-	£0	10.11	932	£9,416	£9,416
ListedBuildings106160	WELLINGTON HOUSE AND ATTACHED STABLES	15.35	-	£0	10.11	767	£7,753	£7,753
ListedBuildings106223	103, STATION ROAD	15.35	-	£0	10.11	767	£7,753	£7,753
ListedBuildings106224	105, STATION ROAD	15.35	-	£0	10.11	767	£7,753	£7,753
ListedBuildings106740		15.35	-	£0	10.11	932	£9,416	£9,416
ListedBuildings106941	65, BALDWIN STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings108882	POWDER HOUSES AND JETTY	15.35	-	£0	10.11	806	£8,148	£8,148
ListedBuildings110960	ABBEY HOUSE, CATHEDRAL SCHOOL	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings111080		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings111087	ST VINCENT'S PARADE, AND ATTACHED FRONT AREA RAILINGS AND GATES	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings111098		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings111108	THE COLONNADE AND ATTACHED FRONT GARDEN RAILINGS	15.35	-	£0	10.11	768	£7,759	£7,759
ListedBuildings111134		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings111148	16-19, FREELAND PLACE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings111536		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings114119	7, ST AUGUSTINES PARADE	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings115313		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings116710		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings116710		15.35	-	£0	10.11	843	£8,522	£8,522

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings116710		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings116767		15.35	-	£0	10.11	813	£8,213	£8,213
ListedBuildings116862	RETORT HOUSE AT ST 5790 7252 WEST OF GASFERRY ROAD	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings116888	FORMER ENGINE HOUSE AT ST 5793 7250	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings117740	STAPLETON MILL, SNUFF MILLS PARK	15.35	-	£0	10.11	884	£8,936	£8,936
ListedBuildings117758		15.35	-	£0	10.11	932	£9,421	£9,421
ListedBuildings117807		15.35	-	£0	10.11	884	£8,936	£8,936
ListedBuildings117857		15.35	-	£0	10.11	928	£9,376	£9,376
ListedBuildings118134	BRISTOL OLD STATION, TEMPLE MEADS	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings118182	DOWRY PARADE AND ATTACHED FRONT WALLS AND PIERS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings118185		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings118218	THE LAMPLIGHTERS PUBLIC HOUSE	15.35	-	£0	10.11	767	£7,753	£7,753
ListedBuildings118291		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings118603	WALL AT WEST END	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings118670		15.35	-	£0	10.11	793	£8,016	£8,016
ListedBuildings119755	THE PHOENIX PUBLIC HOUSE	15.35	-	£0	10.11	1,369	£13,834	£13,834
ListedBuildings119879	WAREHOUSE, FORMER PREMISES OF MARBLE MOSIAC COMPANY	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings121478		15.35	-	£0	10.11	829	£8,375	£8,375
ListedBuildings121490		15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings121681	DOWRY PARADE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings121832		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings121993	BRISTOL AND EXETER BUILDING	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings122035	CHATTERTON'S HOUSE AND SCHOOL AND ATTACHED SCREEN WALL	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings122223	NUMBER 2 AND AREA RAILINGS	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings122317		15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings122454	KING WILLIAM AND NAVAL VOLUNTEER PUBLIC HOUSES	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings122488	THE WOOL HALL, INCLUDING THE FLEECE AND FIRKIN PUBLIC HOUSE	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings122586	NUMBER 5 AND AREA RAILINGS	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings122632	54, BALDWIN STREET	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings122660		15.35	-	£0	10.11	1,369	£13,834	£13,834
ListedBuildings123335	NUMBERS 302 AND 304 AND ATTACHED FRONT AREA WALLS AND PIERS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings123611	20 AND 21, FREELAND PLACE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings124405	NUMBERS 302 AND 304 AND ATTACHED FRONT AREA WALLS AND PIERS	15.35	-	£0	10.11	843	£8,522	£8,522

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings124405	NUMBERS 302 AND 304 AND ATTACHED FRONT AREA WALLS AND PIERS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings124681	20 AND 21, FREELAND PLACE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings125194	8 AND 9, BROAD PLAIN	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings125200	THE PRINTER'S DEVIL PUBLIC HOUSE	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings125367		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings125424	Bristol General Hospital	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings125787	Public lavatory in Mina Road Park	15.35	-	£0	10.11	1,204	£12,166	£12,166
ListedBuildings126308		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings126802		15.35	-	£0	10.11	1,241	£12,545	£12,545
ListedBuildings126922	DOWRY PARADE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings127107		15.35	-	£0	10.11	723	£7,304	£7,304
ListedBuildings127126	DOWRY PARADE AND ATTACHED FRONT BASEMENT AREA RAILINGS AND PIERS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings127180	DOWRY PARADE AND ATTACHED FRONT BASEMENT AREA RAILINGS AND GATES	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings127595	DOWRY PARADE AND ATTACHED FRONT BASEMENT AREA RAILINGS	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings128258		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings128385	TEMPLE MEADS STATION	15.35	-	£0	10.11	1,036	£10,468	£10,468
ListedBuildings128743		15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings129306	WAREHOUSE, PREMISES OF CLARKS WOOD COMPANY	15.35	-	£0	10.11	1,256	£12,692	£12,692
ListedBuildings129525	8, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings129779	MACHINE SHOP	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings130949	STORK HOUSE	15.35	-	£0	10.11	843	£8,522	£8,522
ListedBuildings131057		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings131369		15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings131477	CUSTOM HOUSE AND ATTACHED REAR AREA WALL AND PIERS	15.35	-	£0	10.11	2,608	£26,359	£26,359
ListedBuildings131691		15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings132220	BLACK SWAN PUBLIC HOUSE	15.35	-	£0	10.11	1,168	£11,807	£11,807
ListedBuildings132309	12, VICTORIA STREET	15.35	-	£0	10.11	1,110	£11,216	£11,216
ListedBuildings132346	A BOND TOBACCO WAREHOUSE	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings132384	B BOND TOBACCO WAREHOUSE	15.35	-	£0	10.11	650	£6,566	£6,566
ListedBuildings132642	THE HIPPODROME	15.35	-	£0	10.11	1,744	£17,630	£17,630
ListedBuildings132722		15.35	-	£0	10.11	2,730	£27,597	£27,597
ListedBuildings137931		15.35	-	£0	10.11	757	£7,647	£7,647
ListedBuildings138048		15.35	-	£0	10.11	838	£8,471	£8,471

Asset ID	Asset Name	WTP of visitors	Visitor numbers	Non-market economic benefit of visitors	WTP of non-users	Number of non-users	Non-market economic benefit of non-users	Total economic value
ListedBuildings138048		15.35	-	£0	10.11	838	£8,471	£8,471
ListedBuildings139463		15.35	-	£0	10.11	757	£7,647	£7,647
ListedBuildings140232		15.35	-	£0	10.11	1,168	£11,802	£11,802
ListedBuildings140746	ZION HOUSE AND ATTACHED RAILINGS AND GATEWAYS	15.35	-	£0	10.11	777	£7,855	£7,855
Bristol_HAR_2021_Clippe d_44		11.91	-	£0	6.85	650	£4,450	£4,450
Bristol_HAR_2021_OTHR _OSGB36_59		11.91	-	£0	6.85	650	£4,450	£4,450
Bristol_ScheduledMonum ents_09May2022_184	Fairbairn Crane, Bristol Harbour	11.91	166,796	£1,987,201	6.85	2,608	£17,863	£2,005,065
Bristol_ScheduledMonum ents_09May2022_185	Underfall Yard, Bristol Docks	11.91	164,970	£1,965,443	6.85	650	£4,450	£1,969,893
Bristol_ScheduledMonum ents_09May2022_192	Section of City Wall, King Street	17.60	30,594	£538,436	8.81	2,608	£22,961	£561,397
Bristol_ScheduledMonum ents_09May2022_204	Temple Church	11.91	91,156	£1,086,025	6.85	1,110	£7,601	£1,093,625
Bristol_ScheduledMonum ents_09May2022_209	Part of the Roman Settlement of Abonae	17.60	41,153	£724,260	8.81	637	£5,609	£729,869
Bristol_ScheduledMonum ents_09May2022_195	Dominican Friars (Quaker's Friars)	11.91	31,080	£370,285	6.85	2,608	£17,863	£388,149
Bristol_ScheduledMonum ents_09May2022_196	Hermitage in Quaker burial ground near St Mary Redcliffe	11.91	61,990	£738,545	6.85	2,608	£17,863	£756,409