ENVIMSE500177

Oxford Flood Alleviation Scheme

Outline Business Case

Version No: 1.2

***Date*: 13/06/2017**

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FINANCIAL SCHEME OF DELEGATION (FSoD) APPROVALS

1.

Project name	Oxford Flood Alleviation Scheme				
Project ref.		**Project Code**	ENVIMSE500177	**Start date**	January 2014
Programme				**End date**	July 2027
Hub or Head Office	**South**		For FSOD use only		
Area name	**Thames**		**FSoD reference**		
Function	**FCRM**		**FSoD Date**		

2.

Role	**Name**	**Post Title**	**% time allocated to project**
Project Sponsor	Julia Simpson	Deputy Director - Thames	5%
Project Director	Joanna Larmour	Project Director	80%
Project Executive	Richard Harding	Project Executive	80%
Project Manager	Heather Taylor / Jane Birks	Project Manager	100%

3.

Risk Potential Assessment (RPA) Category	Low	☐	Medium	☒	High	☐

4.

FSoD schedule		**Description**	Delegation	
			National – up to	**Area – up to**
A1	☐	Projects (includes FCRM revenue)	£5m	£5m
A2	☐	FCRM capital project within approved strategy	£100m WLC Defra	£10m
A3	☒	FCRM capital project outside of approved strategy	£100m WLC Defra	£5m
A5	☐	Consultancy project	£500k	£500k
T2	☐	Corporate Property Projects /acquisitions	£5m	£5m

5.

FSoD value			**£k**
Form A	**FSoD reference**	**F/1516/0122**	4,164
Strategic Outline Case (SOC)	**FSoD reference**	**N/A**	N/A
Full Business Case (FBC)	**FSoD reference**	**N/A**	N/A
Whole Life Costs (WLC) of Project			£286.92m
Financial benefits (PV)			£1,112.4m
Non-financial benefits			**Yes**

6.

Required level of Environmental Impact Assessment (EIA)	**N/A** ☐	**Low** ☐	**Medium** ☐	**High** ☒

7.

NPAS/LPRG chair	**Post title**	Assurance confirmation			**Date**
		RED ☐	AMBER ☐	GREEN ☐	

8.

FSoD approver(s) name	**Post title**	Emailed approval	**Date**

9.

Form G	**Form G value (£k)**	**FSoD ref.**	**Latest FSoD authorised cost (£k)**
1	£865k	F/1516/0435	5,029
2	£6,933k	F/1617/0324	11,962
3			

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Version history

Version	Date issued	Brief summary of change	Owner's name
0.1	04/03/16	Format and early draft content of document	Jane Birks
0.2	22/04/16	Added relevant information from SOC and added responsibilities for information feeding in to the OBC.	Jane Birks
0.3	21/06/16	Updated strategic section, business drivers, risks.	Jane Birks
0.4	14/12/16	First draft including added sections for all cases.	Jane Birks
0.5	03/01/17	Plain English review	Laura Littleton
0.6	20/01/17	First draft for review by the core project team	Jane Birks
0.7	01/02/17	Updated draft for review by Project Board and senior management	Jane Birks
0.8	21/02/17	Updated following review by Project Board, Programme Board, Sponsoring Group and senior management	Richard Harding
1.0	22/02/17	Version 1.0 issued to the Large Projects Review Group	Joanna Larmour
1.1	24/03/17	Re-submission to the Large Projects Review Group	Chris Savage
1.2	13/06/17	Updates post Executive Committee	Chris Savage

Notes:

Flood risk is referred to using annual exceedence probability events, i.e. a 1% Annual Exceedence Probability (AEP) event. This refers to a flood level which has a 1% chance of occurrence in any given year. It can sometimes also be referred to as a 1 in 100 year event. In this OBC both methods are used. The table below gives examples of comparisons:

Annual Exceedence Probability (AEP)	Equivalent return period
1% AEP event	1 in 100 year return period event
1.33% AEP event	1 in 75 year return period event
2% AEP event	1 in 50 year return period event
10% AEP event	1 in 10 year return period event

1. Executive summary

1.1. Introduction

Oxford has developed around the River Thames and sits at the confluence of 7 rivers draining a predominately rural catchment area of approximately 3000km^2. The River Thames is generally slow to respond to rainfall and floods are long in duration. The floodplain narrows significantly immediately downstream of Oxford which increases flood levels through the city which has been exacerbated by historical development. The channels and structures that cross the river do not have sufficient capacity to allow the flood water to flow through, even for smaller, more frequent, floods.

The River Thames and its tributaries at Oxford have a large developed floodplain without flood defences. If nothing was done to manage flood risk, approximately 2,500 properties would be at risk in a flood that has a 1 in 100 (1%) annual risk of occurring. The Environment Agency's existing flood risk management activities reduces this but around 1,500 properties still remain at risk. This proposal will reduce the likelihood of flooding for all of these properties, with over 1,200 benefiting from a standard of protection greater than a 1 in 100 (1%) annual risk of flooding on opening. If we don't take action the impacts of climate change means that 3,431 properties will be at flood risk in 50 years' time in the same event.

Critical infrastructure is at risk and traffic disruption is a significant problem during floods, particularly along main arterial routes into the city centre – principally Botley Road and Abingdon Road and the railway line, which forms a key part of the strategic freight network. Once the roads close, traffic quickly builds up back to the A34, which stops traffic movement around the city. The impact on transport links and property, combined with the long duration of flooding brings Oxford to a standstill. In addition to the direct damages it also has the result of reducing investment, limiting growth opportunities and therefore has a much wider impact on the city of Oxford than just the floodplain.

Following successive floods a local partnership was formed to initiate a project to protect Oxford from the most frequent floods and to ensure it continues to thrive. It set challenging objectives to reduce flood risk to homes and businesses, to keep transport links open, to safeguard Oxford's reputation as being open for business and to enhance environmental and recreational opportunities.

This Outline Business Case has developed the shortlisted options from the Strategic Outline Case, which focus on improving the flow capacity of the floodplain. This is in line with the strategic approach for this area. It identifies **option 5b** – a medium sized channel and associated defences – as the **preferred economic choice**, delivering a **net present value** of **£1 billion** and a **benefit:cost** ratio of **10:1**.

The scheme, including development costs is forecast to **cost £121.11 million**. This total includes £116.36 million of design and construction costs and £4.75 million as a commuted sum for the first 10 years of maintenance. Risk has been allowed for in the estimates and is 32.2% of the remaining design and construction cost. Significant partnership funding of £51.05 million has been secured, with £4.35 million in the final stages of agreement. When the present value is entered into the partnership funding calculator the project achieves an **adjusted partnership funding score of 100%**.

The delivery approach for the main construction contract will be via the Water and Environmental Management Framework. This framework has been developed specifically to deliver best value flood and coastal risk management projects. Construction duration is estimated to be 3 years and will deliver an operational scheme by August 2021.

This Outline Business Case seeks approval to develop the Full Business Case. The Full Business Case will procure the value for money solution, set out the contract for the deal and set out the detailed management arrangements for the delivery and operation and maintenance phases. This will be the final control point before entering into a delivery contract. This will bring the total development cost of the project to £11.9 million and includes £2.3 million risk contingency.

1.2. Strategic case

1.2.1. Strategic context

The Government enacted the Flood and Water Management Act in 2010, partly in response to the impacts of the severe flooding in July 2007 when hundreds of thousands of people were affected and billions of pounds of damage were caused. The act created new roles for Regional Flood and Coastal Committees and Lead Local Flood Authorities, as well as additional duties for the Environment Agency. Oxfordshire County Council fulfils the role of Lead Local Flood Authority for Oxford. The Oxford Flood Alleviation Scheme Sponsoring Group was set up in response to repeated flooding.

Defra has specific policies on reducing the threats of flooding and adapting to climate change. How schemes contribute towards delivering these policies is measured using a series of Outcome Measures. Outcomes monitored include economic benefits delivered, properties moved into a lower flood risk category and water framework habitat improved.

The Environment Agency and its partners have duties under the European Union's Water Framework Directive, 2000. This ensures that a sustainable approach is taken to water resources and aquatic ecosystems when managing flood risk, and wider environmental and social benefits are delivered to local communities.

The Thames Catchment Flood Management Plan provides the high level strategic context in which to promote the partnership scheme. The Thames Catchment Flood Management Plan states that "the actions recommended in the Oxford Flood Risk Management Strategy should be delivered". Oxfordshire County Council has produced a Local Flood Risk Management Strategy. This supports the Oxford Flood Alleviation Scheme proposals.

The Oxford Flood Risk Management Strategy was approved in September 2010, following a public consultation, and describes the Environment Agency's preferred approach to managing flood risk in Oxford over 100 years. This is a strategic plan for phased work to reduce flood risk and respond to the potential impacts of climate change.

The Environment Agency has completed the first phase of this strategy with local improvements. £2.5 million has been invested increasing into the capacity of channels and structures and providing temporary defences. This work helped to reduce flooding in the most recent floods.

The second phase describes increasing the flow capacity of the channels in the floodplain. The final phase is upstream flood storage, taking into account the reduced effectiveness of the new channel caused by the effects of climate change.

The 2 later phases were not economically preferable when the strategy was developed. A 5 year review of the options and updating the modelling has changed this thinking. New modelling supports the observation that floods are becoming more frequent. The latest guidance on climate change has also been incorporated. The Strategic Outline Case demonstrated that phase 2 of the Oxford Flood Risk Management Strategy can now be promoted. This Outline Business Case identifies the preferred option for improved flow capacity.

1.2.2. The case for change

Oxford has experienced repeated flooding in recent years. Properties were flooded in 7 of the years between 2000 and 2014.

Flooding causes property damage to homes and businesses, damages critical infrastructure and mains sewers and cuts off road and rail links. Flooding in Oxford is long lasting, typically 7 to 9 days. This duration of flooding to key roads brings Oxford to a standstill, devastates Oxford's residents and businesses and reduces investor confidence, limiting Oxford's future growth opportunities. Flooding has a much wider impact on Oxford than just the area in the floodplain.

The cumulative impacts of significant flooding in the winter of 2012, followed immediately by serious flooding in winter 2013/14, demonstrated that the problem was getting worse and would continue to harm the delivery of partners strategies. This resulted in Oxfordshire County Council, Oxford City Council, Vale of White Horse District Council, Oxfordshire Local Enterprise Partnership, Thames Water, the University of Oxford, the Oxford Flood Alliance, the Thames Regional Flood and Coastal Committee and the Environment Agency joining together to drive the scheme forwards. This culminated in the formation of a formal partnership Sponsoring Group and a commitment from all to deliver the Phase 2 recommendation from the Oxford Flood Risk Management Strategy.

The Government has set a target to reduce flood risk to 300,000 homes as part of the 6 year capital investment programme, a clear objective to demonstrate stronger partnership working. It has a target to bring in £600m in partnership funding across the wider programme.

The support by local partners to address the long term flood risk in Oxford provides an opportunity to deliver the Oxford Flood Risk Management Strategy.

1.2.3 Objectives

The high level partnership objectives and sub-objectives for the project are to:

1. Reduce flood damages to at least 1,000 homes and businesses currently at risk in Oxford.
    - By July 2022, move at least 1000 homes to a lower National Flood Risk Assessment (NaFRA) risk category. Noting all properties will see a reduced likelihood of flooding.
    - By July 2022, reduce the number of commercial properties that suffer damages in a 1 in 100 (1%) annual risk flood outline by at least 100.
    - By July 2022, ensure that temporary defence deployment plans are in place, where suitable, for areas of residual risk after the scheme is completed.
2. Reduce flood impacts on transport infrastructure and utilities in Oxford, particularly to the Botley and Abingdon Road, the railway line and the sewerage service.
    - By July 2022, the Botley Road, Abingdon Road, sewerage service and railway line will not be at risk from a river flood up to the size of that seen in 2007.
3. Safeguard Oxford's reputation as a thriving centre of commerce that is open for business.
    - By July 2022, reduce the risk of flooding to at least 40 utility infrastructure assets at risk of flooding.

- By July 2022, improve the potential for growth by reducing the flood risk to 5 hectares of industrial land with redevelopment potential.

4. Create and maintain new recreational amenities, wildlife habitat and naturalised watercourses accessible from the centre of Oxford.
    - By July 2027, create a net increase of at least 5ha of water-dependant habitat that meets the objectives of the Water Framework Directive.
    - By July 2022, create at least 2km of naturalised watercourses.
    - By July 2022, improve at least 2km of accessible paths within the scheme area.

A more detailed set of critical success factors, defining how the objectives need to be achieved, are explained within the main economic case. It is a requirement of all options to be complementary to any future investments to mitigate climate change impacts.

Constraints and dependencies

The Oxford Flood Alleviation Scheme is not dependent on the delivery of other works in the 6 year capital investment programme. The following constraints have been identified in the development of the preferred option.

Constraint	Details
CPO requirements	To initiate the Compulsory Purchase Order (CPO) in line with the project programme, full funding needs to be secured by August 2017.
Consents and authorisations	The central portion of the floodplain near Redbridge is very constrained with complex road and rail infrastructure, Redbridge Recycling Centre, Redbridge Park and Ride and high voltage overhead and underground cables. Consents will be required from Network Rail, the relevant local authorities and utility operators before work can be done on, or adjacent to, their assets.
Funding time constraint	The Oxfordshire Local Enterprise Partnership funding has to be spent by March 2020.
Materials management constraint	Any option that involves significant earthworks is best undertaken between 1 April – 31 October, constraining the construction programme

Table 1-1 – Main constraints

Strategic risks

We have produced a detailed risk register and it has been quantified in monetary terms. This is explained in detail in the management case. As well as the quantified risks there are 3 key strategic risks.

Risk	Mitigation	Owner
Full funding not secured by critical project dates. Certainty of funding is required in order to serve the CPO notices in August 2017.	Funding strategy developed and approved by the Sponsoring Group which includes a funding contingency plan.	Funding and Benefits Realisation Manager
Downstream flood risk. There is a perception in the wider public that flood schemes pass the problem onto other communities. This creates a risk around public acceptance of any proposal.	Hydraulic model has been independently reviewed by Capita with a further academic review undertaken by Vale of White Horse District Council's	Strategic Engagement Manager

	consultants. There is no increase in risk. Detailed pro-active communications plan being delivered.	
Planning or CPO inquiry required. If the planning application gets called in or lands cannot be negotiated in time a planning or CPO inquiry could result in a 12 month delay.	Planning officers group established and agreement to follow a single determination agreed. Detailed lands discussions via land agent. Detailed engagement plans being delivered.	Project Executive
Programme delays lead to preferred commercial model not being available. If the programme up to contract award is delayed by more than 10 months the preferred framework will no longer be available.	Peer review of programme has been completed to give confidence in its duration and interdependencies. Plan to use the next generation supplier arrangements if WEM unavailable.	Project Executive

Table 1-2 – Strategic risks

1.3. Economic case

1.3.1. Options considered

The Oxford Flood Risk Management Strategy considered more than 100 options that were developed into the approved strategic approach to flood risk management. This took an adaptive approach to climate change over 3 phases. This allows for flexibility in future investments as interventions can be adjusted in scale and timing depending on the actual climate impacts observed over time.

The project will deliver Phase 2 of the strategy. It considered 14 options for improved flow capacity of the watercourses in Oxford as part of the Strategic Outline Business Case. The Strategic Outline Case refined these to a shortlist of technically viable options. It concluded that a medium sized flood channel in the western floodplain was the preferred way forward.

The Outline Business Case has reviewed and refreshed this short list to include combinations of shortlisted options and varying timescales of implementation. These have undergone a detailed economic appraisal to select the preferred option.

Option Number	Option Name	Description
1	Do Nothing	All existing work ceases. No operation or maintenance of assets or watercourses would take place. Blockages would not be removed.
2a	Do Minimum	Existing assets and watercourse would be maintained but not replaced. The standard of service will decrease over the appraisal period.
2b	Do Minimum (Sustain)	Existing assets and watercourses would be maintained and replaced. The standard of service will be maintained over the appraisal period.
3	Raised Defences	Localised raised defences and level for level compensatory storage.
4a	Small Channel	Excavation in the undeveloped floodplain to the west of the city centre to provide increased flood flow capacity of 18 cubic metres per second.
4b	Medium Channel	Excavation in the undeveloped floodplain to the west of the city centre to provide increased flood flow capacity of 38 cubic metres per second.
5a	Small Channel + Defences	Small channel with the addition of raised defences to provide increased protection to properties and the Abingdon Road.
5b	Medium Channel + Defences	Medium channel with the addition of raised defences to provide increased protection to properties and the Abingdon Road.
6a(i)	Small Channel + Defences + Flood Storage (in year 0)	Small channel plus defences with the implementation of a 9.8m m^3 upstream flood storage area at the same time as the flood channel and defences.
6a(ii)	Small Channel + Defences + Flood Storage (in year 20)	Small channel plus defences with the implementation of a 9.8m m^3 upstream flood storage area 20 years after the flood channel and defences.

6a(iii)	Small Channel + Defences + Flood Storage (in year 50)	Small channel plus defences with the implementation of a 9.8m m^3 upstream flood storage area 50 years after as the flood channel and defences.
6b(i)	Medium Channel + Defences + Flood Storage (in year 0)	Medium channel plus defences with the implementation of a 9.8m m^3 upstream flood storage area at the same time as the flood channel and defences.
6b(ii)	Medium Channel + Defences + Flood Storage (in year 20)	Medium channel plus defences with the implementation of a 9.8m m^3 upstream flood storage area 20 years after the flood channel and defences.
6b(iii)	Medium Channel + Defences + Flood Storage (in year 50)	Medium channel plus defences with the implementation of a 9.8m m^3 upstream flood storage area 50 years after the flood channel and defences.

Table 1-3 – Summary of options

1.3.2. Key findings

Option 5b "Medium Channel + Defences" is the preferred and most economically advantageous option based on having the highest Net Present Value, i.e. the option that delivers the greatest economic return in monetary terms. The economic decision tree, via incremental cost benefit ratios, also supports the selection of this option. The decision tree is explained in full in the main economic case.

Option Number	1	2a	2b	3	4a	4b	5a	5b	6a(i)	6a(ii)	6a(iii)	6b(i)	6b(ii)	6b(iii)
PV Costs	0.0	11.2	14.9	64.1	94.7	107.8	98.5	111.2	175.8	138.7	113.7	188.6	151.5	126.4
PV Benefits	0.0	915.6	931.5	1,001.7	1,041.1	1,084.8	1,077.4	1,112.4	1,117.6	1,105.7	1,091.3	1,135.3	1,128.7	1,120.9
Residual damages	1,221.8	306.2	290.3	220.1	180.7	137.0	144.4	109.4	104.1	116.1	130.5	86.4	93.0	100.9
Net Present Value	n/a	904	917	938	946	977	979	1,001	942	967	978	947	977	994
BCR	n/a	81.8	62.6	15.6	11.0	10.1	10.9	10.0	6.4	8.0	9.6	6.0	7.5	8.9

Table 1-4 - Economic appraisal summary (all costs and benefits in £ millions)

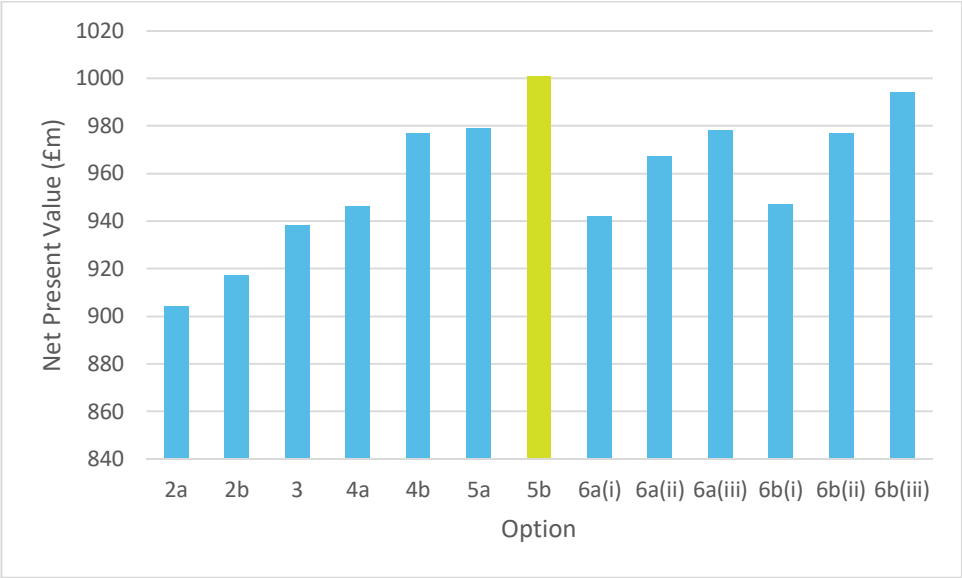


Figure 1-1 – Net present value identifying the preferred option

A detailed multi-criteria analysis, informed by extensive public consultation and stakeholder engagement, developed the options and ensures the preferred option presents the best balance of technical, environmental and social needs.

A Preliminary Environmental Information Report and Water Framework Directive assessment is informing the detailed design of the preferred option. The results demonstrate that there are no major environmental issues and the scheme will deliver an overall net increase in wildlife habitat. The main environmental enhancements will be wetland scrapes, backwaters and small ponds. We will create gravel riffles to improve fish breeding habitats. Overall these enhancements will improve the range of habitats available whilst being in-keeping with the wider landscape scene.

1.3.3. Preferred option

The preferred option identified through the economic appraisal in this Outline Business Case is **Option 5b "medium channel and defences"**. The summary economic information for this option is:

Present Value Costs (PVC)	£111.2 million
Present Value Benefits (PVB)	£1,112.4 million
Net Present Value (NPV)	£1,001.2 million
Benefit Cost Ratio (BCR)	10.0

Table 1-5 – Preferred option economics

Sensitivity tests were applied in a series of cost increase and/or benefit decrease scenarios. Option 5b remains the preferred option in all tests.

The preferred option will provide a reduction in flood risk to all properties at risk in Oxford with 1,157 residential properties moving to a lower flood risk band immediately after implementation. The impacts of climate change are expected to reduce this benefit over time. However, the increase in flood risk without the scheme would be even more significant. Without the scheme the number of properties at flood risk would rise to 3,431.

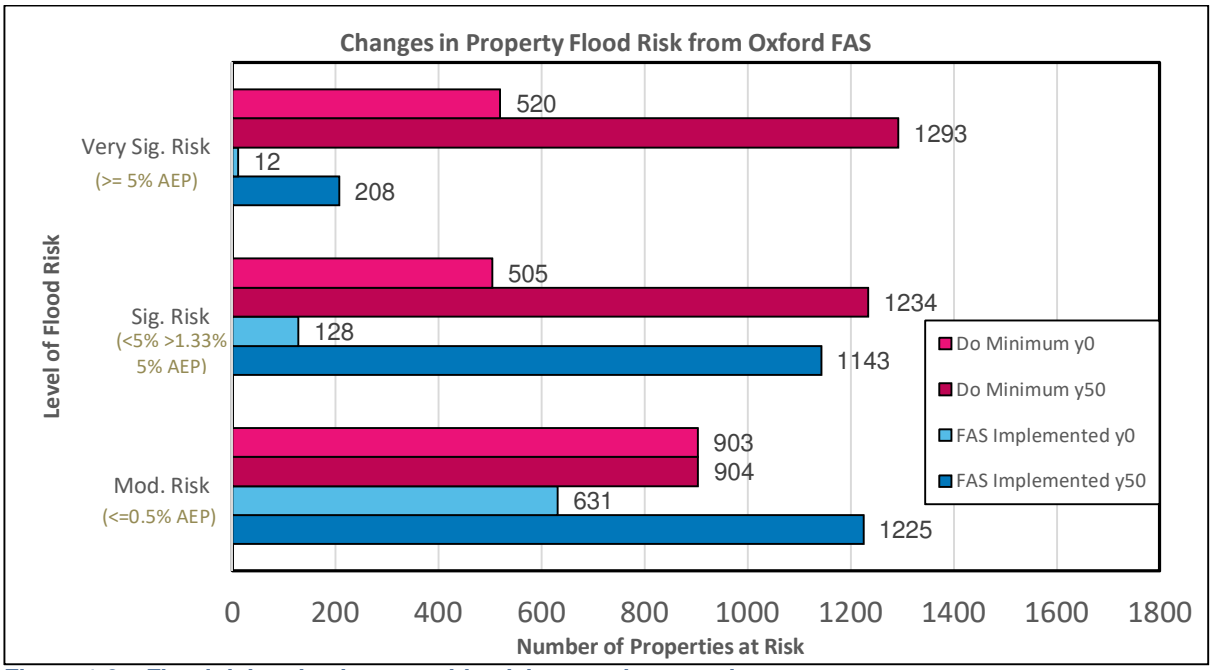


Figure 1-2 – Flood risk reduction to residential properties over time

The findings are consistent with the Oxford Flood Risk Management Strategy's adaptive approach to climate change. Following the implementation of Option 5b "medium channel and defences" as Phase 2 of the Oxford Flood Risk Management Strategy, a future investment decision will be needed on the delivery of Phase 3 of the strategy. Delivery of upstream flood storage is not forecast before 2070, but will be reviewed at 5 yearly periods.

The project is eligible for £62 million of present value Flood and Coastal Risk Management Grant in Aid funding. It has a raw partnership funding score of 54% and requires £53.4 million in present value contributions to be fully funded. This raw economic output is then turn into real cash values for the financial case.

The "medium channel and defences" option has strong public and partner support and will deliver the requirements of the main objectives and sub-objectives, set by the Sponsoring Group. This is a robust economic choice, which is recommended to be progressed to the Full Business Case.

1.4. Commercial case

1.4.1. Procurement strategy

The scheme includes the design and construction of a 5km, 2-stage flood channel, incorporating 6 bridges and 3 major culverts. Major earthworks including excavation, transportation and disposal of 400,000m^3 of topsoil, alluvium and gravels are required. The earthworks and culvert works represent more than half the overall construction cost.

Delivery model

The Oxford Flood Alleviation Scheme benefitted from an Infrastructure and Projects Authority (IPA) Routemap workshop in early 2016 and follow up discussions on the commercial approach with the IPA. The approach to the commercial case and procurement strategy builds on the recommendations identified in this review. In-depth market analysis and engagement has been completed in response to this, together with the development of efficient materials management strategy. The need for targeted market sounding was identified early in the IPA review and has brought significant value to the commercial approach. We have consulted suppliers in detail and they have confirmed their ability and capacity to deliver the project. We have shared our thinking about the commercial model and sought detailed feedback to help shape our approach.

The Environment Agency has an existing accessible framework which has been selected through the Official Journal of the European Union (OJEU) process. This is specifically for work within the 6 year capital investment programme, that the Oxford Flood Alleviation Scheme is a part of. It has been hugely successful in delivering best value for the organisation. The organisation has also developed alternative approaches such as the model for long term asset refurbishment through TEAM2100. The project team have considered a wide range of delivery models within the procurement strategy to ensure that best value is being achieved:

- a bespoke Official Journal of the European Union (OJEU) procurement
- use of the Scape framework
- use of the Water Environment Management framework
- use of a Public Private Partnership arrangement (Design, Build, Fund, Operate / Maintain)

All of the options have their own advantages and disadvantages and the procurement strategy concludes that the Water Environment Management Framework (WEM) offers the best commercial approach for delivering the Oxford Flood Alleviation Scheme. The principle benefits are:

- low procurement costs
- the ability for early benchmarking
- use of the project cost tool
- a short duration tender process
- strong existing relationships that can help us secure the best team
- a well-established culture and ways of working
- A strong focus on driving performance

The end date of the WEM contract has been identified as a strategic risk and mitigation measures are explained in the strategic case summary. The procurement strategy has been peer reviewed and endorsed by Clare Marsden, Head of Defra Group Commercial.

Future maintenance

Annual maintenance cost estimates for the wider Oxford flood risk management system, after the scheme is in place, total £270,000 per year. The design of the Oxford Flood Alleviation Scheme relies on passive operation to ensure limited intervention is required in times of flood, minimising operational costs. The majority of the annual expenditure will be on vegetation management within the channels.

The maintenance is relatively low risk and low value from a commercial perspective. In the Outline Business Case maintenance has been assessed as being the responsibility of the Environment Agency. However, scope for additional cost savings and securing long term local support for the scheme, by adopting a partnership approach for this, will be explored. This will not impact the overall commercial approach and will be finalised between Outline Business Case and the Full Business Case. It could, for example, take the form of a maintenance trust.

1.4.2. Key contractual terms and risk allocation

Key contractual terms

Contractual terms will be the Type C Target Cost model from the New Engineering Contract suite of contracts, as modified under the Water Environment Management Framework Deed of Agreement. We have taken a proportionate approach to project specific risk and we have held risks that are of low probability but high consequence. In key areas we have taken more risk on the basis of obtaining a greater return from the suppliers.

- Public Inquiry to planning or Compulsory Purchase Order is held as an Environment Agency risk and the pricing of this risk by suppliers will be disproportionate to the probability of occurrence.
- Appropriate allocation of flood risk and inclement weather, e.g. earthworks summer flood risk will remain with the Environment Agency to maximise productivity, whilst the risk for dealing with groundwater will remain with the contractors as they are best placed to manage this risk through construction methodology.
- A design and build contract model for the construction of the A423 culverts was selected to drive efficiency, this will require contract drafting to deliver the best result. This will award the design element in line with existing approvals with the construction element award tied into Full Business Case approval.

Risk allocation

The key risks that we have identified and addressed as part of the market sounding approach are:

Risk	Summary	Owner
Planning / Compulsory Purchase Order	Obtaining planning permission and land via Compulsory Purchase Order is complex. We are managing the risk by gaining agreement for a single determination from the 3 Local Planning Authorities and running a Compulsory Purchase Order in parallel with our land negotiations. The risk of delays caused by these is held by the Environment Agency as market sounding established the price for them to take it on would be disproportionate to the likelihood of being realised.	Environment Agency
Earthworks	The earthworks are a significant element of the overall construction cost. The methodology for excavation, transport and removal is key to efficient delivery. However, delivery of earthworks operations are susceptible to	Shared

	ground conditions and the weather. The risks have been allocated as: Weather risk – shared as per the New Engineering Contract, Engineering and Construction Contract Winter flood risk – Contractor Summer flood risk – Environment Agency Groundwater impacts on construction - Contractor	
Major structures	2 culverts are needed under the A423 Southern Bypass. Having undertaken detailed market sounding these will be completed by a separate design and build contract. Risk for these will sit with the contractor.	Contractor
Contaminated land	There are known contaminated land areas at Redbridge landfill site. The design risk for containment and disposal of hazardous waste will be managed by the consultant.	Consultant
Archaeology/ heritage	Discussions have been held with Historic England, Oxfordshire County Council Archaeologist and the Oxford City Council Archaeologist. Requirements have been incorporated into the archaeological investigations work. The risk of impacts from unforeseen archaeological finds remains with the Environment Agency.	Environment Agency
Unidentified Services	There are several known services running across the site that have been positively identified and where necessary, diversion has been proposed in the design. Impacts to design/construction programme from any unidentified services will remain with the Environment Agency.	Environment Agency

Table 1-6 – Contractual risk allocations

Timescales

The procurement timetable for the Oxford Flood Alleviation Scheme is:

Activity	Date
Completion of works information and tender documents	December 2017
Tender issue and evaluation	January 2018 – April 2018
Award recommendation and approvals (including instruct A423 culvert contractor led design element)	April 2018
Full Business Case approval & contract award	September 2018

Table 1-7 – Procurement timetable

1.4.3. Efficiencies and commercial arrangements

Commercial arrangements

Managing risk at this early stage ensures we can reduce risk contingency and drive competitive supplier pricing by agreeing a fair and proportionate risk share. This approach is the most appropriate way to drive efficiency and is supported by the supply chain.

Within our commercial approach we will take measured risks to deliver benefits. Key decisions made to drive efficiency are:

- selection of the Water Environment Management framework to reduce tender timescale and cost, compared to other procurement options.
- gaining agreement to award the detail design contract in parallel with the Outline Business Case, reducing overall programme duration.

- targeted, informed market sounding on 'strategic critical' sub-contract areas that represent greatest cost and complexity to the Environment Agency.
- separate design and construction contracts for the wider scheme, modified to incorporate design and build for the A423 Southern Bypass culverts.
- designed ground investigation scope with the input from tier 1 and tier 2 suppliers to provide the information for detailed risk mitigation.
- taking on low probability, high consequence risks to allow greater innovation and investment in productivity from the supply chain.

Efficiencies

In addition to the commercial approaches listed above there are 3 areas that our risk based approach to project delivery has achieved significant efficiencies. These are summarised as:

Item	Description	Saving
Network Rail culverts	In the Strategic Outline Case we identified the need to improve flow capacity under the railway line. Network Rail had already scheduled a closure of the railway line as part of their electrification upgrades in 2016. We secured additional approval for a 'spend now, save later' opportunity and Network Rail installed these as part of their contract and line closure. This cost the partnership £1 million and would have cost £4 million if done separately, resulting in a £3 million efficiency.	£3 million
Critical review of preferred option	During the development of the outline design, using new survey and model information, we identified that a raised defence (embankment) in the Abingdon Road area could provide greater benefits than the channel section at Sandford proposed in the Strategic Outline Case. By switching design approach we have reduced the amount of material that needs to be removed as well as enabling other earthworks material to be reused on site in the embankment.	£8.1 million
Materials management	At the Strategic Outline Case stage all excavated materials generated on site were to be taken to landfill. We have carried out detailed site investigation and developed a materials management plan that means most material will go to restoration sites, only the contaminated material will go to landfill. This reduces the potential landfill tax costs to the scheme.	£2.2 million

Table 1-8 – Significant efficiencies secured

As well as these large efficiencies, smaller efficiencies have been captured, including those made by working collaboratively in partnership. The project team will continue their approach to realising innovative and creative opportunities to make further savings.

1.5. Financial case

1.5.1. Summary of financial appraisal

The base cost profile used as the basis for this financial case is the same as in the Economic case for design, construction and maintenance post scheme completion. However, the Financial case excludes the current maintenance expenditure up until scheme completion, as the funding for this is already committed through Environment Agency revenue allocations.

The cost profile is baselined to 2016/17 prices and exclusive of VAT. The combined risk allowance is 32.2% of the remaining design and construction costs of the scheme. This is a combination of P95 mean expected value risk and optimism bias.

Inflation (at 2.5%) has been applied compound from a baseline year of 2017/18. Inflation has not been applied for 2016/17 or 2017/18 as the costs for these years are either fixed already under contracts or take into account current market prices.

There are also a series of River Thames locks and weirs in the benefit area. As these assets have a wider base of beneficiaries (such as the boating community) we have assigned 50% of their maintenance costs within this business case to allow for their flood risk management function. When future work is required on these assets additional contributions from the wider beneficiaries will need to be secured.

As part of the approval of the Strategic Outline Case the principle of providing initial funding for a reduced maintenance period was agreed. We have gained support from Defra, Infrastructure and Projects Authority (IPA) and Her Majesty's Treasury to work to an initial maintenance period of 5-10 years to demonstrate longer term affordability. This is in line with other major infrastructure projects. This is shown as being funded up front as a commuted sum.

	Sunk costs	17/18	18/19	19/20	20/21	21/22	22/23	10 Year maintenance period*	Total
Base Cost	6.17	4.95	12.45	29.1	21.2	9.5	1.53		84.90
P95 Risk	-	0.34	2.9	5.95	4.66	2.08	-		15.93
Optimism Bias	-	0.59	1.5	3.49	2.54	1.14	0.19		9.45
Inflation (2.5%)	-	-	0.41	1.95	2.18	1.32	0.22		6.08
Maintenance	-	-	-	-	-	-	-	4.75	4.75
Total (£ million)	6.17	5.88	17.26	40.49	30.58	14.04	1.94	4.75	121.11

*as a commuted sum

Table 1-9 – Financial cost profile

In summary the total scheme cost is £121.11 million. This includes £116.36 million for design and construction and £4.75 million commuted sum for maintenance.

1.5.2. Funding sources

Substantial partnership funding contributions of £51.05 million have been secured towards the scheme, with a further £4.35 million in the final stages of agreement. The overall funding position is summarised as:

	Sunk costs	17/18	18/19	19/20	20/21	21/22	22/23	10 Year maintenance period	Total
Total funding need	6.17	5.88	17.26	40.49	30.58	14.04	1.94	4.75	121.11
FCERM GIA	3.61	4.0	5.62	16.63	24.59	7.15	1.5	2.61	65.71
Thames RFCC – local levy	0.78	1.05	1.0	4	3.75	3.42	-	-	14.00

Growth deal funding (SEP)	-	-	7.5	18.35	-	-	-	-	25.85
Oxfordshire County Council contribution	1.05	0.45	5	-	-	-	-	-	6.5
Oxford City Council contribution	0.73	0.38	0.39	1.0	-	-	-	-	2.5
Thames Water	-	-	-	2.2	-	-	-	-	2.2
High likelihood Contributions				1.35	3				4.35
Total funding secured	6.17	5.88	19.51	43.53	31.34	10.57	1.5	2.61	121.11
Cumulative balance of funding	-	-	2.25	5.29	6.05	2.58	2.14	0.00	0.00

Table 1-10 – Funding profile (all costs are in £ million)

Funding status

The status of the current partnership contributions is summarised as:

Driver for investment	Contributor	Amount	Status
Local choices FCRM	Thames RFCC	£14.00m	Confirmed
Future Economic growth	LEP Growth Deal	£25.85m	Confirmed
Local economic and social benefits – transport resilience (roads)	Oxfordshire County Council	£6.5m	Confirmed
Local economic and social benefits – transport resilience (roads)	Oxford City Council	£1.5m £1.0m (land benefit in kind)	Confirmed Agreement in principle
Utility Resilience	Thames Water	£2.2m	Agreement in principle
	Total Contributions secured	**£51.05m**	

Table 1-11 – Agreed contributions summary

Conditions on funding

The only restriction on the timing of contributions is the use of the Oxfordshire Local Enterprise Partnership Growth Deal funding, which must be used on capital construction work in 2018/19 and 2019/20.

Ongoing negotiations

Our dedicated Funding and Benefits Realisation Team are in the process of negotiating additional contributions from a wide range of contributors. These are detailed in full within the funding strategy negotiating plan. High likelihood contributions have been included in the funding table as there is a reasonable expectation that these will be secured. Moderate and low probability

contributions are still being actively pursued and we aim to secure the maximum possible amount towards the scheme throughout the Full Business Case stage.

Driver	Contributor	Potential Amount	Likelihood of being secured
Economic growth - redevelopment	University of Oxford	£3m	High
Utility resilience	Thames Water (additional)	£1.2m	High
Economic growth – business development	Four Pillars Hotel	£0.15	High
	Subtotal high likelihood contributions	**£4.35m**	
Additional negotiations in progress but not required to demonstrate affordability			
Infrastructure resilience	Network Rail	£1m	Moderate
Utility resilience	SSE	£1m	Moderate
Operational resilience	BMW	£0.5m	Moderate
Economic growth	John Lewis Partnership	£0.5m	Moderate
Transport resilience	Oxford Bus Company	£0.02m	Moderate
Transport resilience	Stagecoach	£0.02m	Moderate
Utility resilience	BT Openreach	£0.01m	Moderate
	Total all potential contributions	**£7.4m**	

Table 1-12 – Ongoing negotiation summary

1.5.3. Overall affordability

The progress that the project has made on partnership funding so far is a success with £51.05 million secured towards its construction and maintenance. Including the high likelihood contributions, the adjusted partnership funding score is 100%.

The project will therefore be fully funded when the high likelihood contributions are confirmed. This includes carrying forward £2.14 million in contributions to cover shared commuted sum financing of the maintenance period.

A number of approaches are being pursued to address this. The Funding and Benefits Realisation Team are continuing to deliver their funding strategy and negotiation plans. The high likelihood contributions will secure an additional £4.35 million towards the scheme.

The Project Delivery Team are investigating options for innovative materials management approaches. These are expected to improve the baseline cost of all material off site to restoration sites. A value engineering exercise will be completed once the detailed design is developed.

The project will be at risk if we do not continue to proceed with it. Delaying the programme would result in losing the time bound growth deal funding (£25.8 million) and the other major contributions, as these have been secured on the basis of having an operational scheme by 2022.

8.5% of the £600 million contributions target for the entire capital investment programme will be delivered through this project. Not proceeding now will put our contribution towards this important organisational target at risk.

Full funding, either by securing the remaining contributions or through efficiency savings, will need to be secured by August 2017 in order to be ready for the Compulsory Purchase Order submission.

The scheme is strong economically (benefit:cost ratio BCR 10:1, Net Present Value £1 billion), will deliver a step change in risk reduction (to 1,157 residential properties when it opens), will remove barriers to growth and re-development and will protect and enhance the environment and provide enhanced recreational opportunities. It will leave a lasting legacy in Oxford and cement the partnership approach we have taken in developing it.

Given the strong performance to date by the team in both securing contributions and efficiency savings, the skills and expertise within the project team and the very strong partnership approach, we believe that continuing would only leave a small exposure to Grant in Aid funding within the 6 year capital investment programme. Continuing at this point with £4.35 million of high likelihood contributions pending final agreement is considered to be a low risk approach. This exposure is equivalent to 3.6% of the project cost which includes more than 30% in risk allocation.

1.6. Management case

1.6.1. Project management

The Oxford Flood Alleviation Scheme follows a PRINCE 2 methodology and is set up to achieve the 'management by exception' principles. Governance is via a Sponsoring Group, Programme Board and Project Board. All 3 groups include partnership representation.

Project governance groups

Overall approval of the proposal rests with Her Majesty's Treasury who will make the final investment decision. Gaining this approval will be supported by the Accounting Officer of Defra and the Accounting Officer of the Environment Agency, following a robust assurance process. This is explained in full in the assurance and approvals section within this management case.

Governance is directed at a project level by the Sponsoring Group which comprises senior managers, who have responsibility for setting the strategic direction, defining business direction, and ensuring the strategic fit of the project within their respective organisations. They have sufficient delegated authority to make decisions on behalf of their organisation.

Partners in the Sponsoring Group have signed a memorandum of understanding. This was updated in December 2016, to ensure that it is aligned to the next phase of delivery. The Sponsoring Group meets approximately every 4 months and is chaired jointly by the Environment Agency's Thames Area Director and Oxfordshire County Council's elected Cabinet Member.

The Programme Board drives the project forward to deliver the outcomes and benefits within the tolerances set by the Sponsoring Group. It is chaired by the Project Director. The Programme Board meet approximately every 2 months. Key issues are dealt with in between these times by correspondence.

The Project Board is chaired by the Project Executive. It is responsible for reviewing issue reports before they are escalated to the Programme Board.

We have agreed tolerances at each governance level. This means that each group understands their level of empowerment and when to escalate risks and issues.

Project team roles and responsibilities

Overall accountability lies with Sir James Bevan as the Accounting Officer for the Environment Agency. Ken Allison, Environment Agency National Flood and Coastal Risk Management Director of Allocation and Asset Management, and graduate of the Major Projects Leadership Academy is the projects' Senior Responsible Owner. The project team is led by Joanna Larmour, Project Director, who has completed the Cabinet Office Project Leadership Programme, is a Registered Project Professional and a Member of the Association for Project Management.

Joanna is supported by a leadership team comprising of the Project Executive, Funding and Benefits Realisation Managers, Strategic Engagement Manager and Assurance and Approvals Manager. Specialist skills from bought in services are embedded within the team to ensure the team has the right mix of skills at the right time.

The team is supported by a resource management plan that sets out the detailed requirements for the next phase (Outline Business Case to Full Business Case) and covers outline arrangements, including transitions through to post project closure activities. The team operate from a dedicated

major projects hub in the Environment Agency's Reading office and suppliers work alongside them there.

Project plan

The project plan, or schedule, has been developed by the project planner. The master programme pulls together individual workstream programmes and includes all main links and interdependencies to identify critical path activities. Progress is monitored at monthly progress

meetings. Workstream leads attend to ensure that issues can be assessed and corrective action is taken.

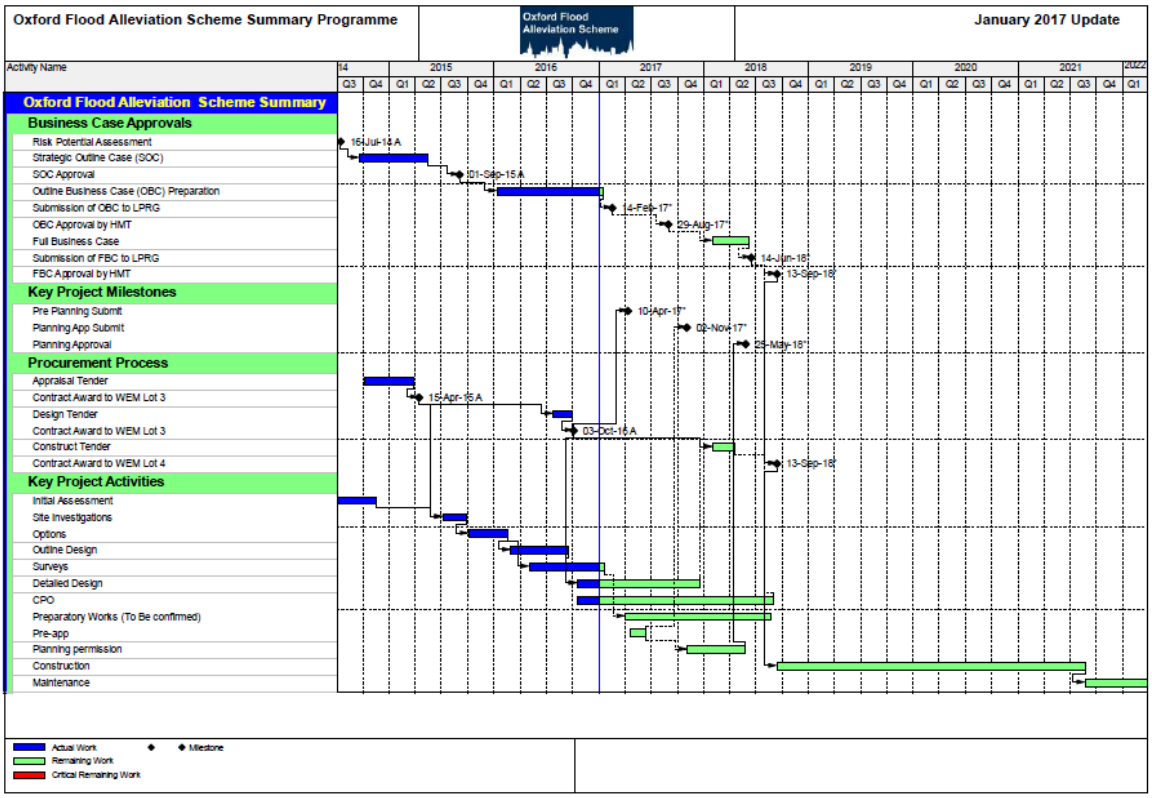


Figure 1-3 – High level programme summary

Task	Milestone
Outline Business Case submission	22 February 2017
Pre-planning application submission	10 April 2017
Outline Business Case approved	8 September 2017
Full planning application submitted	2 November 2017
Detailed design complete	23 November 2017
Construction tender issue	22 September 2017
Planning application approved	25 May 2018
Construction tender evaluation complete	17 April 2018
Full Business Case submission	14 June 2018
Full Business Case approved / contract award	13 September 2018
Construction start	12 October 2018
Construction end and gateway 4	25 August 2021

Table 1-13 – Key milestones

To achieve the programme there are 2 items to note. The first is that a separate approval needs to be gained to let a preparatory works contract prior to the Full Business Case approval. In line with

our previous approvals we will engage early with approvers and have our proposals assured via the Environment Agency Large Projects Review Group, prior to submission.

The second is to agree a 12 week assurance and approvals schedule for the Full Business Case. This has been achieved previously with the Thames Estuary Phase 1 Programme. The schedule would be developed and agreed on the basis of the construction contract falling within agreed tolerances, and engagement with reviewers and approvers about other aspects of the Full Business Case which are not reliant on the final agreed tender price, would be scheduled prior to this 12 week period.

Stakeholder engagement

Communications and engagement has been integral to the scheme from the start and will continue throughout the development of the scheme. By fully embracing the Environment Agency's 'working with others' philosophy, we are developing a scheme in collaboration with partners and stakeholders that is making our scheme objectives a reality.

Stakeholder management

We analyse stakeholders using the 4-box grid methodology which groups stakeholder into inform, monitor, consult, and involve categories. We store this information in our stakeholder database.

We hold a stakeholder analysis workshop twice a year with the project team and partners to ensure stakeholders are in the correct category and the project team are focussing their effort proportionately with them. The outputs from these workshops are used as a basis for engagement planning across the subsequent 6 months.

Communications strategy, plans and communications channels

Our communications and engagement approach ensures consistent messages across the partnership. This includes a Communications and Engagement Strategy that details pro-active and reactive communications approaches.

We produce detailed communications and engagement plans for specific pieces of work that deliver the proactive engagement objectives, such as public consultations. Each plan includes the business objective; engagement objectives; milestones; key messages; key stakeholders; and an action plan. The team evaluate these plans throughout delivery, and at completion, to ensure objectives have been met and lessons learnt are fed into current and future plans.

We have received positive feedback about the communications approaches, and there is widespread support for the scheme overall. We will continue to ask for feedback and use it to shape the communications and engagement throughout the lifecycle of the project.

Through this we have identified the key issues the public have about the scheme. These include concerns about downstream impacts, disruption during construction, and loss of trees. We held a series of focus groups with downstream communities to inform our communications and engagement planning. We are engaging with the public in their local communities, at local events, using the communications tools they have requested. Some people are concerned that the scheme will make flooding worse for them, although there is generally a neutral view to the scheme in downstream communities and the focus is on how the Environment Agency work with them on local flood risk issues.

1.6.2. Benefits realisation

A detailed Benefits Management Strategy and plan sets out how benefits and disbenefits will be managed during the detailed design, delivery and post closure stages of the project. The strategy and plan captures the recommendations from the Infrastructure and Projects Authority routemap

exercise. It describes the scheme's approach to the identification, analysis, tracking and reporting of benefits realisation and the benefits management products that will be used by the scheme.

The Benefits Management Strategy is informed by corporate benefits management guidance from the Environment Agency and partners on the project. All benefits management products are owned by the Funding and Benefits Realisation Manager and changes are approved by the Project Board within their defined tolerances. The benefits management products and process have undergone regular review by the Programme Board and Sponsoring Group. Benefits are captured in the benefits register, which is summarised below:

Ref	Description	Measure	Category	Link to objective
P1	Residential properties suffer less flood damage	1,000 properties move to a lower flood risk band	Economic / Social	1
P2	Commercial properties suffer less flood damage	100 properties will no longer flood in a 1 in 100 (1%) annual flood event	Economic	1
P3	Lower frequency of flooding to Abingdon and Botley Roads	Roads will not flood in a 1 in 20 (5%) annual flood event	Economic / Social	1 & 2
P4	Fewer flood related electricity disruptions	30 substations at lower flood risk	Economic / Social	2 & 3
P5	Improved resilience of broadband network	16 assets at lower flood risk	Economic / Social	2
P6	Lower frequency of flooding to railway line	Lines will not flood in 1 in 75 (1.33%) annual flood event	Economic	2 & 3
P7	Less likelihood of sewer flooding	88 properties at lower risk of sewer flooding from fluvial event	Economic / Social	2 & 3
P8	Opportunity to improve biodiversity	5ha net WFD criteria habitat created	Environmental	4
S1	New riverside environment	2 km of new channel created	Environmental	4
S2	Increased number of people walking and cycling in the area	2 km accessible path created	Social / Environmental	4
S3	Lower frequency of flooding to existing sites with re development potential	5 ha industrial sites removed from 1 in 100 (1%) annual flood event	Economic	4

T1	Lower impact of flood on local economic output	n/a	Economic	1, 2 & 3

Table 1-14 – Benefits register summary

We have produced a benefits map which demonstrates the link between project outputs, delivery of benefits and achievement of the scheme objectives.

Progress updates are reported to the project team in the monthly highlight report. The Programme Board and Sponsoring Group are made aware of any issues with benefits realisation in their meetings and these are escalated as necessary.

1.6.3. Risk management

The scheme's Risk Management Strategy is informed by corporate risk management policies from the Environment Agency and partners on the project. It is owned by the Project Manager and changes are approved by the Project Board. This sets out a 5 step approach of identify, assess, plan, communicate and implement.

Identified risks are captured on the risk register. Response actions are agreed and allocated to named individuals. Risk management progress is included in highlight reports and quarterly risk workshops are held to ensure that the risk register remains current.

The risk register allows for a quantification of the costs associated with each of the risks. Each risk is assessed for a minimum cost, most likely cost and maximum cost. These are estimated using time and resources estimates. The full risk register is then run through a Monte Carlo risk analysis to give a normal distribution of the risk costs. The 50th percentile (P50) and 95th percentile (P95) is then used for economic assessment and financial planning. These are summarised below as their raw baseline values.

Risk Percentile	Expected Value
50th	£11.73 million
95th	£15.93 million

Table 1-15 – Quantified risk summary

Top 5 risks and mitigation by mean expected value (MEV):

Risk	MEV	Mitigation	Risk Owner
Weather event during construction	£3.4m	Restricting earthworks to period between 1 April and 31 October annually.	Richard Harding, Project Executive
Increase in lands costs	£1m	Ongoing dialogue with landowners to reach negotiated settlements.	Michael Thorne – Estates Agent
Planning or Compulsory Purchase Order Inquiry	£0.8m	Continued dialogue with landowners and stakeholders. Early scoping opinions and pre-planning consultations to understand requirements.	Veronica James – Planning Manager

Cumulative impact of risks delaying construction by 1 year	£0.8m	Active programme management and development of detailed preparatory works schedule.	Richard Harding, Project Executive
Material volumes higher than expected	£0.6m	Full topographic survey commissioned and used in 3D earthworks model.	Phil Marsh, Consultant Project Manager

Table 1-16 – Top 5 risks by mean expected value

Optimism bias

In line with Environment Agency assessment guidelines we have reassessed the optimism bias at the Outline Business Case. At the Strategic Outline Case stage it was calculated as being 38%. Within this Outline Business Case optimism bias has been assessed separately for the construction and maintenance periods. This has been calculated at 12% for construction and 5% for maintenance.

Between the quantified risk and optimism bias a total risk allowance of 32.2% is being carried forward in the design and construction costs.

Risk Potential Assessment

The Risk Potential Assessment has been updated as part of the Outline Business Case. There has been no change in the overall classification for the Oxford Flood Alleviation Scheme being medium risk within the national context of major projects.

1.6.4. Assurance, approval and post project evaluation

Due to the value of the project, Her Majesty's Treasury approval is required. At project initiation it was confirmed in discussions with Defra that the scheme would not join the Governments Major Projects Portfolio and external assurance reviews will be managed by Defra as the lead government department.

In order to gain Her Majesty's Treasury approval, the Outline Business Case will undergo internal assurance reviews through the Environment Agency's Large Projects Review Group. This group also undertakes the Accounting Officer's tests report. The business case will also gain the support of the Flood and Coastal Risk Management Committee of the Environment Agency's Board and Defra's Executive Committee (which includes Sir James Bevan, Environment Agency Chief Executive Officer and Accounting Officer, and Claire Moriarty, Defra Permanent Secretary and Accounting Officer) before being submitted to Her Majesty's Treasury for consideration.

A detailed Integrated Assurance and Approvals Plan, which is included as an appendix, has been produced for the scheme which adopts the requirements of the Environment Agency's Integrated Assurance and Approvals Strategy. The key milestones are included within the schemes master programme.

External Gateway Reviews

An external Gateway 1 review was completed in April 2015 as part of the assurance and approval of the Strategic Outline Case submission. The review team found that it is likely the project will achieve its objectives and can be delivered successfully. They also acknowledged that the scheme is being delivered using an exemplar and innovative partnership approach that covers funding and is also achieving public and political support. They gave the project an amber rating with 9

recommendations to consider. This was considered to be a good outcome at the stage of the project. These recommendations have all been addressed prior to the submission of this Outline Business Case.

Future Gateway reviews

A joint meeting was held with the Infrastructure and Projects Authority, Defra and the Environment Agency in January 2017. It was indicated that an external Gateway 2 review is not required for the Oxford Flood Alleviation Scheme. If confirmed, the requirements of the gateway review will be included in the enhanced Large Project Review Group scrutiny of the business case.

Project initiation routemap review

The partnership completed the Infrastructure and Projects Authority routemap review in March 2016. This structured approach explored the timings and interdependencies of the actions that were already identified and further strengthened the likelihood of successful delivery. This culminated in the production of an enhancement action plan with an overall objective of 'committed partners working collaboratively to achieve the scheme objectives with engaged communities'. The full report and progress delivering the actions is included with this submission. Oversight of delivery has been via the scheme's Programme Board.

Post project reviews

The outline arrangements for Post Implementation Review and Project Evaluation Review have been established. These will be carried out at set milestones, followed by defined review periods. The reviews will incorporate team performance, benefits realisation assessment, better information management, asset performance evaluation, and environmental monitoring.

Reviews will be carried out in the spirit of continuous improvement. Outputs from reviews will be added onto the Project and Programme Management Tool lessons learnt database and shared at the Environment Agency Major Projects Community of Practice. This will support continuous improvement in the wider project delivery profession.

1.7. Recommendation

We, the project partners, recommend to Her Majesty's Treasury that the Outline Business Case for the Oxford Flood Alleviation Scheme is approved with the cumulative sum of £11.9 million authorised to be spent in the development of the Full Business Case. This figure includes a contingency of £2.3 million.

The Full Business Case will procure the value for money solution, set out the contract for the deal and set out the detailed management arrangements for the delivery and operation and maintenance phases. This will be the final control point before entering into a delivery contract.

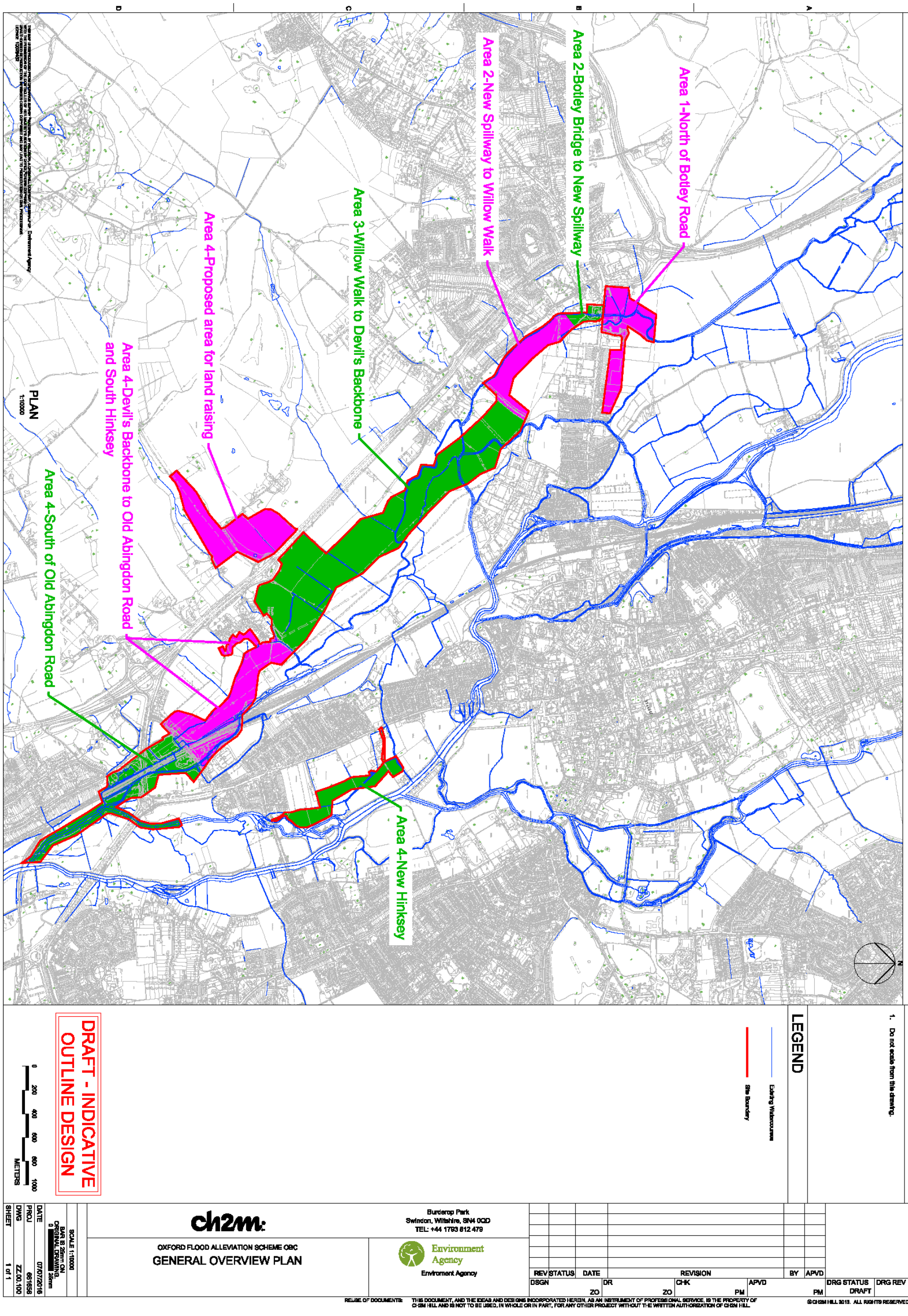


Figure 1-4: Scheme map

2. Strategic Case

2.1. Introduction

The Strategic Case of the Outline Business Case (OBC) provides an overview of the Environment Agency and its partner organisations, their relevant business strategies and the case for change in Oxford. Its purpose is to explain and revisit how the scope of the proposed scheme fits within the existing business strategies of the partners' organisations, and to provide a compelling case for change in terms of the existing and future operational needs of their organisations.

The Environment Agency is seeking approval of this OBC to further develop the Oxford Flood Alleviation Scheme (Oxford FAS) proposals to Full Business Case (FBC). The current estimated inflated cash cost (including risk) is £116.36 million for design and construction and £4.75 million as a commuted sum for the first 10 years of maintenance. The scheme is a major construction project to reduce flood risk and deliver wider social, environmental and economic benefits for communities in and around Oxford.

Defra has specific policies on reducing the risk and impact of flooding and adapting to climate change. How schemes contribute towards delivering these policies is measured using a series of Outcome Measures. Outcomes monitored include economic benefits delivered, properties moved into a lower flood risk category and Water Framework Directive (WFD) habitat improved.

2.2. Business strategies

2.2.1. Organisational overview

The Oxford FAS is a partnership project jointly chaired by the Environment Agency and Oxfordshire County Council on behalf of a Sponsoring Group representing the following organisations:

- Environment Agency
- Oxfordshire County Council
- Oxford City Council
- Vale of White Horse District Council (VoWH DC)
- University of Oxford
- Oxfordshire Local Enterprise Partnership (OxLEP)
- Oxford Flood Alliance (OFA)
- Thames Regional Flood and Coastal Committee (Thames RFCC)
- Thames Water

Environment Agency

The Environment Agency is an executive non-departmental public body, sponsored by the Department for Environment, Food & Rural Affairs (Defra), with responsibilities relating to the protection and enhancement of the environment in England. It has a strategic overview of all sources of flooding and coastal erosion and advises on the planning and management of flood risk. It is responsible for the delivery of flood and coastal erosion risk management activities, and it works in partnership with the Met Office to provide flood forecasts, flood mapping and warnings. It manages central Government grants for capital projects carried out by all risk management authorities. Its funding varies year-on-year, but is approximately £1 billion nationally.

In response to the Pitt Review into the 2007 floods published in 2008, the Government enacted the *Flood and Water Management Act* in 2010. This legislation clarified responsibilities for tackling local sources of flood risk, and created a new role for lead local flood authorities (LLFAs). The act also required that the Environment Agency develop, maintain, apply and monitor a strategy for flood and coastal erosion risk management in England, as part of its strategic overview role. The strategy was published in May 2011 and is explained further below.

Oxfordshire County Council

Oxfordshire County Council is an elected body responsible for strategic local government services in the county including education (schools, libraries and youth services), social services, highway maintenance, waste disposal, emergency planning and consumer protection as well as town and country planning for matters to do with minerals, waste, highways and education. This makes it one of the largest employers in Oxfordshire, with an annual budget of just under £800 million. It is also designated as an LLFA. The council's key objectives and priorities for action are set out in their corporate plan/strategy:

- create a world class economy for Oxfordshire
- have healthy and thriving communities
- look after our environment and respond to the threat of climate change
- reduce inequalities and break the cycle of deprivation

District councils

The county is divided into 5 local government districts shown in Figure 2-1: Oxford City (1), Cherwell (2), South Oxfordshire (3), Vale of White Horse (4) and West Oxfordshire (5), which deal with such matters as town and country planning, economic development, waste collection, housing and services such as parks and leisure. The district councils lead in reducing flood risks from development in the floodplain through the planning system and the management of drainage and non-main river watercourses. The key priorities of each of these councils can be found in their respective corporate plan and strategy. The proposed physical works cross both Oxford City and Vale of White Horse who are also both direct beneficiaries.

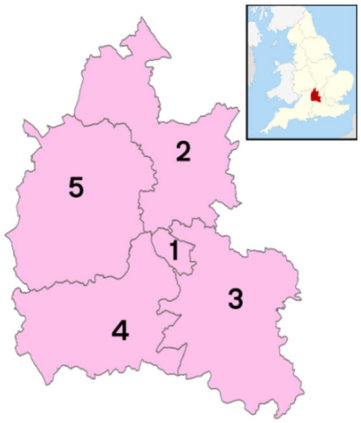


Figure 2-1: County district map

University of Oxford

The University of Oxford is the UK's leading research university and sits at the heart of one of the top 5 university-based innovation ecosystems in the world. The university and its colleges are cognisant of their role in the future development of the city of Oxford to enhance the intensity of innovation, driving economic growth and improved productivity in the local economy. This scheme will enable further redevelopment to realise this shared aim.

Oxfordshire Local Enterprise Partnership (OxLEP)

The OxLEP was launched by the then Business Minister, Mark Prisk MP, in March 2011. It is responsible for championing and developing the Oxfordshire economy, working with businesses, academia and the public sector and bringing disparate initiatives together. The OxLEP has received significant Growth Deal funding for the Oxford FAS from round 1 of local government funding which is detailed in the Financial Case.

Oxford Flood Alliance

The Oxford Flood Alliance (OFA) is a voluntary community group set up after the severe floods of 2007. It suggests ways to reduce flood risk, based on local knowledge, and works as a critical friend of the Environment Agency and other flood risk authorities. It receives support from fellow residents and elected representatives including members of parliament Andrew Smith MP, of Oxford East, and Nicola Blackwood MP, of Oxford West and Abingdon.

Thames Regional Flood and Coastal Committee (RFCC)

Thames RFCC is a committee established by the Environment Agency under the *Flood and Water Management Act 2010.* It brings together members appointed by LLFAs and independent members with relevant experience from across the Thames catchment. Its purpose, as set out by the Environment Minister, is:

- to ensure there are coherent plans for identifying, managing and communicating flood risks across catchments
- to encourage efficient, targeted and risk-based investment that represents value for money and benefits for local communities
- to provide a link between the Environment Agency, LLFAs, other risk management authorities, and other relevant bodies to engender mutual understanding of flood and coastal erosion risks in its area

It has a key role in balancing local priorities and in promoting climate change considerations in local decisions. It advises on, and consents to, the Environment Agency's flood and coastal erosion risk management investment programmes, and provides a forum for raising and allocating Local Levy funding and for sharing good practice.

Thames Water

Thames Water Utilities Ltd, known as Thames Water, is the private utility company responsible for the public water supply and waste water treatment in large parts of Greater London, the Thames Valley, Surrey, Gloucestershire, Wiltshire, Kent, and some other areas of the United Kingdom. Thames Water is the UK's largest water and wastewater services company, with 15 million customers. It is regulated under the Water Industry Act 1991. The name of the company reflects its role providing water to the drainage basin of the River Thames and not the source of its water, which is taken from a range of rivers and boreholes. Full details of their key aims and objectives can be found in their corporate plan. They aim to improve the sewer system, reducing the risk for 2,127 properties during the AMP6 period, including major sewer flood relief work in west London, deliver sustainable drainage solutions, preventing blockages, reducing the infiltration of groundwater into sewers and reducing the incidents of pollution.

2.2.2. Business policies and strategies

Defra policy

On 28 January 2016 Defra launched the first single strategy for the whole of the Defra group which sets the priorities and direction for Defra until 2020. The strategy, 'Creating a great place for living: Defra's strategy to 2020', is split into 7 strategic objectives:

- Objective 1: environment – a cleaner, healthier environment, benefitting people and the economy.
- Objective 2: food and farming – a world leading food and farming industry.
- Objective 3: rural – a thriving rural economy, contributing to national prosperity and wellbeing.

- Objective 4: protection - a nation better protected against flood, animal and plant disease and other hazards, with strong response and recovery capabilities.
- Objective 5: excellent delivery – excellent delivery, on time and to budget and with outstanding value for money.
- Objective 6: an outstanding organisation – an organisation continually striving to be the best, focused on outcomes and constantly challenging itself.
- Objective 7: our people – an inclusive, professional workforce where leaders recognise the contribution of people and build capability to deliver better outcomes.

Whilst all the objectives impact on the Environment Agency's work and therefore the delivery of Oxford FAS, objective 4 specifically covers investment in flood defence.

These strategic objectives are to be met using 4 themes: data; productivity; better regulation; and working internationally.

Environment Agency corporate plan

The Environment Agency's Action Plan 'Creating a better place: our ambition to 2020', was launched in April 2016 in response to the release of Defra's Strategy in January 2016. The plan is built around 3 main objectives, the first 2 of which are also Defra objectives:

- a cleaner, healthier environment which benefits people and the economy
- a nation better protected against natural threats and hazards, with strong response and recovery capabilities
- higher visibility, stronger partnerships and local choices

National Flood and Coastal Erosion Risk Management (FCERM) Strategy

The National FCERM Strategy, dated September 2011, sets out the statutory framework for managing the risk of flooding and is applicable to all organisations involved in flood and coastal erosion risk management. It helps organisations and communities to understand their different roles and responsibilities and is particularly relevant to LLFAs and RFCCs, which have duties under the Act. It promotes local decision-making and engagement and encourages beneficiaries to invest in flood risk management.

Flood Risk Management Plans (FRMPs)

FRMPs are a legal requirement of the EU Floods Directive 2007 brought in to UK law via the Flood Risk Regulations (2009), and cover flooding from rivers, the sea, surface water, groundwater and reservoirs. They focus on the reduction of potential adverse consequences of flooding for human health, the environment, cultural heritage and economic activity. FRMPs are also required to look at reducing the likelihood of flooding through, for example, structural initiatives. FRMPs require all risk management authorities to work together and also take account of the European Commission's Water Framework Directive, 2000. This is to ensure that, in managing the risk of flooding, water resources and aquatic ecosystems are also managed sustainably, and wider environmental and social benefits are delivered to local communities.

FRMPs build on the aims and objectives of the National FCERM Strategy. They are based around river basins and are produced on a 6-year planning cycle, the current cycle running from 2015 to 2021. They are grouped into 4 categories: preventing risk; preparing for risk; protecting from risk; and recovery and review.

The current proposals for Oxford FAS are specifically referenced in the Thames FRMP as the preferred method of reducing flood risk within the city.

Thames Catchment Flood Management Plan (CFMP)

CFMPs help establish long term flood risk management policies against inland flooding across England over the next 50 to 100 years. The Thames CFMP published in 2009 gives an overview of the flood risk across the Thames catchment and sets out the preferred plans for sustainable flood risk management. CFMPs are built around 4 key themes: flood defences cannot protect everyone; climate change will make the situation worse in the future; the floodplain is our most important asset in managing flood risk; and development/urban regeneration provides crucial opportunities to help manage flood risk.

The Thames CFMP is broken down in to 43 sub-areas which generally follow river catchments or urban area boundaries. Oxford falls into one sub-area under policy option 5 'heavily populated floodplain' with 'areas of moderate to high flood risk where we can generally take further action to reduce flood risk'. One of the actions relevant to Oxford from Thames CFMP policy option 5 states that "we will deliver the actions recommended in the Oxford Flood Risk Management Strategy, once approved".

The Oxford Flood Risk Management Strategy (Oxford FRMS)

In response to the July 2007 flooding, which devastated much of southern England, the Environment Agency developed the Oxford FRMS. The strategy was approved in September 2010. It investigated over 100 different option combinations and recommended a 3-stage adaptive approach to managing fluvial flood risk in Oxford over the next 100 years, with the stages linked to predicted impacts from climate change:

Phase 1 (short term measures), now complete, confirmed continuing the existing operation and maintenance of the River Thames and its tributaries in Oxford, as well as enhancing the local maintenance regime, installing several new culverts at key pinch points and purchasing demountable barriers for several particularly vulnerable areas. These works are known to have protected up to 150 properties in recent flood events.

Phase 2 (medium term) recommended the construction of a flood channel in the western floodplain. Whilst technically viable, the channel was not financially viable at the time. The channel had a good benefit:cost ratio, but the incremental benefit:cost ratio, whereby the value of additional costs against additional benefits are measured, was significantly less than one, making additional investment not the preferred choice to implement at that time. The Oxford FRMS noted that climate change could change this situation and therefore the strategy should be regularly reviewed.

Phase 3 (long term) noted that should climate change impacts materialise as predicted at the time, the benefits of the new channel recommended in stage 2 would reduce over time and that further works, likely to involve upstream flood storage, might be required. Since the Oxford FRMS our understanding of the benefits and opportunities of natural flood management have improved and this would undoubtedly form part of any longer term option.

The first review of the Oxford FRMS coincided with the 2013-14 winter flooding and a local flood summit in Oxford hosted by Oxfordshire County Council. The Oxford FAS initial assessment reviewed the viable options from the strategy, including further localised options. It concluded that the new channel was now both economically and financially viable. Whilst there were many reasons for this change, the main reasons were:

- The Oxford flood mapping model had been independently updated by Mott MacDonalds in January 2014 and showed that smaller flood events were occurring more frequently, causing additional damages.
- Climate change is now incorporated as baseline in the economics (in 2010 it was a sensitivity test) as per updated national guidance.

- Partnership funding, introduced in 2010, meant that local funding could be used for flood schemes alongside central government funding. Previously, schemes that did not qualify for full funding by central government could not get any FCERM Grant in Aid (GiA) funding at all.

Oxfordshire Local Flood Risk Management Strategy (LFRMS)

Under the Floods and Water Management Act 2010, LLFAs such as Oxfordshire County Council are required to produce a local flood risk management strategy (LFRMS). These consider an assessment of local flood risk from surface water and groundwater; set out objectives for managing local flooding; list the costs and benefits of measures proposed to meet these objectives; and outline how the measures will be paid for. Developed in partnership with the district councils and the Environment Agency, the LFRMS remains the specific responsibility of Oxfordshire County Council.

The Oxfordshire LFRMS supports the proposed Oxford FAS as reducing the fluvial flood risk in Oxford, as a key contributor to reducing flood risk across the county as a whole. Other sources of flood risk, such as from surface water, are not found within the fluvial floodplain in Oxford. They therefore do not present the problems associated with properties at multiple sources of flood risk such as needing to share economic benefits or partnership funding. Surface water schemes being progressed by the Lead Local Flood Authority focus on the storage and controlled release of surface water. This holistic approach means that surface water schemes in other parts of the county will help to have an overall benefit of reducing peak flows draining into the river system.

National Resilience Review

In response to the extreme weather events in winter 2015-16 the government commissioned a National Resilience Review to assess how the country can be better protected against such events in the future. It reported in September 2016 using Oxford as a case study and helped confirm our modelling of extreme events is very good. Whilst the review deals primarily with extreme events, it also recognises the future 25 year plan for the environment and better management of the whole river catchment, and reinforces the importance of the current 6-year programme in reducing flood risk. The review also supports increasing the stock of temporary flood defences. Temporary flood defences have already been used in Oxford in recent years and this will help give further protection in areas such as South Hinksey until the Oxford FAS is operational.

2.2.3. Other key organisational drivers

Flood and Coastal Erosion Risk Management Grant-in-Aid (FCERM GiA) investment programme

Defra sets out guidance on the appraisal and prioritisation of capital schemes to reduce flood risk (the FCERM Appraisal Guidance). This ensures that limited resources are targeted most effectively across England and deliver best value for money. High-level strategic targets known as Outcome Measures assess performance in reducing flood risk. FCERM GiA funding is allocated to risk management authorities to deliver schemes to meet (and exceed) these targets. The process by which this funding is allocated is described in the Economic Case.

Defra announced a 6-year programme of FCERM GiA investment in 2014, following the 2013 Spending Review. The new approach allows for better long term planning and assumed £2.5billion of government grant in aid spend with a reduction in risk of flooding from rivers, sea, groundwater and surface water to 300,000 homes between 2015/16 and 2020/21 and a clear objective to demonstrate stronger partnership working. It has a target to bring in £600 million in partnership funding across the wider programme.

UK Climate Projections 2009 & 2018 (UKCP09 & UKCP18)

UKCP09 is intended to give government and other organisations evidence to help them take informed, cost effective and timely decisions to prepare for the changing climate. Research suggests that wet and mild winters like the extremely wet weather we experienced in 2013/14 could become more common. In response to this, the Environment Agency appraises its projects in accordance with the latest guidance entitled 'Flood risk assessments: climate change allowances' which was published in February 2016. This ensures projects are appraised incorporating climate change increases as baseline with sensitivity tests undertaken against other climate change scenarios.

2.3. Environmental and other considerations

The following are additional relevant environmental strategies that have been taken into account during the development of the Oxford FAS.

Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services

This biodiversity strategy published by Defra in 2011 builds on the *Natural Environment White Paper.* It sets out the Government's ambition to halt overall loss of England's biodiversity by 2020, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for the benefit of wildlife and people.

Thames River Basin Management Plan (RBMP)

The Environment Agency prepared this plan under the EU's Water Framework Directive, 2000, which requires all countries throughout the European Union to manage the water environment to consistent standards. Each country has to:

- prevent deterioration of the status surface waters and groundwater
- achieve objectives and standards for protected areas
- aim to achieve good status for all water bodies or, for heavily modified water bodies and artificial water bodies, good ecological potential and good surface water chemical status
- reverse any significant and sustained upward trends in pollutant concentrations in groundwater
- cessation of discharges, emission and losses of priority hazardous substances into surface waters
- progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants

The RBMP was updated in December 2015. The plan sets out environmental objectives for protected areas and water bodies in the river basin district. Achieving the objectives will optimise the benefits to society from the water environment. These environmental objectives are legally binding and all public bodies must have regard to these objectives when making decisions that could affect the quality of the water environment. The plan refers to the implementation of the Oxford FAS as a way to help meet these objectives.

2.3.1. Town and country planning

There are 3 local planning authorities with regulatory responsibility for the project, 2 district authorities (Oxford City Council and Vale of White Horse District Council) and Oxfordshire County Council which is responsible for minerals and waste planning. Following discussions with all 3 authorities we have agreed that it will be preferable to submit a single planning application for the entire scheme, resulting in a single decision notice. Oxfordshire County Council has agreed to take

responsibility for determining the application, while Oxford City Council and Vale of White Horse District Council have both agreed to hand their decision-making powers for the application to the County Council. This arrangement is subject to formal agreement between the 3 authorities and Memorandums of Understanding will be established to ensure the process runs smoothly.

Town and Country Planning (Environmental Impact Assessment)

The scheme falls under the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 2011 (SI 2011 No.1824). The scheme is likely to give rise to significant environmental effects and as such requires a statutory Environmental Impact Assessment and an Environmental Statement will need to be submitted with the planning application. A scoping opinion has been provided by Oxfordshire County Council which raised nothing unexpected or requiring further work which had not already been identified.

2.4. Investment objectives

2.4.1. Strategic investment objectives

The investment objectives set the goals the project is trying to achieve. The partnership investment objectives for this project remain the same as at Strategic Outline Case (SOC):

1) Reduce flood damages to at least 1000 homes and businesses currently at risk in Oxford
2) Reduce flood impacts on transport infrastructure and utilities in Oxford, particularly to Botley and Abingdon Roads, the railway line and the sewerage system
3) Safeguard Oxford's reputation as a thriving centre of commerce that is open for business
4) Create and maintain new recreational amenities, wildlife habitat and naturalised watercourses accessible from the centre of Oxford

The objectives encompass the local political desire that the scheme needs to deliver more than just core flood reduction outcomes and that reducing the flood risk will support economic growth and enhance the local environment. These themes for investment form a core element of communications for the project, and are clearly referenced in external material about the scheme.

Whilst the 4 high-level objectives capture the high level vision for the project, for the OBC they need to be SMART, that is specific, measurable, achievable, realistic and time-bound (SMART). This is so that project benefits can be better tracked against them. The partnership feels strongly that the phrasing used in the SOC is well-defined for the public and therefore agreed to use SMART sub-objectives to define the aspects of delivery that need to be tracked. The proposed sub-objectives are shown in Table 2-1 below.

The sub objectives describe the specific outcomes that the project will track to demonstrate delivery against strategic investment objectives. The objectives and sub-objectives have been referenced to allow tracking through this document. Targets capture the minimum standards for delivery acceptable to all partners. Better understanding of the solution to deliver these and the programme dependencies to achieve this have changed the partner-agreed delivery date from March 2021 to July 2022, outside of the current 6 year settlement period. Subsequent programme reviews indicate delivery is now likely to be August 2021.

Table 2-1: Scheme sub-objectives

Objective	Sub-objective
1. Reduce flood damages to at least 1000 homes and businesses currently at risk in Oxford	1a) By July 2022, lower the National Flood Risk Assessment (NaFRA) flood risk category for at least 1000 homes 1b) By July 2022, reduce the number of commercial properties that suffer damages in the 1 in 100 (1%) annual flood event outline by at least 100 1c) By July 2022, ensure that temporary defence deployment plans are in place, where suitable, for areas still at risk after the scheme is completed.
2. Reduce flood impacts on transport infrastructure and utilities in Oxford, particularly to Botley and Abingdon Roads, the railway line and the sewerage system	2a) By July 2022, the Botley Road, Abingdon Road, sewerage system and railway line will not be at risk from a river flood up to the size of that seen in 2007.
3. Safeguard Oxford's reputation as a thriving centre of commerce that is open for business.	3a) By July 2022, reduce the risk of flooding to at least 40 utility infrastructure assets at risk of flooding 3b) By July 2022, improve the potential for growth by reducing the flood risk to 5 hectares of industrial land with redevelopment potential.
4. Create and maintain new recreational amenities, wildlife habitat and naturalised watercourses accessible from the centre of Oxford.	4a) By July 2027, create a net increase of at least 5 hectares of water-dependant habitat that meets the objectives of the Water Framework Directive. 4b) By July 2022, create at least 2km of naturalised watercourses. 4c) By July 2022, improve at least 2km of accessible paths within the scheme area.

We will capture the baseline values, targets and delivery against these objectives through the benefits realisation plan, further described in the Management Case.

The main benefits that will be used to demonstrate delivery against these objectives are described in Table 2-2.

2.4.2. Critical success factors

Whilst the objectives set the aim for what the project partners want to achieve, critical success factors (CSFs) outline what must be delivered to determine the project as a success. The full list of CSFs are detailed in the Economic Case and have been used as part of a multi-criteria analysis to choose the preferred route option. Outlined below are 4 specific themes that partners have highlighted as being important to the successful delivery of the project, which need to be considered in relation to strategic investment objectives.

Themes:

- The technical solution needs to maximise the outcomes it delivers to ensure the city is as resilient as it can be to climate change.
- Communications messages need to be clear in the limitations of scheme and the impact of future climate change.
- The scheme needs to mitigate for adverse effects on water levels and flows elsewhere and clearly communicates messages related to this.
- How the scheme operates in wet, high flow and dry, low flow conditions must be fully understood by all operating parties.

2.5. Current arrangements

Oxford has developed around the River Thames and sits at the confluence of 7 rivers draining a predominately rural catchment area of approximately 3000km^2. The floodplain narrows significantly immediately downstream of Oxford to only 300m wide which constrains flow and increases flood levels through the city. The River Thames is generally slow to respond to rainfall and flood events are long in duration, typically lasting 7 - 9 days, due to the nature of the catchment. The hydraulic gradient through Oxford is very shallow, which further slows the passage of water as it drains towards Sandford Lock. Flooding has been exacerbated by historical development within the floodplain including both road and railway embankments. The constraining effect of the development means that the channels and structures that bridge the current channels do not have sufficient capacity to pass flood flows, even for the smaller, more frequent, flood events such as those experienced in recent years. This leads to flood waters backing-up and spilling into vulnerable areas.

Oxford also has an extensive network of braided watercourses that leave and re-join the River Thames, often bypassing the main weir complexes. The braided nature of the watercourses means implementing flood risk measures to one area could leave properties and infrastructure at risk of flooding from another watercourse and could even exacerbate flooding in other areas.

The River Thames and its tributaries at Oxford have a large area of developed floodplain without flood defences. If nothing was done to manage flood risk, approximately 3500 properties would be at risk in a 1 in 100 (1%) annual flood event. In this case this means that there would be flood water within 300mm of the property threshold. The key areas of Oxford affected are New Botley, Osney, New Osney, Grandpont, North Hinksey and New Hinksey. There is also flood risk associated with outlying areas such as Wolvercote, South Hinksey and Kennington. Critical infrastructure is also at risk and traffic disruption is a significant problem during flood events, especially on 2 of the 4 main arterial routes (Botley Road and Abingdon Road) into the city centre and the railway line, which forms a key part of the strategic freight network. Once the 2 main roads close, traffic quickly builds back on to the A34 which then effectively stops all traffic movements around the city.

The current constraints and flood risk are highlighted in

Figure **2-2** below which shows flood zone 2 (1 in 1000 (0.1%)) annual flood event in light blue and flood zone 3 (1 in 100 (1%) annual flood event in dark blue).

Figure 2-2: Current flood risk in Oxford

Oxford is an important employment centre, an internationally-renowned seat of learning and a popular tourist destination. Disruption to major infrastructure severely impacts Oxford's ability to function during flooding, with significant effects on the local economy.

The risk to property is currently managed through the Oxford Multi-Agency Flood Plan. This describes the responsibilities of various local and national agencies to manage the impact of flooding. Responsibilities include:

- maintenance of channels
- operation of flow control structures
- monitoring of river levels
- issuing flood warnings
- deploying temporary flood defences
- emergency response

Even with this existing work, over 1,500 properties remain at risk of internal flooding in a 1 in 100 (1%) annual flood event. This figure will rise to nearly 3,500 if climate change materialises as currently predicted and nothing else is done. This is explored further in the Economic Case.

Annual expenditure on maintenance across Oxford has been re-examined in detail as part of the OBC update. The Environment Agency currently spend approximately £140,000 per annum on general river maintenance in the scheme area which is detailed further as part of the Economic Case. This figure excludes major capital works on the weirs which is detailed separately.

Oxford has experienced repeated flooding in recent years with properties flooded in 2000, 2003, 2007, 2009, 2011, 2012 and 2013/2014. Whilst the largest of these recent events in 2007 is known to have internally flooded at least 168 properties, Oxford has been fortunate to escape the much more significant flooding seen across the country in recent years. Critical infrastructure such as an electrical substation and mains sewers are also at risk. A typical recent flooding event is shown below in

Figure 2-3:

Figure 2-3: Recent flooding in Oxford

The hydrological review carried out by Mott Macdonald and JBA in January 2014 as part of the Oxford model update has highlighted that the frequency and intensity of flooding in the city has increased. This means that the 1 in 100 (1%) annual flood event as seen in 2010 should now be considered with a higher likelihood, equivalent to a 1 in 48 (2.1%) annual flood event. In addition, climate change can already be seen to be impacting on flood risk in the city.

The presence of a gravel aquifer and the high surface water and groundwater connectivity mean there is a risk of groundwater and sewer flooding, particularly in Osney, Grandpont and New Hinksey. The River Thames interacts with the gravel aquifer and peak levels on the Thames are thought to correlate with groundwater flooding levels. The main geological features in the scheme area are formed from alluvial silts (typically 1m depth) overlying river terrace gravels (3-6m thickness). Beneath these strata, Oxford Clay is present down to bedrock. The river gravels provide an effective flow path for groundwater which is at a level of 1-2m below ground. There is good hydraulic continuity between groundwater and surface water as many of the watercourses break through the alluvial material into the gravel beneath.

2.5.1. Environmental arrangements

Landscape

The landscape character of the area comprises low-lying agricultural floodplain, which allows access to rural open space close to Oxford city centre. The fields are dissected by intertwining streams and ditches and this rural meadow and watery setting, with the backdrop of the Oxford skyline, has been much celebrated in art and literature. The landscape also includes overhead electricity cables, pylons and large retail and industrial buildings on the edge of the city.

Designated sites

The scheme area includes Hinksey Meadow Site of Local Importance for Nature Conservation and Local Wildlife Site. This is a floodplain meadow and is known to support the nationally-rare grassland community, MG4a and the protected plant species, snakes-head fritillary.

There are 2 other groundwater-sensitive sites close to the proposed scheme, including Port Meadow, part of the Oxford Meadows Special Area of Conservation (SAC), to the north and Iffley Meadows Site of Special Scientific Interest (SSSI) to the south-west.

Kennington Pond Local Wildlife Site, at the southern end of the scheme area, is a former borrow pit surrounded by woodland and scrub that supports a diverse range of invertebrates and wetland wildflowers.

Notable and protected species

The scheme area includes several protected and notable species including: creeping marshwort, great crested newts, badgers, bats and otters. The invasive non-native species, Himalayan Balsam, is present along significant stretches of the streams and ditches in the site area, whilst Japanese Knotweed is restricted to the land between Old Abingdon Road and the A423.

Archaeology

There is one Scheduled Monument within the scheme area, which lies beneath the Old Abingdon Road. The ancient causeway with historic stone culverts under the road are known to be at least medieval and could possibly be Roman or Saxon.

Another area of key archaeological interest is the public right of way known as Monks' Causeway, which may have been a major route into Oxford in medieval times.

While the remainder of the project area is of largely unknown archaeological value, crop-marks, find-spots and areas of surviving ridge-and-furrow farmland have been identified.

Contaminated land

There are 3 known historic (now closed and sealed) landfill sites in the south of the scheme area centred on Redbridge.

Traffic and transport

The road network in Oxford is heavily-trafficked and prone to congestion. While the A34 and the ring road have capacity to handle construction traffic, other roads in the scheme area such as Botley Road and Old Abingdon Road can become congested and can lead to traffic problems elsewhere in the city if they are blocked. The EIA will include a traffic impact assessment, which will focus on the construction of the scheme only, as traffic required during operation will be very occasional and involve very few vehicles (thus having no significant impact).

Air quality

Traffic pollution has a significant impact on local air quality in Oxford, with both annual mean and hourly mean air quality objectives for nitrogen dioxide frequently exceeded. Resultantly, since 2010 Oxford has been declared a city-wide air quality management area (AQMA), including 7 localised hotspots where pollution levels of nitrogen dioxide have exceeded national targets.

2.5.2. Business needs

Despite current flood risk management, there remain various flood risk issues in Oxford: residential and business properties that remain at risk of fluvial flooding, and the associated effects; the impacts of climate change; ground water flood risk; and low-flow issues.

The effects of flooding can be demonstrated by the most recent event in winter 2013/14, which saw across Oxfordshire: 48 flood warnings issued, 150 plus properties flooded, 32 people evacuated, 45 roads closed, the main north/south rail line from London closed, 80 elderly and vulnerable clients provided with emergency transport, 1 rest centre opened, 1 school closed and 500 bridges

in need of inspection following the event. Mains sewers were also affected so residents could not flush their toilets.

The OxLEP's successful Growth Deal bid highlights that businesses, especially on Botley Road reported significant revenue losses as a result of being closed during the floods.

Looking ahead, current projections indicate that these types of flood events will become more frequent as the effects of climate change cause more frequent and severe storms. To offer an insight into what Oxford might be like in just a few decades without further intervention, we have listed some bullets below.

- The growth of Oxford's economy is likely to be constrained by increasingly frequent and damaging flood events, which prevent access into the city by road and rail, and cause a significant amount of damage year-on-year.
- Businesses looking to move into the area are put off Oxford by these events, and existing businesses already in the area will look to move away.
- Currently occupied parts of the city will lose their value and become less sustainable, eventually causing significant residential areas to require redevelopment or relocation.
- Increasingly frequent flooding of Oxford's public open spaces will impact on protected habitats and recreational space.
- Increasingly frequent flooding of roads, sewers and industrial areas cause pollution of the watercourses, with a knock-on effect on our fish stocks and biodiversity, not just in Oxford, but in the catchment as a whole.

Due to its extensive river network, Oxford also suffers from low river flows and the Environment Agency often has to implement the agreed low flow protocol for Oxford to prioritise which watercourses receive the limited available water. Priority is given to the River Thames for navigation and abstraction purposes meaning smaller watercourses often either run dry or simply stop flowing. This has a knock on impact on water quality, siltation and weed growth and causes problems for aquatic species. Recognising the Oxford FAS cannot solve the issue of limited availability of water during much of the year, the implementation of the scheme does give us the opportunity to review which watercourses should be prioritised during low flow scenarios and how all watercourses might be better managed.

Oxford has a wealth of history and is renowned worldwide for its cultural heritage characterised by the historic colleges, punting on the Thames and views of the dreaming spires from Boars Hill. Tourism is an important industry all year round and visitors are attracted from all over the world. Although flooding only directly affects a small number of the historical college buildings, they are all affected by the transport problems and perception of flooding. Many of the benefits (tourism, business, learning and research) that these internationally recognised institutions deliver to the local and national economy are more difficult to quantify in monetary terms.

2.6. Main benefits

2.6.1. Benefit identification

A benefit is an outcome perceived as positive by one or more stakeholders. The SOC included indicative benefits against each of the strategic investment objectives by sector. For the OBC, we have carried out more detailed benefits analysis. This work has been completed under the structure of the Environment Agency Benefits Management Framework with project specific details outlined in the benefits management strategy.

The benefits dependency map (Appendix H) shows how the high level benefits map from the strategic investment sub-objectives described in section 2.4.1 This map shows direct and indirect

benefits along with disbenefits. Disbenefits are outcomes of the scheme perceived as negative by one or more stakeholders.

The direct benefits are categorised as primary, secondary and tertiary depending on their importance. Successful delivery of the Oxford FAS is the enabler to realising these benefits.

These benefits are explored in greater detail in the Economic and Management Cases but initial details on primary and secondary benefits are shown in Table 2-2 below.

Table 2-2: Direct benefits identified for Oxford FAS

Benefit reference	Description	Type	Category	Strategic investment objective
P1	Residential properties suffer less flood damage	Non-cash releasing	Economic/ Social	1
P2	Commercial properties suffer less flood damage	Non-cash releasing	Economic	1
P3	Lower frequency of flooding to Abingdon and Botley roads	Non-cash releasing	Economic/ Social	2 & 3
P4	Fewer electricity disruptions as a result of flooding	Non-cash releasing	Economic / Social	2 & 3
P5	Improved resilience of high-speed broadband network	Non-cash releasing	Economic / Social	2 & 3
P6	Lower frequency of flooding to railway line	Non-cash releasing	Economic	2 & 3
P7	Less likelihood of subsequent sewer flooding	Non-cash releasing	Economic / Social	2
P8	Opportunity to improve biodiversity	Quantitative	Environmental	4
S1	New riverside environment between North Hinksey and South Hinksey	Qualitative	Environmental	4
S2	Increased number of people walking and cycling in the area	Qualitative	Social / Environmental	4

S3	Lower frequency of flooding to existing sites with redevelopment potential	Non-cash releasing	Economic	3
T1	Lower impact of flood on economic output	Non-cash releasing	Economic	1, 2 & 3

Potential business scope and key service requirements

Following detailed review post-SOC and as reinforced by the Oxford FRMS, it is considered that the scope for the scheme remains improving flood flow capacity through the floodplain, supplemented by local secondary defences allowing water to pass through and around Oxford more efficiently.

This is explored further in the Economic and Management Cases.

2.6.2. Standard of protection

The proposed scheme does not give a standard level of protection throughout Oxford as it works by lowering existing flood levels. As such, the level of protection to individual properties is set by their individual threshold levels (i.e. the level at which flood water can enter a property) meaning that even neighbours might have different levels of protection.

However, on completion the Oxford FAS will reduce flood risk to all properties currently at risk, with over 80% of these properties having a standard of protection in excess of the 1 in 100 (1%) annual flood event.

This is explored in detail within the Economic Case.

2.7. Main risks

By their nature, all projects are unique and as such carry uncertainty in terms of outcomes required, dependencies and constraints. This uncertainty is managed through good risk management. The Oxford FAS risk management strategy (detailed within the Management Case) describes the agreed approach to managing risks on the project.

Good risk management requires risks to be identified, communicated, assessed, quantified, owned and controlled. It is an iterative and repetitive process which helps ensure the impacts of any risk occurring are understood and effectively managed.

Whilst a project risk register had already been developed at SOC stage, there was still much uncertainty about the actual details of the scheme and as such the risk figure used within the SOC was calculated using optimism bias. This is an accepted approach to calculating risk early in a project's lifecycle. Key risks are simply allocated on a percentage basis against a pre-defined list of contributing factors, grouped around key themes, and based on historic data from similar projects. The overall risk figure at SOC stage for Oxford FAS was set at 38%. This is lower than the usual 60% at appraisal stage on the basis that there was already information available from the earlier Oxford FRMS and a detailed site investigation completed early in the appraisal stage. It was also based on the key assumption that all excavated material, then estimated at nearly 650,000m^3, was disposed off-site to tip.

With the appraisal stage now complete and a preferred alignment agreed, the project team and partners have now updated and quantified the project risk register. Risks have been presented as

both known, quantifiable risks, calculated using the Monte Carlo statistical tool, together with a smaller and revised element of optimism bias recognising that even at this stage there are still risks that are unknown and therefore cannot be costed. The Economic Case uses the 50% Monte Carlo risk figure (P50), whilst the Financial Case uses the 95% Monte Carlo risk figure (P95). Both cases also include the updated optimism bias figure of 12%. The difference in approach between the 2 cases helps highlight how the scheme remains affordable even if all risks are realised. Whilst we have been able to significantly reduce overall earthwork quantities during the appraisal stage (see the Economic Case for details) we are still investigating options for materials management and therefore scheme costs are still based on the assumption that all excavated material, now nearer 400,000m^3, is sent to off-site restoration sites.

The main risks to overall project delivery and mitigation measures associated with the Oxford FAS are shown in Table 2-3 below. The full Monte Carlo risk register and optimism bias calculation are included as Appendix N whilst the key quantified risks are detailed in the Economic case. As such, the risks highlighted below are considered the main risks to the successful delivery of the Oxford FAS at this stage.

Table 2-3: Main risks to overall project delivery and mitigation measures

Top project risks (un-costed)		
Risk	**Mitigation**	**Risk owner**
Funding shortfall not closed before critical project dates: significant progress has been made closing the funding gap identified in the SOC. Certainty of funding is required for both FBC sign-off in August 2018 and in order to serve the Compulsory Purchase Order (CPO) notices in November 2017. Without certainty of funding the project would be delayed or stop.	Funding Contingency Plan (Appendix Q) developed and approved by the Sponsoring Group which identifies options for managing any shortfall.	Funding & Benefits Realisation Manager
Downstream flood risk: There is a perception amongst the wider public that flood schemes can pass the problem on to other communities. Whilst we can demonstrate this is not the case for Oxford, the message is not always heard and creates risks around public acceptance.	Hydraulic model has been peer reviewed by Capita as per normal practise and a further independent academic review has been completed on behalf of VoWH DC. Both confirm the approach is robust and there is no increase in risk as a result of the scheme but work is ongoing with downstream communities.	Strategic Engagement Manager
Planning and/or CPO inquiry required: The programme assumes no inquiry is required. If planning is called in or a successful challenge made against our CPO the delivery could be delayed by 12 months.	Planning officers group established and has made an agreement to follow a single determination. Detailed lands strategy developed which is kept under constant review. Engagement plan being delivered.	Project Executive
Commercial model not available: Programme delays lead to preferred commercial model not being available. If the programme up to contract award is delayed by more than 10 months the preferred framework will no longer be available.	Peer review of programme has been completed to give confidence in its durations and interdependencies. The next generation supplier arrangements is the planned alternative delivery vehicle.	Project Executive

We have updated the risk potential assessment (RPA) carried out at SOC stage to support the OBC. Whilst the scoring within several sub-sections has changed as more information has become available, the overall RPA remains as medium risk. This can be found in Appendix L.

2.8. Constraints

2.8.1. Demonstrating economic and financial viability

The preferred option selected must be economically viable, and must demonstrate an incremental benefit:cost ratio robustly greater than 1 when compared against the other options, in line with FCERM appraisal guidance on the decision-rule. This is explored in detail in the Economic Case.

The overall financial affordability of the proposal is demonstrated at OBC. This is done against a provisional scheme cost that still includes a number of assumptions. Full funding must be secured and committed for the delivery of the scheme to meet final price before approval of the FBC. However, to ensure programme certainty Oxford FAS is running a CPO alongside land negotiations. The CPO process requires known funding to be secured before CPO notices can be issued, this is currently programmed for November 2017 and is in advance of the FBC submission.

2.8.2. Built constraints

The central portion of the western floodplain near Redbridge is very constrained containing a complex layout of road and rail infrastructure, Redbridge Recycling Centre, Redbridge Park and Ride and high voltage overhead and underground cables. Consents will be required from Network Rail, the relevant local authorities and utility operators before work can be done on, or adjacent to, their assets. Negotiations with all parties are ongoing.

Oxford FAS must also gain planning permission before works can commence. The project team have engaged with the 3 local planning authorities early and have already sought a scoping opinion that has helped shape the project. A further pre-planning consultation process is planned before formal submission of the planning application in late 2017. Once our scheme is constructed any land at reduced flood risk will be designated as Flood Zone 3, benefiting from defences. Any development or redevelopment proposals will be reviewed in line with national planning policy. Flood Risk Assessments will have to assess residual risk including the breach or overtopping of defences.

Public consultation with key stakeholders, including landowners and tenants, has helped to further shape the preferred option. In the scheme design we have included access arrangements and tweaks to the scheme route, to enable them to use their land once the scheme is in place. These negotiations are ongoing as landowners have raised concerns about how their land might be managed going forward.

Constraints and dependencies are carefully monitored and managed throughout the project lifecycle.

2.8.3. Programme constraints

The original programme for Oxford FAS presented at SOC stage was based on limited information regarding site conditions, design and buildability and showed how the scheme might be deliverable within the current 6-year settlement period ending March 2021. As more information became available during the appraisal stage it became clear this date was not realistic, due to programme independencies and in particular a review of the number of vehicle movements possible during construction. In particular, the movement of material away from site on to the wider highway network is seen as the key constraining factor. As such, the Sponsoring Group have confirmed they accept delivery of Oxford FAS outside of the current 6-year settlement period. Therefore the overall delivery of the project is no longer time constrained and delivery of the scheme is no longer linked to Defra high level targets.

However, the OxLEP funding is time constrained and must be spent by March 2020. This is being managed by the Funding and Benefits Realisation Manager through annualised spend profiling and is detailed within the Financial Case.

Materials management

Any option that involves significant earthworks will be constrained to seasonal construction arrangements. The earthworks are likely to be in the existing floodplain and therefore construction involving excavation will be unlikely to take place during the wet winter months. The ground is expected to be too wet to work on, or to excavate material from. Construction works are likely to be seasonally constrained to 1 April to 31 October. This constrains the programme as the contractor will not be able to start works outside of this season.

Early works

The Network Rail culvert works highlighted in the SOC were seen as an opportunity to spend now, save later, and therefore the enlarged culverts were supported on an evidence-based decision by the Sponsoring Group. These culverts have now been installed and will be maintained by Network Rail and form an integral part of the proposed scheme. This means we can demonstrate that we have contributed £1 million towards culvert works that would have cost us at least £4 million if installed by our contractor.

2.9. Dependencies

2.9.1. Programme dependencies

The Oxford FAS is being promoted as a standalone scheme and as such there are no programme dependencies now that the updated hydraulic model between Sandford and Mapledurham has been completed as part of a separate study.

2.9.2. Other project dependencies

To enable contractors to bring as much innovation to their programme as possible, we try to minimise constraining them at tendering stage. Excluding legal compliance (e.g. translocation of protected species at specific times during the year) the main driver behind the overall programme delivery will be to ensure that no-one is placed at greater flood risk during the construction phase. Effectively this will mean careful sequencing of the construction activities, for example, the secondary walls and embankments cannot be completed until the main channel is operational.

3. Economic Case

3.1. Introduction

In accordance with the capital investment manual and requirements of HM Treasury's Green Book, this section of the Outline Business Case (OBC) documents the range of flood alleviation options that have been considered though the development of the scheme to date.

In order to arrive at the best value for money options, the analysis follows the procedure set out in the following documents:

- Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG), Environment Agency, 2010
- Multi Coloured Manual (MCM), Flood Hazard Research Centre, 2016
- Defra guidance note 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities' (April 2016).

In order to determine the most effective solution for Oxford which meets project objectives and is deliverable, we have completed a review of potential scheme options and their costs compared to the flood risk reduction benefits. This provides a benefit:cost ratio to allow options to be compared based on economic performance.

The development of options for the OBC has built on previous work on the scheme which reviewed all potential options and refined them to identify the current preferred option. The development process is outlined below:

- An initial long list of over 100 options/combination of options was developed at strategy (Environment Agency, 2010) stage, see Table 3-2 for more details. This reviewed all potential flood risk management techniques and options. This stage identified that increasing the capacity of the river and floodplain system through Oxford would provide the optimum technical solution to reduce flood risk in the Botley and New Hinksey areas of Oxford.
- Black & Veatch were commissioned to review the technically viable solutions (Initial Assessment (IA) 2014). The IA focussed on conveyance improvement and formed the basis of the options presented in the Strategic Outline Case (SOC) in November 2014. The SOC still highlighted earlier options identified at the strategy stage (Table 3-3 below) but the focus of the SOC was on the viable conveyance options.
- Building on the earlier work, the OBC reviewed the 6 options identified around the flood channel. As part of this detailed review we considered various channel sizes and identified local raised defences to work in combination with the new channel. This resulted in the number of options being increased to 14. We have reviewed and refined these 14 detailed scheme options (renumbered 1 to 6biii) further, and this process is explained further in section 3.4.

3.2. Critical success factors (CSFs)

We have used the critical success factors detailed in Table 3-1 alongside the investment objectives for the project (detailed in Table 2-1) to evaluate the long list of possible options. These CSFs need to be met for the scheme to succeed and deliver the projects objectives and benefits.

Table 3-1: Critical success factors

Critical success factors	Description
Strategic fit & business needs	How well the option: • meets the partnership strategic investment objectives • continues to deliver benefits over the next 100 years, allowing for climate change • is adaptable and compatible with future options for further flood risk reduction or to mitigate the effect of climate change • demonstrates that it does not worsen flood risk downstream or elsewhere • helps to meet Water Framework Directive (WFD) targets • delivers wider benefits to the local economy • fits with the study area's constraints • mitigates for any adverse effects on water levels and flows elsewhere • is resilient to both wet (high flow) and dry (low flow) conditions once operational
Potential value for money (VFM)	How well the option: • achieves a viable benefit cost ratio and incremental benefit cost ratio, when compared with the other available options • delivers efficiencies • minimises future maintenance requirements and landscape management costs
Potential achievability	How well the option: • meets and exceeds requirements under the relevant legislation to secure necessary consents • generates and maintains political and stakeholder support including during low flow situations and when the design capacity is exceeded • follows a clear, timely and deliverable approval route • is integrated with related schemes in the area
Supply-side capacity and capability	How well the option: • allows a clear delivery model to be agreed • allows for the establishment of an integrated project team in accordance with the stage of the project • allows future maintenance and management to be agreed and clearly understood

Potential affordability	How well the option: • delivers outcome measures according to Defra's partnership funding rules • employs a joined-up funding strategy • includes benefits to potential funding partners in the design

3.3. Long list options

At strategy stage, a long list of over 100 options or combination of options were assessed, through consultation with Environment Agency specialists, consultants, flood action groups and local residents. Effectively these options are built around 4 main engineering interventions: increase flow capacity, defence, transfer, or storage. The long list options, categorised by type, are detailed in Table 3-2 below:

Table 3-2: Long list options considered at strategy stage

Option	Description	Benefits delivered / issues involved	Reason for rejection or inclusion on shortlist
Widening the River Thames	Widening of River Thames to increase flood flow capacity. The river would need to be widened significantly, (e.g. from 18m to 40m at Botley Road), and would require the compulsory purchase of up to 80 properties to facilitate implementation.	Unlikely to gain planning permission due to landscape impacts	Rejected, as unlikely to gain planning permission.
Increasing flow capacity in western floodplain	Maximising flows thought the existing floodplain to the West of Oxford by widening existing sections of channel and interconnecting with new sections of river channel. Reducing flow constrictions. Lowering surface water levels also reduces risk of groundwater flooding.	Effective in reducing flood risk, acceptable against all other criteria.	Taken forward – effective in reduced flood risk, and acceptable against all other criteria.
Raised flood defences	Construction of flood defence walls or banks. Not appropriate as a standalone solution due to high level of surface and groundwater interconnectivity. Long lengths of defence would be required due to the presence of a braided river system.	Effective in some locations, but not as an overall solution.	Rejected as independent solution, but considered in conjunction with other options.
Water transfer	Combination of pipes and pumping to transfer flood water to an adjacent river catchment.	Costs prohibitive, would worsen flood elsewhere. Difficult to implement and expensive to operate.	Rejected, as transferring flood water would cause flooding elsewhere, and be economically unfeasible.
Upstream storage	Construction of a storage reservoir upstream of Oxford to hold back flood peaks, reducing flows through Oxford to below those which cause flooding.	Not currently economically viable as a standalone solution.	Rejected as an economically viable standalone solution, may be viable in future in conjunction with other options.

Flood proofing	Providing partial reduction in damage to properties by individual adjustments to houses, e.g. moving kitchens upstairs, raising electrical circuits.	Does not reduce probability of flooding. May be technically unviable unless fluvial levels can be lowered initially by other means.	Rejected as a standalone solution as does not have a significant impact in isolation, may be viable in future in conjunction with other options.
Non-structural measures	Making improvements to flood planning, flood warning and development control.	Does not reduce probability of flooding. Unlikely to significantly reduce consequences of flooding in isolation.	Rejected as a standalone solution as does not have a significant impact in isolation, may be viable in future in conjunction with other options.

At the SOC stage 14 options were reviewed all focused on increasing flow capacity. Those taken forward and considered as shown in Table 3-3 below:

Table 3-3: Options focused on increasing flow capacity considered at SOC stage

Option No	Option	Description	Benefits delivered / issues involved	Reason for rejection or inclusion on shortlist
1	Do nothing	No new flood alleviation schemes promoted, no maintenance works carried out to channels or existing flow control structures.	Results in significantly increased flooding.	Rejected as a practical solution, as it is not considered to meet the Environment Agency's legal obligations, or scheme objectives. However, it is included as a baseline in the shortlist as a requirement of FCERM-AG.
2	Do minimum (sustain)	Maintenance of existing flood defence assets until failure. Replacement of structures and temporary defences is anticipated in year 60 to maintain the current standard of service through the 100 year appraisal period.	Existing flooding regime continues	Included as a baseline in the shortlist as a requirement of FCERM-AG.

3	Channel widening	Widening of River Thames and other streams to increase conveyance	Reduces flooding in some locations, but is subject to physical constraints, land availability issues, environmental impacts and high costs.	Rejected as a standalone options due to physical constraints, land availability, adverse environmental impacts, high costs, and in some locations, failure to reduce impact of flooding. However, may be practical in combination with new channel works, so included on shortlist as part of other options.
4	Removal of control structures	Control structures (weirs, locks) removed	Flood flow capacity improved, but may cause existing walls and bridges to fail, would have adverse environmental impacts, and result in loss of navigation.	Rejected as we would be unable to maintain legal requirements for navigation on the River Thames.
5	Enhancement of control structures	Improving locks and weirs	Does not improve flood flow capacity, as constraints are elsewhere in the system.	Rejected as it does not meet scheme objectives or deliver the flood risk reduction required by the scheme.
6.1	New flood channel (small: 18m^3/s)	A combination of new flood channels and widening of existing channel in some locations. Three potential sizes assessed.	Economically viable means of reducing flood risk. Acceptable against all criteria.	Taken forward – effective in reduced flood risk, and acceptable against all other criteria.
6.2	New flood channel (medium: 38m^3/s)			
6.3	New flood channel (large: 57m^3/s)			
7	Reduce frictional resistance of existing channel	Reducing frictional resistance of existing channel. By smoothing channel boundaries (for example, with concrete channel bed and walls, rather than the existing uneven bed and vegetation)	Unacceptable environmental impact, costs too high.	Rejected as investment objectives and critical success factors would not be satisfied.

8	Culverting	Watercourses culverted to prevent escape of water in flood events	High cost and high environmental impacts. Also contravenes Environment Agency policy of not culverting watercourses.	Rejected as investment objectives and critical success factors would not be satisfied. Major issues with maintenance of culverts.
9	Enhanced maintenance	Consists of silt removal, vegetation clearance and vegetation removal on secondary watercourses, leading to improved flood flow due to enlarged cross section and reduced friction.	Discounted on the Thames (where regular maintenance is already carried out), and on the Cherwell, where it does not provide any benefits.	Rejected due to adverse environmental impacts and limited effectiveness.
10	Reduce downstream flood levels	Reducing downstream water levels to increase velocity and therefore reduce water levels through the study area	Little benefit in terms of flood risk.	Rejected, as does not solve flooding problem and hence does not meet scheme objectives.
11	Remove localised constrictions in watercourse	Removing localised constrictions (e.g. undersized bridges and culverts) in the watercourse.	Little benefit in terms of flood risk.	Rejected, as does not solve flooding problem. However, may be effective in certain local locations in conjunction with other methods.
12	Interim measures	Combinations of swales, de-silting of watercourses, refurbishment of existing structures and bunds.	Has some limited benefit in terms of flood risk in the short term.	Retained as an option and subsequently implemented in some localised areas as enhanced maintenance.

3.4. Short list options

3.4.1. Overview

The SOC developed the scheme from the strategy stage and identified a refined list of possible flood risk management options.

The following options were taken forward from the above Table 3-3 at SOC stage:

- do nothing (withdrawal of all maintenance)
- do minimum sustain (continuation of the existing maintenance regime)
- new flood channel in the western floodplain (small)
- new flood channel in the western floodplain (medium)
- new flood channel in the western floodplain (large)
- interim measures

Whilst the SOC identified the medium sized channel as the preferred way forward at that stage, the short list was still brought forward. The sensitivity tests at SOC stage identified that the channel size was sensitive to change (depending on the factors) but the preferred option was always for a channel of some size. This was then further reviewed at the OBC stage. As a result of the detailed review and hydraulic modelling work completed as part of the OBC, we made the following refinements to the options list:

- We found the large channel to be impractical due to the culvert sizes below Old Abingdon Road being constrained by the height of the road surface, a very small hydraulic gradient and the presence of scheduled monuments within the road. The existing culverts and bridges under the railway also restrict the routes which flood water can take to reach the River Thames downstream of Oxford. Network Rail has installed a new culvert under the railway with a contribution from the scheme, as part of a network shutdown, which helps increase capacity for flood flows across the railway. However, installing additional new culverts under the railway to facilitate the large channel option is prohibitively expensive due to the high costs (even if allowed) of railway closures.
- The SOC indicated that a second section of conveyance channel at the south end of the scheme was required. When reviewing the practicalities of this channel, we identified a number of constraints such as services and a road crossing, which limited the benefits of this section of channel. Once these constraints were included in the modelling, the flood risk reduction benefits of this section of channel were reduced. When reviewed in conjunction with the raised defences discussed below we concluded the scheme objectives could be achieved without the need for this section of channel. This reduced the costs, environmental impacts and local disruption to the village of Kennington whilst still achieving the scheme benefits.
- We investigated the option of constructing local raised defences. Additional flood risk benefits could be achieved by the use of local raised defences along the north side of Botley Road and in New Hinksey. Where there is space for earth embankments these would use material arising from the channel excavation works thus reducing material management costs and providing additional flood risk reduction. For the options appraisal process these raised defences were investigated both in isolation and in combination with small and medium channel options. Where we considered the raised defences in isolation, we included compensatory storage.

- In line with the Oxford FRMS, we investigated a storage area with a volume of 9.8 Million cubic metres (Mm^3) upstream of Oxford to mitigate the effects of climate change in a range of future years (the published guidance requires reviews in year 0, year 20 and year 50). We investigated this in conjunction with both options for a small flood channel with defences and a medium flood channel with defences.
- We added in an additional do minimum scenario, which included not replacing the temporary defences currently deployed at Osney Island, New Hinksey and South Hinksey at the end of their 35 year design life.

This technical and modelling review of the practicalities of implementing the SOC options led to the options shown in Figure 3-1 being considered for the OBC. At this point the options have been renumbered from the list shown in the SOC, the numbers shown in Figure 3-1 below are referenced in the remainder of the document.

The arrows represent where incremental benefit:cost ratios are calculated. Due to the possible combinations of different channel sizes and raised defences it should be noted that there is more than one route through the incremental benefit:cost ratios. This occurs because there are a number of elements to the scheme which can be considered individually, or in combination. For example:

- the small channel alone can be tested for economic viability
- the incremental economic viability of increasing the channel size to medium can then be tested
- the incremental economic viability of constructing defences in addition to the medium channel can then be tested
- the incremental economic viability of constructing a storage area in either year 0, year 20 or year 50, in addition to the medium channel and defences can be tested

To ensure we found the optimum combination of channel size and raised defences, we investigated all the options shown in Figure 3-1 in turn, through a step-by-step economic appraisal process.

3.4.2. Technical assessment

We reviewed the SOC options in detail against additional data gathered at the start of the OBC stage. This included a detailed review of the topography, services locations, detailed fluvial modelling of watercourses and environmental constraints and opportunities.

This review identified a number of potential routes through the western floodplain. The study area was initially subdivided into 7 geographical areas for ease of reference and for better appraisal of the specific opportunities and constraints in each area. Subsequently, 3 to 5 localised routes were identified for each geographical area - refer to the 'Channel Corridor Options Report' (November 2015) for further information. Each of the areas were hydraulically independent and thus the appraisal process could select the preferred route for each area which would then be combined to create the preferred overall route of the scheme.

We then consulted stakeholders and the public on the options in each area during 5 public events and via an e-consultation in January 2016. The feedback from this consultation along with a technical review was incorporated into a 2-stage multi-criteria options appraisal process (MCA). The first phase of the MCA determined the preferred route in each of the geographical areas based on the economic, social, technical, environmental, and institutional objectives of the scheme. The preferred route for each area was combined to give an overall route for the scheme. In the second phase the overall route was tested with different channel sizes and each in combination with raised

defences. This was then followed by an economic analysis as noted in the report entitled 'Multi-Criteria Options Appraisal Report' (October 2016) in Appendix D.

Due to the complexity of the options appraisal process and economic analysis, we brought in Professor Edmund Penning–Rowsell[1] of Middlesex University to provide specialist advice on the development of this process and to peer review the detailed economic analysis.

The options are shown in Figure 3-1 below. We completed hydraulic modelling of the preferred route to confirm the flood risk management benefits of each, and then compared these benefits to the estimated costs. This process is described in more detail in section 3.5.

Table 3-5 below summarises the preferred option selected in each area and the major site constraints and limitations that were identified during outline design. We tested the various elements of the scheme proposed in the SOC for effectiveness during the hydraulic modelling of the river system completed as part of the outline design process.

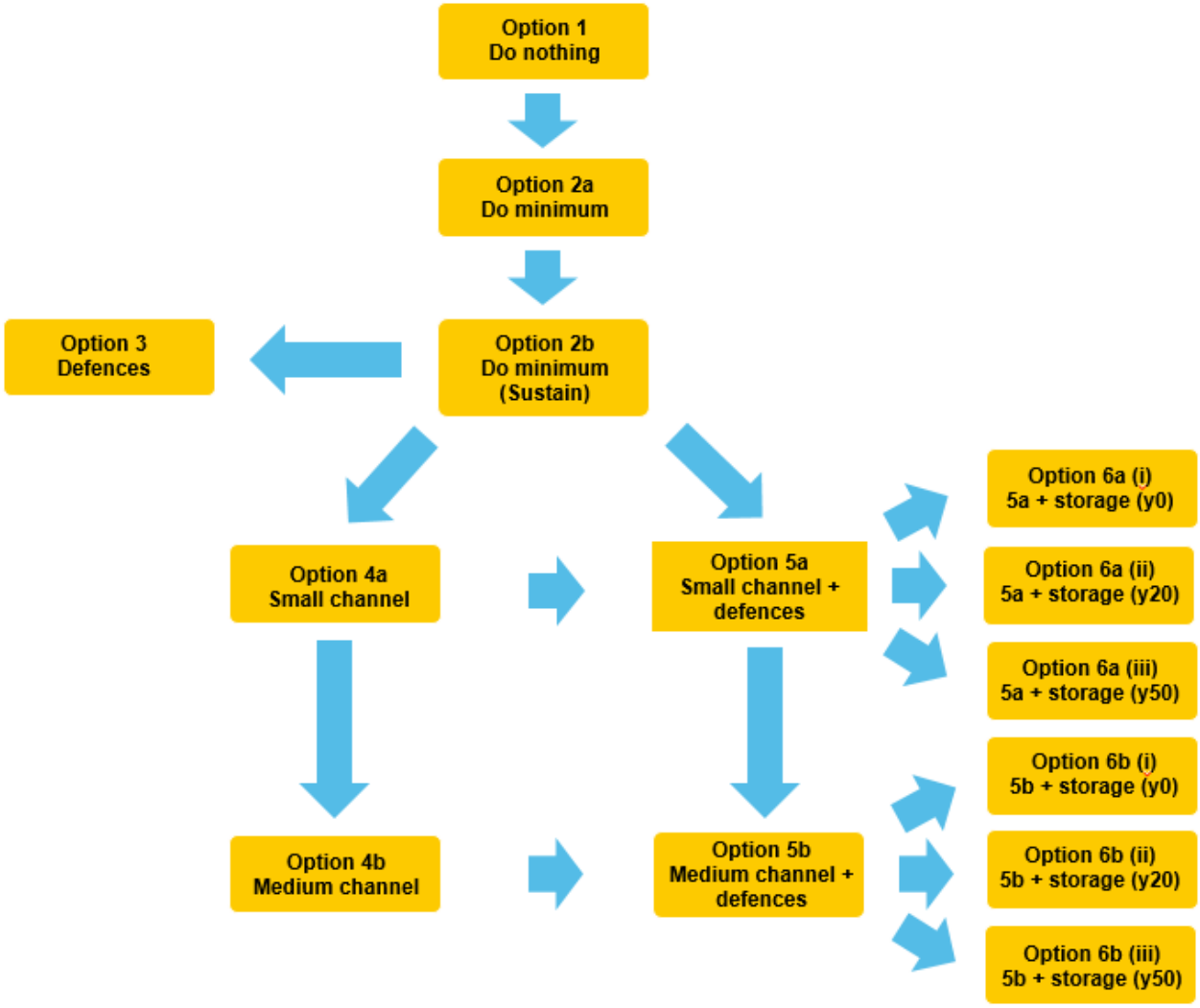


Figure 3-1: Options considered for the OBC

These options are further described in Table 3-4 below.

[1] Professor Penning-Rowsell is one of the country's leading specialists in flood hazard research. He founded the Flood Hazard Research Centre at Middlesex University in 1970 and is co-author of the FCERM Manual for Economic Appraisal which defines the basis for estimating flood risk benefits on all schemes in the UK. He was also twice the Chair of the Defra/ Environment Agency Advisory Group on Flood and Coastal Defence Research and Development (2004/5).

Table 3-4: Options considered for the OBC

Option Number	Option	Description
1	Do nothing	All existing work ceases. No operation or maintenance of assets or watercourses would take place. Blockages would not be removed.
2a	Do minimum	Existing assets and watercourse would be maintained but not replaced. The standard of service will decrease over the appraisal period.
2b	Do minimum (sustain)	Existing assets and watercourses would be maintained and replaced. The standard of service will be maintained over the appraisal period.
3	Defences	Localised raised defences and level for level compensatory storage.
4a	Small channel	Excavation in the undeveloped floodplain to the west of the city centre to provide increased flood flow capacity of 18 cubic metres per second.
4b	Medium channel	Excavation in the undeveloped floodplain to the west of the city centre to provide increased flood flow capacity of 38 cubic metres per second.
5a	Small channel and defences	Small channel (Option 4a) with the addition of raised defences to provide increased protection to properties and the Abingdon Road.
5b	Medium channel and defences	Medium channel (Option 4b) with the addition of raised defences to provide increased protection to properties and the Abingdon Road.
6a (i)	Option 5a plus storage (yr0)	Small channel plus defences (Option 5a) with the implementation of a 9.8Mm^3 upstream flood storage area at the same time as the flood channel and defences.
6a (ii)	Option 5a plus storage (yr20)	Small channel plus defences (Option 5a) with the implementation of a 9.8Mm^3 upstream flood storage area 20 years and 50 year after the flood channel and defences respectively.
6a (iii)	Option 5a plus storage (yr50)	
6b (i)	Option 5b plus storage (yr0)	Medium channel plus defences (Option 5b) with the implementation of a 9.8Mm^3 upstream flood storage area at the same time as the flood channel and defences.
6b (ii)	6b (ii) – Option 5b plus storage (yr20)	Medium channel plus defences (Option 5b) with the implementation of a 9.8Mm^3 upstream flood storage area 20 years and 50 years after the flood channel and defences respectively.
6b (iii)	6b (iii) – Option 5b plus storage (yr50)	

The original SOC proposal included a section of new conveyance channel from Rose Isle to just south of Sandford Lock on the River Thames, which was intended help improve capacity through the system and draw down water upstream in the flood risk area of New Hinksey and Grandpont. The length of this channel was 1400m, and consisted of a deep and wide two-stage channel through low lying agricultural floodplain. During the development of the outline design we found that the physical restrictions such as the height of banks on the River Thames, need for a control weir to maintain navigation depths, location of overhead and buried services and the need to build a new bridge to cross Sandford Lane, along with the influence of groundwater, reduced the depth and width of the channel which would be physically achievable in this area.

When a narrower and shallower channel was modelled, the reduction in water levels in the flood risk area of interest was less significant, changing benefits from a 250mm drop in flood levels (at the SOC stage) to a 120mm drop. This reduction in benefits prompted a review of alternatives to this element of the original SOC proposal. We discovered through additional site visits and the modelling work that a raised defence between the River Thames and New Hinksey combined with the remainder of the conveyance channel, provided improved benefits over those proposed by the original option in the SOC, particularly in the protection of Abingdon Road, a key infrastructure link and one of the main objectives of the scheme.

This review allowed us to remove the downstream section of channel around Sandford Lock. This also avoided significant impacts on the management of the meadows and visual aspect of the area, in turn reducing the quantity of material to be removed from site during the construction process by 200,000m^3. The works to Weirs Mill Stream which would have been disruptive to residential boat moorings could now also be avoided by constructing a raised defence in New Hinksey. A further efficiency is that the material for the proposed raised defence can be constructed from selected alluvium material generated elsewhere on the scheme which reduces use of primary materials and also reduces the volume of material which needs to be removed from site, along with the associated environmental impacts.

A full set of outline design drawings is provided in Appendix B along with a fly-through visualisation of the overall scheme. A summary map identifying the different scheme areas and features is shown in Figure 3-2 overleaf.

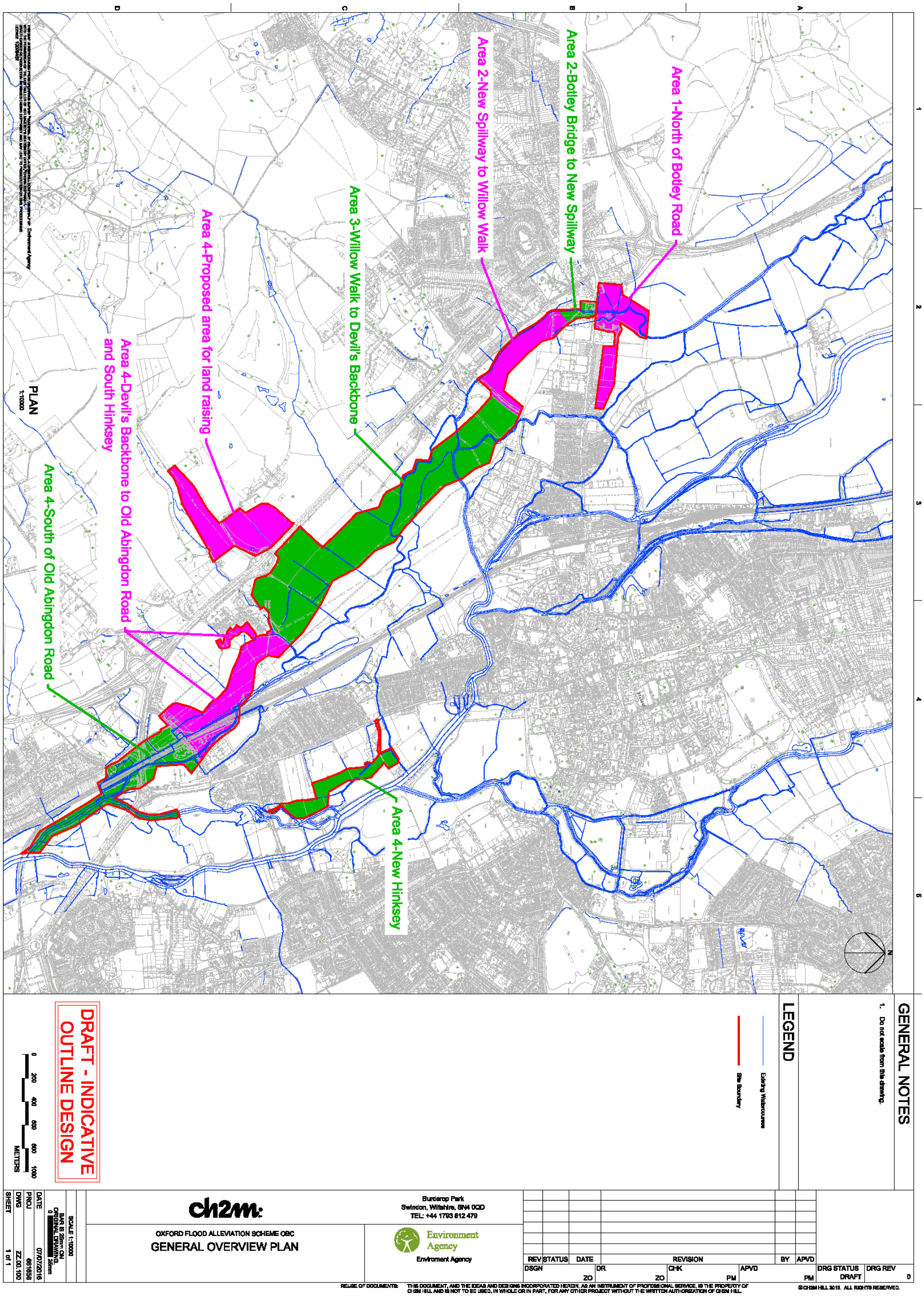


Figure 3-2: Scheme route and area map

Table 3-5: Summary of design proposals and key constraints in each area

Area and summary of proposed works	Summary of constraints in each area
All areas	Ground investigation results confirmed that the water table is generally high (between 1m to 2m below ground level) across the whole study area. This presents a number of technical difficulties with the construction process. Excavations for foundations will encounter water and we will need to deal with this using cofferdams and temporary pumping to maintain a dry construction area. The excavation of the first stage of the channel will also need to be carried out under groundwater level which will require implementing pollution prevention measures to prevent any disturbed material creating sedimentation problems downstream of the working area.
Area 1 (North of Botley Road) The proposed works include: - raised defences to the north of Botley Road, mainly in the form of a flood bund but short lengths of floodwalls are also proposed - a second-stage channel based each side of the Seacourt Stream - modifications to Botley Road Bridge to increase flow capacity - small flood gates on 2 pedestrian bridges in Helen Road and Henry Road	All of the access routes into Area 1 are via Botley Road which is one of the main roads into Oxford and is always heavily trafficked, especially during peak hours. It is also within one of the 7 air quality hot spots where pollution levels of nitrogen dioxide have exceeded national targets as outlined in the city-wide air quality management area (AQMA). The proposed works are designed to minimise construction traffic impacting on this road by incorporating measures such as re-utilising the excavated material to minimise vehicle movements, and maximising the flow capacity of the existing Botley Bridge to avoid the need for new culverts below the road. We need to design the scheme carefully to minimise impacts on badger setts on the land to the north of the proposed raised defences. We are consulting with the Oxfordshire Badger Group and will continue to do so throughout the subsequent stages of the scheme. It may be necessary to adjust the line of the defences in this area to reduce impacts on the badgers in the area. We need to design the scheme carefully to minimise impacts on Seacourt Park and Ride which forms an essential part of the transport infrastructure for visitors and workers in the city. It may be necessary to adjust the line of the defences in this area to accommodate plans for a car park extension currently submitted to the local planning authority for approval consideration. Botley Bridge is a 2-span, simply supported bridge, with both spans supported on mass concrete blockwork piers and abutments. The foundations of the pier and abutments are all in the form of reinforced concrete piles. There is a commercial property on the south western side of the bridge which restricts access. The volume of flows through Botley Bridge has a direct influence on the efficiency of the scheme to lower water levels in the Botley and Osney areas. However, modifications to an existing bridge bring inherent engineering challenges and

Table 3-5: Summary of design proposals and key constraints in each area

Area and summary of proposed works	Summary of constraints in each area
	risks. Additional topographical, bathymetry, and structural surveys are planned to develop a better understanding of the condition of the bridge. The bridge is owned and maintained by Oxfordshire County Council who we have consulted to gain further information on the bridge and who will be involved in the design development of the bridge modifications.
Area 2 (from Botley Bridge to Willow Walk) The proposed works include: - a 2-stage channel on the Seacourt Stream - a new footbridge to replace existing Westway Cycle Bridge - a spillway from the Seacourt Stream to a new scrape channel - an accommodation bridge at Willow Walk	The existing Westway Bridge is situated within close proximity to a commercial building on the western bank of the Seacourt Stream and there are overhead electric lines running across the eastern abutment. Replacing this bridge without impacting on these restrictions will require careful design and implementation. There is an area of high ecological value to the north of Willow Walk. A species-rich meadow with a Natural England National Vegetation Classification of MG4a is found within the proposed channel route. The preferred route uses a small footprint as possible and is located along the side of the Seacourt Stream. This alignment minimises impact on the meadow but does result in the loss of a line of mature trees. We will review the overall channel size as part of the detailed design process and if possible reduce it to minimise the environmental impacts on this meadow. We will also review how changes to the groundwater regime could influence the MG4a area.
Area 3 (from Willow Walk to Devil's Backbone) The proposed works include: - a 2-stage channel that interconnects with existing streams. Simple low-flow control structures are also included at connection points with existing streams - various environmental features in the first and second stages of the channel - a stone-surfaced access track running north adjacent to the left bank of the new channel - footbridge at Monk's Causeway - footbridge at Devil's Backbone - a flow control structure on the Eastwyke Stream	We have selected the alignment of the scheme in this area to link to the natural topography of the area and to avoid the major services through the area which would be prohibitively expensive to move or relocate. Even so, there are a number of services which will require rerouting or diversion, including the lowering of a gas main and water pipe which crosses the channel route and the diversion of an 11kV cable cross the channel route. Environmental mitigation and enhancements are proposed along the channel both within the second stage and in the wider area. Exact details are subject to ongoing discussions with landowners. We have derived a low flow protocol for the new channel system in conjunction with Environment Agency internal departments. This will ensure a balance between maximising environmental benefits and ensuring sustainability of key ecology during periods of low flows, whilst maintaining navigation on the River Thames. We are proposing to include 4 fixed low level weirs to manage the low flows and ensure that channels are favoured where the maximum environmental benefit is achieved. This will be drowned out

Table 3-5: Summary of design proposals and key constraints in each area

Area and summary of proposed works	Summary of constraints in each area
	during normal flows and all existing channels will continue to be used whenever possible.
Area 3 – West of South Hinksey Proposed works include land raising	The fields to the west of the A34 South Hinksey junction have been identified as possible fields for raising the land with the excavated material from the channel works. This will require a landfill licence and separate planning application. We continue to consult with the landowners and planning officers to confirm feasibility. If land raising is to go ahead, then the high voltage electricity line may restrict the extent of the land raising to maintain certain clearance for the overhead line. Discussions are underway with Scottish and Southern Electricity to confirm the minimum clearance height. There are also known habitats for great crested newts in this area, as well as the presence of badgers which will restrict any filling operation. Any potential impact on the adjacent Chiswell Valley Nature Reserve would also need to be considered and mitigated.
Area 4 – North of Old Abingdon Road (from Devil's Backbone to Old Abingdon Road) The proposed works include: - raised defences at South Hinksey - a two-stage channel including control structures - a number of environmental features in the second stages of the channel - an accommodation bridge 100m south of Devil's Backbone to maintain access to the National Grid compound - a culvert through the railway (already designed and constructed by Network Rail) - channel clearance works on Hinksey Stream to the east of the railway	There are numerous underground and overhead electrical services in this area. Some of these are oil-filled 33kV cables which are sensitive to ground movements. Where the defence crosses these, concrete protection slabs will be required. The construction of the sheet pile wall around the eastern side of South Hinksey village will require careful and constrained working methods due to the presence of buried 33kV cables and 11kV overhead cables. There are 2 separate overhead high voltage electric lines with pylons that run in parallel to the channel. We have designed the alignment of the channel to avoid interacting with these overhead lines as far as possible, but the risks associated with working underneath overhead electric lines would still be present. The opportunity to combine the accommodation bridge and the Devil's Backbone bridge has been investigated with landowners to try and rationalise and improve access in this area, reduce the visual impact of the scheme and generate efficiencies and cost savings for the scheme. However the landownership and wayleave agreements along with the need for 24hr unrestricted access to the National Grid compound in this area preclude the combination of the structures.
Area 4 – South of Old Abingdon (from Old Abingdon Road to River Thames) The proposed works include:	The Hinksey Drain widening would require digging into the former landfill site. We looked into a number of options for sealing this channel as part of the outline design. We have recommended using a reinforced earth arrangement with a

Table 3-5: Summary of design proposals and key constraints in each area

Area and summary of proposed works	Summary of constraints in each area
- 3 x 7m wide parallel culverts through Old Abingdon Road - widening Hinksey Stream and Hinksey Drain adjacent to the railway embankment - removal of Towles Mill Weir - a constrained reinforced earth channel through former landfill area - culverts through both sides of the A423 Bypass - channel clearance works on the southernmost part of the Weirs Mill Stream - channel clearance works on Hinksey Stream down to the confluence with the River Thames	sealed liner to create a barrier between the landfill material and the widened channel. The Hinksey Drain would be within close proximity to the railway, therefore sheet piling is used in the current design to avoid long term scour risk to the railway. It may be possible to design these piles out during the next stage and develop a more cost effective option. There is an overhead high voltage electric line with pylons that run in parallel to the channel. The pylon located near Kennington Pond is relatively close to the proposed channel works, therefore protection works have been proposed to avoid the risk of scour around its foundations. These works will be designed in conjunction with National Grid. There are a number of scheduled monuments in the form of medieval culverts below sections of Old Abingdon Road. This restricts the space and location available to install the new precast culverts. The existing alignment, although not hydraulically efficient, is skewed across the road to avoid the known scheduled items. Archaeological investigations have been carried out to ascertain the location of any other items of interest at the proposed crossing point. The 2.8m x 3.5m culverts through the A423 Bypass will require an innovative construction method. The A423 embankment is over 10m high and this along with the high traffic density and overhead cables makes traditional open trench construction methods difficult. We are proposing to install the new culverts using box jacking or a horizontal cofferdam technique to avoid impacts on the stability of the A423 embankment. These can be constructed below the live carriageway with no disruption to vehicle flows. We need to design the placement of the eastern culvert carefully to minimise impacts on Redbridge Park and Ride, which forms an essential part of the transport infrastructure for visitors and workers in the City. It may be necessary to adjust the number or/and final placement of construction compounds to allow us to construct the new culverts in situ. The southernmost stretch of the Weirs Mill Stream is adjacent to a Special Site of Scientific Interest (SSSI). The proposed channel clearance works on the Weirs Mill Stream are still to be confirmed following additional topographical and bathymetry surveys. Any proposed works will consider the environmental and ecological impact to the adjacent SSSI site.
Area 4 – New Hinksey	Groundwater flooding in the Grandpont area is an existing problem. Whilst the scheme reduces groundwater levels in

Table 3-5: Summary of design proposals and key constraints in each area

Area and summary of proposed works	Summary of constraints in each area
The proposed works include: - raised 1.5m high defences across low lying meadows to the east of Abingdon Road - local groundwater measures	the area for any given event, groundwater flooding is likely to be an ongoing challenge. The current design provides 2 small groundwater pumping stations in this area to help control groundwater local to residential areas during flood events. There is a 24-inch medium pressure gas line that would be overlain by the proposed earth bund at 3 locations. The design will need to consider the additional loading onto the pipe as well as the impact of construction methods on the gas line. There are known to be badgers in the area which will restrict the alignment of the new defences and require reinforcement in the embankment to avoid badger excavations compromising the flood defences.

3.4.3. Scheme maintenance

The outline design of the scheme has considered the long-term maintenance to ensure this is minimised and managed in a sustainable manner. The channel will be designed to be as stable and self-cleansing as possible to reduce the need for ongoing sedimentation management. However, it will be a natural channel and will be subject to natural river processes, including the movement of materials during major flood events which may need intermittent interventions. A geomorphological assessment has identified 2 key areas where sedimentation may occur, these are upstream of Botley Road Bridge and just upstream of Old Abingdon Road culverts. The Environment Agency Field Services Team have experience of working within the existing water courses in the area and have provided an estimate of the frequency and costs of carrying out this intermittent silt removal, which we have included in the maintenance costs estimate for the scheme.

We are discussing ownership of the new bridges with Oxfordshire County Council Highways to investigate opportunities for these to be adopted. Based on discussions to date it is likely that the County Council will adopt culvert structures below public highways subject to agreement on commuted sums. The costs of ongoing maintenance of bridges have been included in the scheme costs regardless of the maintenance authority.

It is anticipated that the second stage of the new channel will be grazed by landowners and tenants in the long term. This will help to maintain a relatively short cover of grass in the area which will help to convey flood flows.

Due to the high water table and soft material in the base of the second stage of the channel, we expect that it will take between 5 to 7 years following excavation to establish a suitable vegetation mat to support long term cattle grazing. During this establishment period all maintenance and grass cutting will be carried out by the Environment Agency until a grazing regime can be reintroduced. This has been allowed for in the scheme costs.

The second stage will incorporate an allowance in the channel sizing for a range of roughness values to be accommodated. However, even if grazing takes place we anticipate that the Environment Agency will need to cut vegetation twice a year, to ensure that woody vegetation which could reduce channel capacity is kept under control.

For the purposes of the OBC and to test the viability of the scheme it has been assumed that all future maintenance of the scheme is carried out by the Environment Agency or its partners.

3.4.4. Environmental assessment

In line with legal requirements the environmental benefits and impacts of the scheme need to be assessed and quantified during the design process. One of the Environment Agency's key objectives is to provide environmental enhancements over and above those required as mitigation for the disbenefits of the scheme, so that there is an overall net environmental benefit to the area as a result of the scheme. This assessment of the environmental impacts and benefits considers the preferred route identified through the MCA process described in section 3.4.2.

The environmental assessment is at an early stage. A series of desk based studies and a number of site surveys and walkovers have been carried out by ecologists to understand the existing environmental features and constraints of the area covered by the scheme. We have assessed the impacts of the scheme based on the findings of the surveys and the outline design. The scheme incorporates a number of environmental features and we have assessed the overall area of improved environmental benefits as 6.6 hectares. The detailed design process will ensure that this will be delivered and established within 10 years of completion of construction of the scheme.

We have sent a scoping consultation letter covering the environmental aspects of the scheme to the planning department at Oxfordshire County Council. They have consulted with a wide range interested parties, including local authority departments (from Oxfordshire County Council, Oxford City Council and Vale of White Horse District Council) which cover the scheme area and a number of third party consultees. These included local wildlife groups who have an in depth local knowledge of the area and provided comprehensive responses on the environmental implications of the scheme.

Based on the results of the scoping consultation responses, we have produced a Preliminary Environmental Information Report (PEIR) to capture all the key environmental information and to record any mitigating measures required to manage the impacts of the scheme. The PEIR is included in Appendix J of this document. The PEIR will be referred to through the detailed design stage of the scheme to inform the detailed Environmental Impact Assessment (EIA), which will culminate in a detailed Environmental Statement (ES) to accompany the planning application and cover all the environmental impacts, associated mitigation and benefits which the scheme will provide.

In addition, we have completed a preliminary WFD appraisal along with an ecosystems services appraisal, which have identified additional impacts and benefits which have fed into this assessment.

A summary of the key environmental impacts and benefits are presented in Table 3-6 below.

Table 3-6: Summary of PEIR: key issues

Topic	Key issue
Ecology	The scheme is designed to have an overall benefit for ecology, with benefits for water-dependent habitats outweighing impacts on terrestrial habitats. The scheme will have a significant impact on MG4a grassland at Hinksey Meadow, with the loss of approximately 2ha of high-value neutral grassland. MG4a grassland is a recognised Natural England classification for a nationally rare type of grassland which can be developed in floodplain meadows over a number of decades of sustainable management of hay cutting and aftermath cattle grazing. The channel design has been located and reduced in size as far as possible to minimise impact on the MG4a grassland. In addition we are working with the landowner in the hope of translocating the MG4a to nearby sites which are considered suitable in terms of hydro-dynamic conditions. The project has engaged the Floodplain Meadows Partnership, who are experts in this type of habitat, to advise on the mitigation measures which will include identifying

Table 3-6: Summary of PEIR: key issues

Topic	Key issue
	possible translocation sites, however there is no guarantee of success in replacing the MG4a community. There is a benefit to fish migration from removal of Towles Mill Weir, partially counterbalanced by loss of a migration route along Bulstake Stream at very low flows (Q_{95} and below, i.e. the flow that occurs for only 5% of the year, typically in late summer). There will be a significant reduction in the size of Kennington Pond, which is of high value. The nationally-rare glutinous snail which was formally found there is now believed to be locally extinct. There will be a significant loss of trees and hedgerows, particularly at Kendall Copse community woodland. Trees will be replanted wherever possible.
Landscape and visual	The scheme will result in significant changes to landscape character, particularly the removal of trees, hedges and fence lines. The second-stage channel will differ in appearance from the existing grassland and need revised agricultural practices to manage boundaries. New structures (such as bridges over the new channel) will be prominent and need to be designed sensitively. There are opportunities for improvements in some areas. We need to minimise impacts on the views of the 'dreaming spires of Oxford' from the hills to the west of the city.
Archaeology	The scheme avoids direct impact on the known scheduled monument (medieval culverts under Old Abingdon Road) but does affect its surroundings and the setting of the scheduled monuments. There is a high risk of encountering unknown archaeology across the scheme area; this is being mitigated through targeted advanced archaeological investigations to facilitate early discussions with local council archaeologists and Historic England. We have carried out archaeological investigations through Oxford Archaeology at the location of the proposed culvert at Old Abingdon Road. The findings of this investigation are yet to be determined but may impact the flood channel alignment in this area. The desk-based assessment (DBA) raised potential for further archaeological finds across the remainder of the project area, particularly around Monks' Causeway which may be an ancient route into the city. Archaeological investigations were carried out across the wider area to give further information about the archaeological risk. The investigations consisted of geoarchaeological boreholes and magnetometer surveys, to identify areas of high potential for archaeological finds and to identify where ground conditions are suitable for archaeological finds. Once the information from these surveys has been analysed and the reports are complete this will inform further archaeological investigations across the wider area to be carried out in 2017, before submission of the planning application.

Table 3-6: Summary of PEIR: key issues

Topic	Key issue
Traffic, transport and air quality	Although most HGVs can access the construction areas directly to and from the A34, some will need to use other roads, particularly Botley Road which is a known congestion and air quality hotspot. There is potential for a short term increase in traffic congestion and therefore exceedence in nitrogen dioxide beyond national targets. We have developed a Materials Management Plan to minimise vehicle movements as far as possible. Old Abingdon Road and Kennington Road will need to be closed for up to 9 months during construction, with diversions in place. Closures of this road are known to cause congestion on the diversion routes. We are likely to need to close or divert several footpaths, a bridleway and a non-statutory cycle route for all or most of the construction period. Temporary diversions are available via the highway network but in some cases these are significantly longer. After construction, all will re-open, and some footpaths and bridleways will have minor permanent diversions.
Flooding	There is a significant benefit through reduced flooding of residential and commercial areas, plus reductions in frequency that the Botley and Abingdon Roads are closed by floodwater which is one of the key objectives of the scheme.
Geo-morphology	There are several areas of the proposed channel network where we expect there will be localised changes to sediment mobility following the implementation of the scheme. In general terms, this means that some of the smaller tributaries and channels will be more vulnerable to sediment deposition and may require interventions to maintain conditions suitable for habitats and aesthetics.
WFD	Potential benefits include: • increased diversity in flow conditions, sediment and habitat – improved water body quality elements • increases in the 'in-stream' vegetation habitat due to diverse flow conditions and creation of marginal berms – this increases the potential for suitable fish spawning habitat • varying flows within the 2-stage channel will allow diverse habitat • increased longitudinal connectivity to streams due to barriers being removed • overall improved fish passage following the removal of the existing Towles Mill weirs on the Hinksey Stream which currently restrict fish passage in this watercourse • increased sediment transport potential thereby improving hydro-morphological conditions within the water bodies • potential for new wetland habitat in scrapes and backwaters • opportunity to improve some of the existing watercourses in the area
WFD	Potential disbenefits: • loss of trees could lead to bank destabilisation and increased water temperature

Table 3-6: Summary of PEIR: key issues

Topic	Key issue
	• culverts could become 'dark barriers', inhibiting fish movement • loss of bed habitat in Botley Stream, for example, due to loss of flows and flow widths – this should be temporary as habitats should re-adjust within the stream channel to provide additional habitat for invertebrates and macrophytes • where flow is reduced in places, risk of temporary sedimentation until high flows flush out material. • increased sediment deposition in some areas requiring additional maintenance with impacts on ecology Mitigation needs to be considered and incorporated as recommended in the WFD preliminary assessment. As a result of the proposed works, there will be a requirement for a detailed WFD assessment due to the range of potential impacts to the water body.

In addition to the key environmental impacts and benefits listed in Table 3-6 there are a number of other environmental issues which are specific to the Oxford FAS and the surrounding area, the details of which are provided in Table 3-7 below.

Table 3-7: Summary of PEIR: other issues

Topic	Other issues
Recreation	Hinksey Meadows is the only open space within the scheme areas where there is permissive public access. The area available for public access will be reduced for a proportion of the year when the second stage is wetter than the current land. At present there is no formal access for the public to the majority of the other open areas other than formal footpaths which run east to west across the area. These footpaths will remain open to the public once the scheme has been implemented through the use of new bridges over the channel. Set against this, the new channel with its ecological enhancements and the other water-dependent habitats being provided could enhance the experience of walking in the fields. However, initial discussions with landowners indicates that providing additional public access to the area is unlikely. There will be additional fishing opportunities on the new channel.
Water	No changes to water quality are anticipated. Risks of silt pollution and runoff from contaminated ground during construction can be managed. Groundwater effects have been modelled. This process has shown that there are some local benefits which will help to reduce flood risk from groundwater. However there are no wider impacts which will have any effect on Port Meadow or Iffley Meadows. The groundwater modelling indicates there may be a change to the regime in Hinksey Meadow and the consequences of this on the MG4a grassland will be reviewed by local specialists, the Floodplain Meadows Partnership, as part of the detailed design.
Cultural heritage	There are features of cultural heritage value within the scheme area; the effects on these are covered under visual impact and archaeology.

Table 3-7: Summary of PEIR: other issues

Topic	Other issues
Material assets and the local economy	There are minor gravel deposits under the works area. At present these are not in the Local Minerals Plan and the small scale of these deposits compared to other existing sites elsewhere mean it is not financially viable to extract these minerals in current market conditions. It is not expected that significant quantities of minerals will be generated by the scheme. The deposit in the area of the new channel would be put beyond reach by the scheme being built over the top of the areas and some financial compensation for this will need to be paid to the landowners. There will be disruption to numerous local businesses during construction, counterbalanced by long-term benefits from reduced flooding. There will be disruption to farming, there are several tenant farmers who would have a large proportion of their land out of production for several years. One local horse-riding business has expressed concerns about long-term viability if forced to close for several years.
Sustainability and carbon	There will be significant carbon emissions during construction, mostly from transport of alluvium away from the site.
Land use	A significant area of agricultural land, within the second-stage channel, will become wetter and may become less productive. No change to the current land-use (a combination of meadow and grazing) is foreseen. Removal of fences within the second-stage channel will make it harder for farmers to use the land efficiently and retain livestock in the area. A number of options for managing stock in the second stage of the channel in the future have been identified and discussed with the landowners and tenant farmers through a series of landowner workshops to ensure the area is agriculturally viable once the scheme is completed.
Geology and soils	Several former landfill sites are present in the scheme area, particularly Kendall Copse. Impacts due to these can be managed through engineering solutions using proven technology to ensure the new channel is sealed against infiltration from contaminated material and groundwater.
Waste	We have developed a Materials Management Plan to optimise the management of materials arising from the works. Current proposals are for some of the excavated alluvium to be used in the raised defences and we are investigating the potential to dispose of some as permanent landraising of agricultural fields on the west side of the A34. However most is likely to be taken offsite due to limited space outside of the floodplain. There are a number of existing local gravel extraction sites which are due to be reinstated, these sites will re-use material from the scheme for environmental benefits. Landfill material from the Kendall Copse area will need to be removed from the site to a licenced waste facility. The works in this area are being designed to minimise the volumes of landfill material which needs to be removed.
Health	There is a significant benefit to health from direct and indirect effects of reduced flooding. There will be a temporary loss of recreational land and diversion of walking and cycling routes during construction leading to lost health benefits.

Table 3-7: Summary of PEIR: other issues

Topic	Other issues
	Any longer-term changes in recreation or walking/cycling routes will have minor effects. Landowner discussions to date indicate that providing improved pedestrian and cycle access through the main area between Old Abingdon Road and Osney Mead is unlikely to be possible due to the potential conflict with their farming practices.
Air quality	Temporary impacts on air quality relate to vehicle emissions, mainly from any increase in traffic congestion but to a lesser extent direct emissions from project vehicles. All residential areas in the Oxford City Council area, and some in the Vale of White Horse, are in Air Quality Management Areas (AQMAs) and therefore sensitive to increases in air pollution over any significant period.
Noise	Noise impacts are mainly due to construction of the raised flood defences, as these are close to houses whereas the new channel is mainly in agricultural land. In this case, option 4b (medium channel) would have lower impacts than option 5b (medium channel and defences).
Cumulative effects	We are not currently aware of any other developments which would have cumulative effects with the scheme. We are maintaining contact with the various local councils to ensure we are aware if any are proposed.

Water Framework Directive (WFD)

Under WFD all waterbodies are given a status classification based on their ecological and chemical quality. The 5 classes are high, good, moderate, poor or bad. Classifications indicate where the quality of the environment is good, where it may need improvement and what may need to be improved. The principal water bodies impacted by the scheme are the Thames (Evenlode to Thame), Thames (Wallingford to Caversham) and River Cherwell (Ray to Thames). All are classified as having moderate ecological status at present.

We have completed a preliminary WFD compliance assessment providing a high level assessment of potential impacts of the Oxford Flood Alleviation Scheme. This can be found in the PEIR at Appendix J. The quality of habitat in the existing channel is relatively poor in terms of ecological interest and he preliminary assessment has concluded that we can achieve WFD compliance on the scheme with appropriate mitigation. This will include improving habitats by designing backwaters for fish refuges, pools and gravel riffles to provide improved bed substrate, and wet land scrapes and ponds within the second stage to create a wider diversity of habitats. The assessment recommends a full compliance assessment once the detailed design has been completed.

Environmental mitigation

We have designed environmental mitigation into the scheme, in particular through the choice of the detailed route.

Key environmental measures:

- We will minimise the 2ha area of MG4a grassland lost at Hinksey Meadow through narrowing the second-stage channel and running it alongside Seacourt Stream as much as possible, to reduce the impact on the MG4a area. The contractor's working areas outside the footprint of the new channel will be minimised in this area, or removed if possible. The permitted working area will be fenced to prevent accidental damage to the retained grassland. As part of the ground investigation for the detailed design stage we propose to

install additional groundwater monitoring points so any changes to the environment of the MG4a grassland can be monitored in the future.

- We are currently in discussion with the landowner, the Oxford Preservation Trust, regarding the possibility of using topsoil, turf and green hay to attempt to establish additional MG4a grassland at other sites. The landowner has identified another site they own close to Oxford which appears to have favourable conditions for establishing MG4a which they are keen to try and seed from the arisings in Hinksey Meadows. We are also discussing the opportunities of attempting to translocate the MG4a grassland to another location within the scheme area which has similar groundwater conditions. This will require moving part of the subsoil as well as the turf. This is an experimental procedure and has never been attempted before due to the time periods for establishment, therefore long term monitoring of this work is proposed. We are designing the ecological mitigation programme to ensure a net benefit to ecology, even if this translocation fails.
- We will attempt to establish new areas of MG4a or MG4 grassland through use of locally-sourced seed or green hay. 5 trial pits have been excavated to replicate the second stage of the proposed channel to investigate this possibility.
- We will replace trees lost due to the scheme with native trees. This is particularly the case at Kendall Copse where several hundred semi-mature trees will be affected, and we will replace as much as possible with indigenous species.
- We will provide a new access onto the South Hinksey junction of the A34, to allow HGVs direct access to the project site. This will be the sole access for the main part of the site, with other access routes used only for areas which cannot be accessed via this route.
- A Materials Management Plan has been developed to re-use the materials arising from the implementation of the scheme as much as possible.
- Removal of Towles Mill Weir is important to maintain fish passage. It should be done as early in the programme as possible, preferably before Bulstake Stream is severed below the Q_{95} flow levels.
- We are carrying out a programme of protected species surveys and will design suitable mitigation for any species we may be affecting.
- The scheme will be designed to fit in with the existing landscape as far as possible. For some bridges, particularly the bridleway at Willow Walk, we will work with the local council to design a bridge that might differ from highway standards to avoid excessive visual impact. We have started discussions with the local council with respect to obtaining an approval in principle for the bridge designs prior to planning submission.
- The extent to which we can amend the route of the channel is very limited, hence mitigation for any archaeology found will be through recording finds, and preserving off-site where appropriate. We are agreeing investigations prior to construction, rules for watching briefs and other mitigation with the county archaeologist and the Oxford City Council archaeologist.

Environmental enhancements

One of the key objectives for the scheme is to deliver environmental improvements and enhancements to the area. There will be significant temporary environmental impacts during the construction of the scheme. However, in addition to the environmental mitigation, there is an opportunity to build in enhancements to ecology, to landscape and to recreation.

These will focus on the riverine and floodplain environment and will consist of the creation of wetland scrapes, backwaters and small ponds to improve the range of habitat in the locality whilst

being in-keeping with the landscape concepts for the scheme. At present many of the channels in the area are heavily shaded and parts of the grass land have relatively little environmental interest. There will also be channel improvements through the creation of gravel riffles to improve fish breeding habitats.

We will plant trees and hedges to replace those lost in the second stage of the new channel and look for further opportunities for additional planting. The overall concepts and high level proposals are outlined on the Indicative Landscape Plans provided in Appendix J of this document. Many of these will need to be delivered in agreement with the landowners. Discussions are underway to secure these enhancements and they will be further developed and refined during the detailed design process. It is anticipated that the majority of the environmental improvements will be within the second stage of the new channel.

There is also an opportunity for an enhancement in the area to be used for permanent material storage, west of the A34. The land will be raised, with potential benefits for agriculture, while at the same time the buffer zone between Chilswell Copse and agricultural activity could be enlarged. This enhancement is subject to this land being retained as part of the scheme, which remains under review and is also subject to consultation and negotiation with landowners.

3.5. Economic appraisal

3.5.1. Introduction

This assessment follows the procedure set out in the following documents:

- Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG) (Environment Agency, 2010)
- Multi-Coloured Manual (MCM), Flood Hazard Research Centre, 2016)
- Defra Guidance Note ‘Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities’ (April 2016)

Damages and benefits have been calculated for each option over a 100 year appraisal period and details of the assessment can be found in Appendix C.

3.5.2. Benefits

When assessing the national economic benefits of a flood defence scheme the principle measure used is defined by the government in the FCERM-AG guidance as Outcome Measure 1 (OM1). This is defined as the average benefit:cost ratio across the capital programme based upon the present value whole life cost and benefits of projects delivering in the current Government spending review. This allows benefits to be quantified and compared across the country to ensure they are delivering best value for money for the Government. OM1 is a specific Government target. This section describes OM1 benefits for the Oxford scheme, and how they are derived.

In the list below, damages refer to the cost of repairing property affected by flooding. Refer to chapters 4-6 in the MCM for more details.

OM1 benefits:

- Residential property damages, typically residential houses and flats: these are calculated using residential property-specific depth damage curves, detailing damages to building fabric obtained from the MCM, and flood depths derived from hydraulic modelling.
- Non-residential property damages, typically commercial property such as offices and factories: these are calculated using non-residential property specific depth damage curves, detailing damages to building fabric and obtained from the MCM, and flood depths derived from hydraulic modelling.

- Residential evacuation/accommodation damages: these are calculated using a matrix provided by the MCM based on depth of flooding and type of property, and taking into account average property rents, cost of temporary accommodation, food, additional transport costs and loss of earnings.
- Non-residential property indirect damages: these are calculated using an uplift factor applied to non-residential property damages, representing the costs of trying to minimise indirect losses such as losses of business to overseas competitors, and the additional costs of seeking to respond to disruption or the threat of disruption which fall upon firms when flooded.
- Vehicle damages, including those in residential garages, on-street parking and an allowance for any public car parks within the flooded areas: these are calculated using average figures for vehicle value and location of vehicles obtained from the MCM.
- Emergency response and recovery damages: this covers the costs for emergency services activities during and after a flood event. This includes police, ambulance, fire services and any military assistance provided. These are calculated using data based on the summer 2007 floods, where it was found that the average emergency costs applicable to flood events were 5.57% of the total damages. This figure is therefore applied as an uplift factor to the residential and non-residential direct property damages detailed above.
- Risk to life damages: these are based on the Defra Supplementary Note to Operating Authorities – 'Assessing and valuing the risk to life from flooding for use in appraisal of risk management measures', which takes into account depth, velocity, frequency and locations of flooding, and an average value assigned to life. It is noted that the risk to life figure calculated for this study is lower than that calculated in the initial assessment. This is because the 2014 study made use of an average occupancy per house figure of 2.3, whereas this study uses a more conservative figure of 1.15. Both of these figures are deemed acceptable by the Defra supplementary note, but the lower figure has been used here to be conservative and hence ensure more robust calculations, and based on local knowledge, is considered to be more applicable to the population density of Oxford.

3.5.3. Difference between the small and medium channel (with defences)

The scale of the scheme means that differences between the channel-only options, channel with raised defences options (both small and medium channel) and between the small channel and the medium channel (options shown in Figure 3-1), are minimal, as the same route corridor from the first stage of the MCA process is used for all options therefore the impacts of each will be similar.

The impacts and benefits of options 1, 2 and 3 are all insignificant compared to those of options 4 and 5, see Figure 3-1 for details of the options. Exceptions to this, e.g. noise, are noted in the text of Table 3-6 and Table 3-7 below.

This section explains the key differences in benefits between option 5a (small channel and defences) and option 5b (medium channel and defences – the preferred option) in a 1 in 100 (1%) or higher annual flood event. The results of this investigation are shown in Figure 3-3 and Figure 3-4.

- In the current scenario, 1560 residential and commercial properties are internally flooded in a 1 in 100 (1%) or higher annual flood event.
- With option 5a implemented, 562 properties remain at risk in a 1 in 100 (1%) or higher annual flood event.
- With option 5b implemented, 283 properties remain at risk in a 1 in 100 (1%) or higher annual flood event.

- The 283 properties which remain at risk in a 1% AEP event benefit from an improved standard of protection. They may previously have been at risk in a 1 in 10 (10%) or higher annual flood event, for example.
- Methods of further reducing the flood risk (AEP) to these properties are still under investigation.

Therefore, a further 279 properties are protected by option 5b in a 1 in 100 (1%) or higher annual flood event, in addition to the reduction of flood risk to the A420 Botley Road and A4144 Abingdon Road which are key transport links into the centre of Oxford.

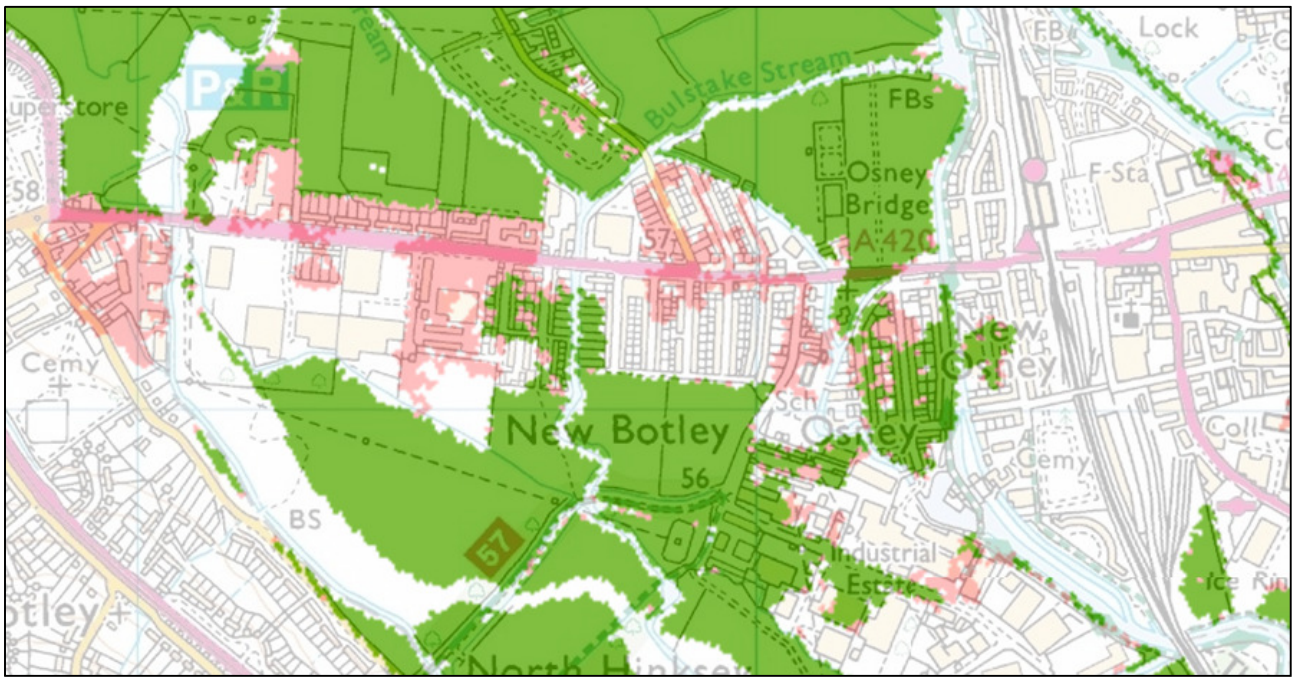


Figure 3-3: Difference in areas at flood risk in 1% AEP, option 5a (small channel and defences) and option 5b (medium channel and defences), Botley area.

- Areas remaining at flood risk in 1 in 100 (1%) or higher annual flood event for option 5a (small channels and defences) are shown in red
- Areas remaining at flood risk in the 1 in 100 (1%) or higher annual flood event for option 5b (medium channel and defences) are shown in green

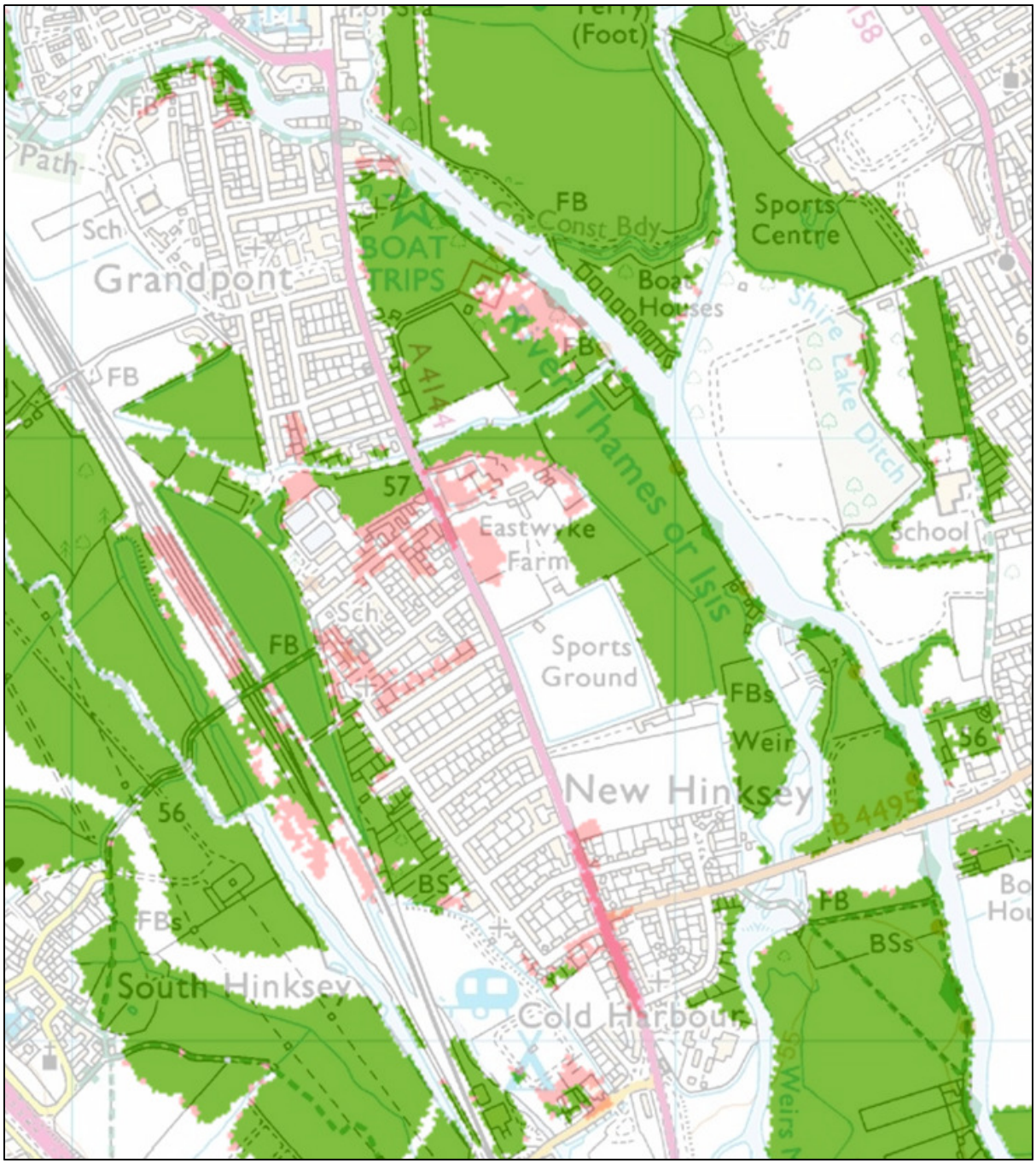


Figure 3-4: Difference in areas at flood risk in 1% AEP, option 5a (small channel and defences) and option 5b (medium channel and defences), Grandpont and New Hinksey areas.

- Areas remaining at flood risk in the 1 in 100 (1%) or higher annual flood event for option 5a (small channels and defences) are shown in red
- Areas remaining at flood risk in the 1 in 100 (1%) or higher flood event for option 5b (medium channel and defences) are shown in green

3.5.4. Costs

All costs used are based on 2016 rates. The costs for the scheme were developed from the outline design by the relevant specialists in the team based on similar previous work. These were compiled and reviewed by the cost consultant.

Method for developing costs:

- Detailed construction costs were based on option 5b – medium channel and defences. These were generated by the Early Supplier Engagement (ESE) contractor, Team Van Oord. These are based on a 3 year construction programme, with the baseline scenario of all surplus excavated materials arising from the works being removed from site. We have derived costs for other options (4a, 4b, 5a) from those developed for option 5b according to size of works required. These were developed in conjunction with the ESE contractor and the cost consultant.
- We obtained advice from a specialist culvert installation contractor, Delta Civil Engineering, on the cost estimates for the new large culverts below the A423 Oxford Bypass due to the specific nature of the installation works required at this location to minimise traffic disruption.
- Detailed design costs were developed by the WEM lot 3 consultant.
- Construction costs for the stage 3 upstream flood storage area were obtained from the Oxford FRMS briefing note, 'engineered flood storage' (April 2009) and scaled up to present day costs using the Construction Output Price Index for New Construction.
- Maintenance costs for the existing system and new flood alleviation scheme were provided by the Environment Agency field services team who have local knowledge and experience of maintaining the existing channel.
- One of the largest costs on the scheme will be to remove the material from the excavation of the channel out of the floodplain and away from the scheme. We have developed a Materials Management Plan to identify potential sites for re-use of the materials. Team Van Oord have tested the market place to ensure that costs for materials management are robust based on the current market conditions.

Costs have been benchmarked against the project cost tool (PCT) and other recent schemes by the cost consultant. Costs have been input to the appropriate scheme years and discounted to present values.

Risk items to cover uncertainties at the outline design stage have been developed using a detailed Monte Carlo analysis and through the inclusion of an element of optimism bias.

Present values

The costs and benefits described above have been discounted to present values. The discount rates used are in line with standard discounting rates used for FCERM projects, these are;

- 3.5% discount for project year 0 to year 30
- 3.0% discount for project year 31 to year 74
- 2.5% discount for project year 75 to year 99

Table 3-8 provides these present values of both costs and benefits associated with each option. Details of the damages/benefits calculations are contained in Appendix C.

3.5.5. Option ranking and economic appraisal conclusion

The economic assessment has reviewed all the options presented in Figure 3-1. Even if all options demonstrate a benefit:cost ratio in excess of 1, the FCERM-AG guidance requires that incremental benefit:cost ratios between the various options are proven to be robust and hence allow progression to increasingly more expensive schemes. This helps to ensure that the optimum value for money for each project is achieved.

Using this process we identified option 5b (medium channel and defences) as the preferred option based on the FCERM-AG (2010) decision rule. Figure 3-5 overleaf shows the options identified in

Figure 3-1 and highlights the progression routes through the options assessment process. Green arrows indicate a viable incremental benefit:cost ratio allowing the process to progress to the next option. Red arrows indicate a non-viable incremental benefit cost ratio (iBCR) preventing the scheme selecting the next step change option. Figure 3-5 shows that option 5b (medium channel and defences) can be demonstrated to be the preferred option via 3 possible routes through the economic appraisal process providing confidence in the robustness of the economic viability of this option rule.

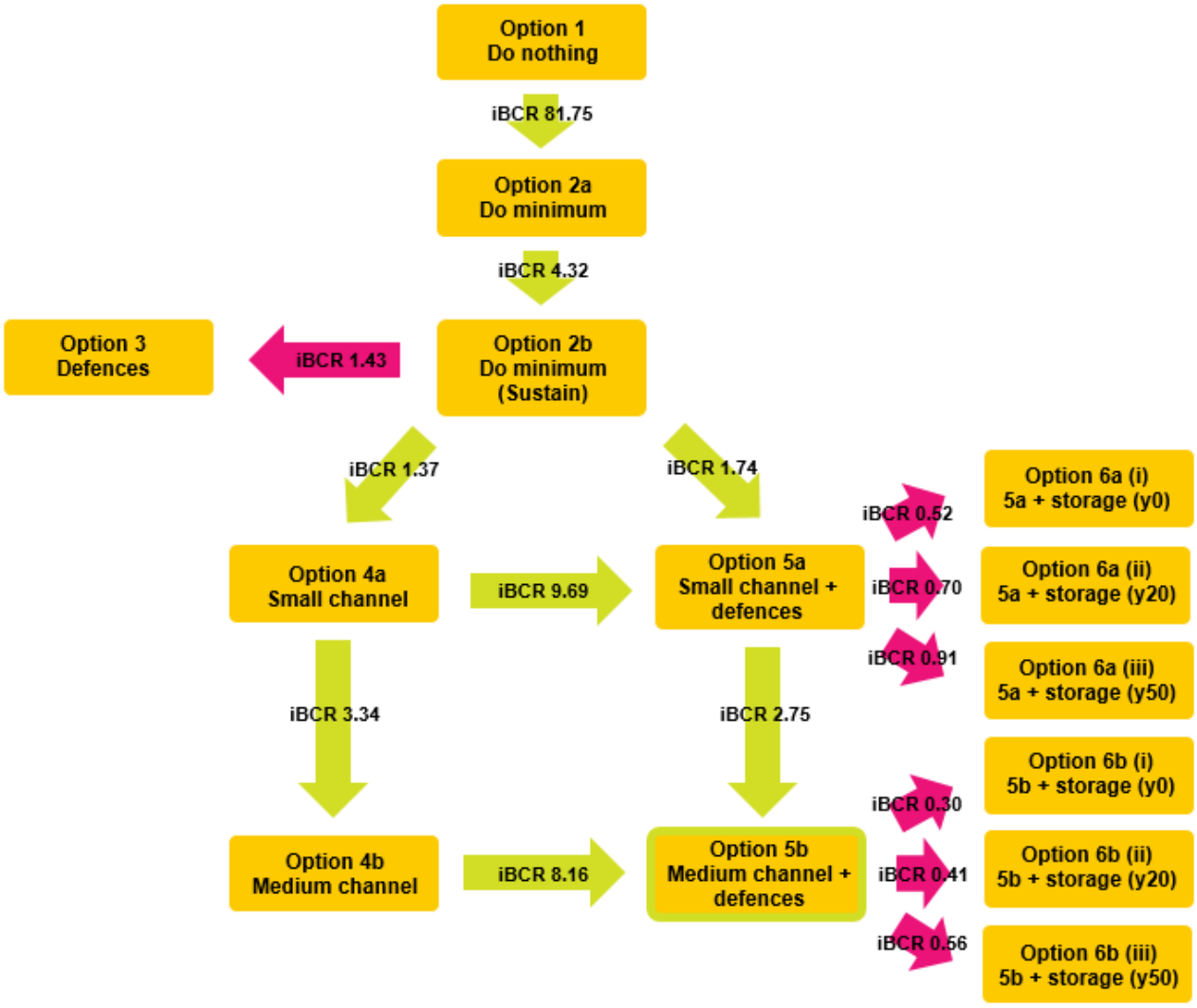


Figure 3-5: Process for determining the preferred option

The selection process shown in Figure 3-5 above is explained in bullet points below, and the figures which back up this selection process are presented in Table 3-8 below;

- The option with the highest average benefit:cost ratio (ABCR) is identified as the leading option. This is the Do minimum (2a) option, with an ABCR of 62.6. The AEP of the next option (2b, do minimum sustain) is <1.3%, with an incremental benefit cost ratio (iBCR) of 4.32. This is greater than the iBCR of 1 required to progress, so it is possible to progress to option 2b.
- At this point, iBCR tree diverges, and there are 3 paths which ultimately arrive at the preferred option of 5b. A description of these follows. In all cases, there remain properties with an AEP of > 1.3%, so the iBCR required to progress is always 1, these are explained below:

- Path 1 – option 2b (do minimum, sustain) → 4a (small channels) → 4b (medium channel) → 5b (medium channel and defences). The iBCR 2b → 4a is 1.37, so it is possible to progress to option 4a. The iBCR 4a → 4b is 3.34, so it is possible to progress to 4b. The iBCR 4b → 5b is 8.16, so it is possible to progress to 5b.
- Path 2 – option 2b (do minimum, sustains) → 4a (small channel) → 5a (small channel and defences) → 5b (medium channel and defences). The iBCR 2b → 4a is 1.37, so it is possible to progress to option 4a. The iBCR 4a → 5a is 9.69, so it is possible to progress to 5a. The iBCR 5a → 5b is 2.75, so it is possible to progress to 5b.
- Path 3 – option 2b (do minimum, sustain) → 3 (defences). The iBCR 2b → 3 is 1.43, so it is possible to progress to option 3. However, option 3 does not meet the scheme objectives as agreed by the project partners. It provides only localised benefits reducing flood risk to a 1 in 20 (5%) annual flood event. There is also the need to provide substantial compensatory storage for removal of floodplain. Whilst this option has therefore been discounted it is explored further as a fall back option in section 6.13.1 in the Management case.
- None of the options with storage on the right hand side of Figure 3-5 provide an iBCR of greater than 1, so it is not possible to progress to any of these in the future even with the effects of climate change.

Based on the outputs from the modelling and the estimated damages resulting from the flooding in the do nothing option, the preferred option 5b (medium channel and defences) will result in £1112.4 million of damages avoided. The breakdown of these benefits are shown in Figure 3-6 below.

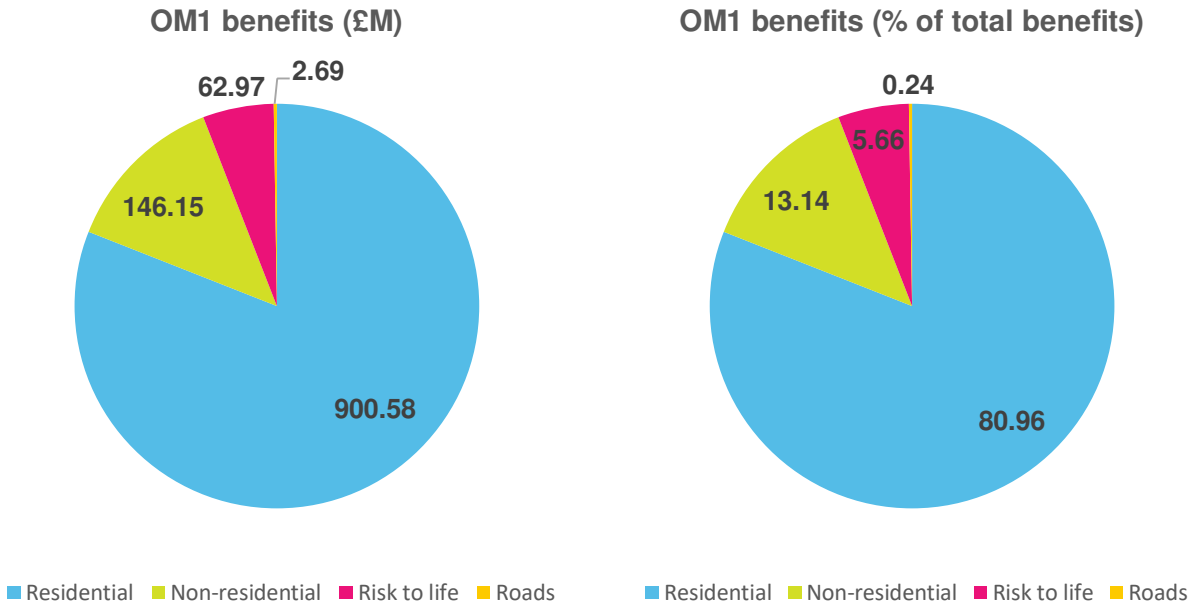


Figure 3-6: Breakdown of damages avoided by preferred option

When compared to the maintain scenario the proposed scheme will result in an additional £180.9M of damages avoided. In year 0, in comparison with the maintain scenario, the proposed scheme will better protect (i.e. flooding within 0.3m of threshold) 2057 (1836 residential and 221 commercial) properties against in a 1 in 100 (1%) or higher flood event. The impacts of climate change are presented in section 3.10.

3.5.6. Conclusion

In accordance with the FCERM-AG decision rule, option 5b (medium channel and defences) has been selected as the preferred option which delivers the optimum flood risk reduction benefits and delivers the project's key objectives.

Table 3-8: Economic assessment summary

Option number	Option 1	Option 2a	Option 2b	Option 3	Option 4a	Option 4b	Option 5a	Option 5b	Option 6a (i)	Option 6a (ii)	Option 6a (iii)	Option 6b (i)	Option 6b (ii)	Option 6b (iii)
Option name	**Do Nothing**	**Do Minimum**	**Do Minimum (sustain)**	**Defences and Compensatory Storage**	**Small Channel**	**Medium Channel**	**Small Channel + Defences**	**Medium Channel + Defences**	**Small Channel + Defences + Storage y0**	**Small Channel + Defences + Storage y20**	**Small Channel + Defences + Storage y50**	**Medium Channel + Defences + Storage y0**	**Medium Channel + Defences + Storage y20**	**Medium Channel + Defences + Storage y50**
Costs:														
PV capital costs	-	0.0	3.7	52.8	82.0	93.6	85.7	96.9	161.2	125.0	100.6	172.4	136.2	111.8
PV operation and maintenance costs	-	11.2	11.2	11.3	12.7	14.3	12.8	14.4	14.6	13.8	13.1	16.1	15.3	14.7
Total PV Costs £m taking contributions into account	0.0	11.2	14.9	64.1	94.7	107.8	98.5	111.2	175.8	138.7	113.7	188.6	151.5	126.4
Benefits:														
PV monetised flood damages	1,221.8	306.2	290.3	220.1	180.7	137.0	144.4	109.4	104.1	116.1	130.5	86.4	93.0	100.9
PV monetised flood damages avoided		915.6	931.5	1,001.7	1,041.1	1,084.8	1,077.4	1,112.4	1,117.6	1,105.7	1,091.3	1,135.3	1,128.7	1,120.9
Total monetised PV damages £m	1,221.8	306.2	290.3	220.1	180.7	137.0	144.4	109.4	104.1	116.1	130.5	86.4	93.0	100.9
Total monetised PV benefits £m		915.6	931.5	1,001.7	1,041.1	1,084.8	1,077.4	1,112.4	1,117.6	1,105.7	1,091.3	1,135.3	1,128.7	1,120.9
Total PV damages £m	1,221.8	306.2	290.3	220.1	180.7	137.0	144.4	109.4	104.1	116.1	130.5	86.4	93.0	100.9
Total PV benefits £m		915.6	931.5	1,001.7	1,041.1	1,084.8	1,077.4	1,112.4	1,117.6	1,105.7	1,091.3	1,135.3	1,128.7	1,120.9
Decision making criteria, excluding contributions, based on total PV benefits:														
Net present value (NPV)		904	917	938	946	977	979	1,001	942	967	978	947	977	994
Average benefit/cost ratio (ABCR)		81.8	62.6	15.6	11.0	10.1	10.9	10.0	6.4	8.0	9.6	6.0	7.5	8.9
Incremental benefit/cost ratio (iBCR)			4.32	1.43	1.37	3.34	1.74	2.75	0.52	0.70	0.91	0.30	0.41	0.56
Option used for iBCR			2a → 2b	2b → 3	2b → 4a	4a → 4b	2b → 5a	5a → 5b	5a → 6a (i)	5a → 6a (ii)	5a → 6a (iii)	5b → 6b (i)	5b → 6b (ii)	5b → 6b (iii)
Incremental benefit/cost ratio (iBCR)							9.69	8.16						
Option used for iBCR							4a → 5a	4b → 5b						

3.6. Non-financial benefits appraisal

The main non-financial benefits relate to environmental enhancements and improvements made to achieve WFD targets. These are covered in detail within section 3.4 above. A Frontier Toolkit Analysis has been completed as part of the scheme, which investigates the local benefits to businesses and transport links which are not covered by the FCERM-AG economic analysis. These are considered to be benefits to the local economy and are not included in the economic analysis as they either do not qualify as national benefits or could be double counting. However they have been used to help secure funding by demonstrating additional benefit to local businesses and organisations within Oxford who would be affected by flooding. See the Financial Case for further information on the scheme funding.

An ecosystems services assessment (ESA) has also been carried out on the scheme. This investigates the environmental benefits provided by the scheme under the following categories:

- carbon sequestration (based on current and future land use and related services)
- aquatic and land based species diversity/habitat improvement
- water quality regulation related to WFD criteria
- recreational use (including walking, cycle commuting, equestrian use, bird watching, fishing etc)
- education

This process provides a framework for a qualitative review of some of the wider benefits of the scheme. A detailed quantitative review using the ESA was not carried out due to the limited benefits compared to the direct financial benefits of the scheme, and whilst they help to meet the wider scheme objectives, they do not significantly contribute to the economic viability of the scheme. This was a result of many of the recreational activities already existing in the local area and the likelihood that limited new recreation activities would take place but could result in a transfer of activities to new facilities created through the scheme.

The findings of the ESA assessment will be taken forward in the detailed design stage to ensure that the scheme objectives are achieved and that we have maximised the environmental benefits.

3.7. Preferred option

Based on the assessment described in the previous sections the preferred option is option 5b (medium channel and defences). In summary this provides the following economic benefits in line with the published FCERM-AG guidance:

- present value benefits of £1,112.4 million at a present value cost of £111.2 million, based on the 50th percentile (P50) risk value
- an average benefit:cost ratio of 10.0
- a net present value of £1001.2 million

3.8. Risk appraisal

The approach to risk management on the project is detailed within the Risk Management Strategy within the Management Case, whilst an overview of the approach is given in the Strategic Case.

With the appraisal stage now complete and a preferred alignment agreed, the project team and partners have now updated and quantified the project risk register using the Monte Carlo statistical

tool. Scheme costs are still based on the assumption that all excavated material, now nearer 400,000m^{3,} is sent to off-site to restoration sites. The Economic Case uses the 50% Monte Carlo risk figure (P50), whilst the Financial Case uses the 95% Monte Carlo risk figure (P95). These figures are £11.73 million and £15.93 million respectively.

Even at this stage of the project there are still risks that are unknown and therefore cannot be costed. These risks are accounted for via optimism bias using the 2003 Defra supplementary guidance. This guidance reviewed cost overruns on historic projects and assigned percentages against 5 main scheme factors. Projects are reviewed against this guidance. At this stage the optimism bias figure for Oxford FAS is 12% or £9.45 million.

Risk therefore equates to 32.2% of the remaining design and construction costs of this submission. If a detailed risk review had not been undertaken optimism bias at this stage of a project is usually 30%.

The main quantified project risks, mitigation measures and risk owners associated with the Oxford FAS are shown in Table 3-9 below. The full Monte Carlo risk register and optimism bias calculation are included as Appendix N.

Table 3-9: Main risks and mitigation measures

Top 5 project risks by value (following mitigation)		
Risk	**Mitigation**	**Risk owner**
Weather event during construction works (Mean Estimated Value (MEV) £3.4m): with the main construction activity involving earthworks in the floodplain we and our early supplier engagement have reviewed our historic rainfall and flood records (stretching back over 100 years) and can calculate how many days would be lost historically from wet weather and flooding.	Restricting earthworks to 1 April – 31 October minimises the risk of construction works being aborted due to higher flood risk over the winter months. Suppliers have suggested that with July 2007 being the only significant summer flooding in the last 100 years the client takes the risk of summer flooding allowing them to fully commit plant and equipment to the project. The impacts of rainfall remains a risk and this risk will be passed to the contractor in accordance with the contract.	Richard Harding, Project Executive
Increase in lands compensation costs (MEV £1m): the most likely costs within the baseline are based on current market values within Oxford and assume the Environment Agency takes freehold ownership of the 1st and 2nd stage channel through a Compulsory Purchase Order (CPO). Land values can vary locally and this risk allows for additional land costs being agreed.	We are continuing dialogue with landowners to try to reach negotiated settlements and avoid freehold ownership. However, in many cases we may still need to pay a high percentage of the land value for the 1st and 2nd stage due to the diminution in value caused by lowering the land.	Michael Thorne, Estates Agent

Inquiry from either planning or CPO (MEV £0.8m): programme has been baselined on the assumption that the risk can be managed through ongoing dialogue and agreements. An inquiry (which must be for a material reason and not simply because someone doesn't like the scheme) could delay delivery by 12-18 months.	Continued dialogue with landowners and other stakeholders will minimise the risk of need for and objection to CPO. We will seek scoping opinion and carry out a pre- planning consultation to understand risk in planning and enable dialogue with interested parties.	Veronica James, Planning Manager
Cumulative impact of risks delaying start on site by 1 year (MEV £0.8m): programme assumes main contract award in late 2018 and therefore earthworks starting in spring 2019. With earthworks being seasonal any delays to award would delay the scheme by 1 year.	We will monitor the programme and develop preparatory works schedule once site surveys are complete, as main risk is around key constraints such as seasonal environmental work and assurance process.	Richard Harding, Project Executive
Material volumes increase due to inaccurate data (MEV £0.6m): the majority of topographic data has been obtained using Lidar. Whilst this is sufficient for appraisal work it has tolerances of +/- 200mm which could result in a significant change in earthwork volumes.	Full topographic survey has been commissioned which will be used to both re-run the hydraulic model and help prepare a 3D model for earthwork purposes to be used during detailed design and construction.	Phil Marsh, Consultant Project Manager

3.9. Partnership funding calculator

The partnership funding calculator is a standardised published method for estimating the Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) level of contribution to a flood risk management scheme and the amount of third party funding necessary. This analysis uses the P95 risk allowance, which is different to the cost figures for the economic assessment.

The partnership funding calculator for option 5b (medium channel and defences) with a 100 year duration of benefits and 95%ile risk shows a partnership funding score of 54%, and that an external contribution of £53,439,484 (Present Value) is required to give an adjusted score of 100%. This raw economic output is then turn into real cash values for the financial case.

A copy of the partnership funding calculator including the present value of contributions can be found in Appendix E.

3.10. Impacts of climate change

FCERM-AG guidance requires the review of the numbers of residential properties moving within specially defined flood risk bands. There is one of these Government targets for each spending review cycle. These are categorised as Outcome Measure 2 (OM2) benefits.

The number of properties in the 'very significant', 'significant' and 'moderate' risk bands is shown in Figure 3-7 below.

In line with the recommendations of the guidance 'Adapting to climate change: advice for flood and coastal erosion risk management authorities' (Environment Agency, 2016), the performance of the

preferred option has been assessed against the recommended climate change allowances for the Thames catchment:

- lower (10%ile) climate change estimate applied
- central (50%ile) climate change estimate applied
- higher central (70%ile) climate change estimate applied
- upper (90%ile) climate change estimate applied

The scheme provides a significant improvement in the number of properties at risk immediately after implementation and continues to provide significant benefits to those properties at very significant risk even by year 50.

However, by year 50 the effects of climate change mean additional properties outside of the current risk categories become at risk as shown below in figure 3.7. It should be noted that these numbers are for residential properties only, and will therefore not match overall properties benefiting quoted elsewhere in this document. We have reviewed and confirmed we cannot justify undertaking phase 3 of the Oxford FRMS (upstream flood storage) either now or in the foreseeable future. The project partners are aware of this and if the evidence changes this situation will be reviewed.

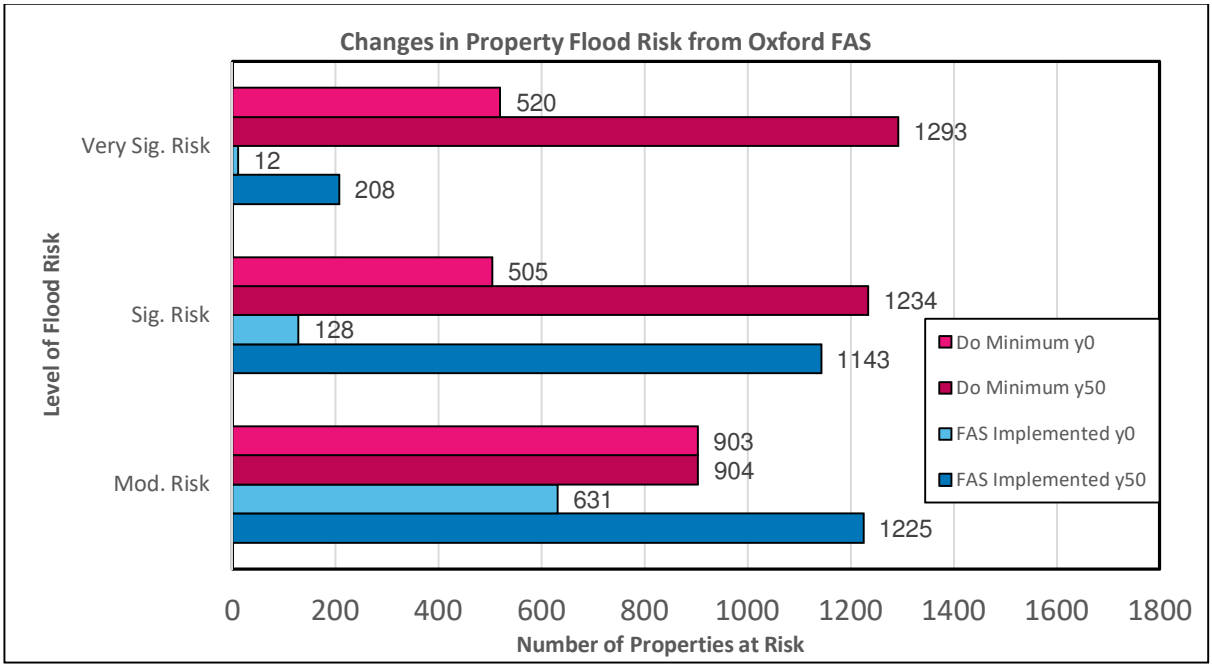


Figure 3-7: Number of residential properties at risk pre and post (year 0 and year 50) implementation of the Oxford FAS with the central (50%) climate change scenario

The AEP events each of the above risk bands relates to are shown below:

- very significant risk >=1 in 20 (5%) annual flood event
- significant < 1 in 20 (5%) but > in 75 (1.33%) annual flood event
- moderate <= 1 in 75 (1.33%) but > 1 in 200 (0.5%) annual flood event

3.11. Sensitivity analysis

Once the preferred option had been selected through the economic appraisal route, we carried out a number of sensitivity tests to review the robustness of the economic viability of the scheme. This looked at a number of parameters within the scheme which could vary either due to physical

changes in the local area, changes or outside influences to the scheme in the development process or changes to the outcomes of the scheme.

Sensitivity tests completed:

- Risk to life damages and benefits omitted: this sensitivity analysis was completed due to concerns that the Defra supplementary note to operating authorities – 'Assessing and valuing the risk to life from flooding for use in appraisal of risk management measures' may overestimate damages (and therefore benefits) attributable to risk to life. As a worst case scenario, the sensitivity was completed by removing risk to life damages and benefits completely, rather than reducing them by a factor.
- Non-residential properties damages and benefits reduced by 33%: this sensitivity analysis was completed due to concerns that non-residential benefits may be overestimated due to some sites currently being vacant. The 33% figure was selected as a worst case scenario based on the results of a site walkover.
- Implementation costs increased by 30%: this represents a worst case scenario of the combined risk figures of the Monte Carlo and optimism bias figures.
- Non-residential properties damages and benefits reduced by 33% and costs increased by 30%: this sensitivity analysis was done as a worst case scenario based on a combination of the 2 scenarios above.

Based on climate change guidance we have assessed all the lower, higher and upper sensitivity tests. Option 5b (medium channel and defences) demonstrates a robust resilience to changes to the tested parameters and remains the preferred option. Full details of the sensitivity analyses are included in Appendix C. A summary of the results of these sensitivity tests is provided in Table 3-10.

Table 3-10: Summary of preferred option under each scenario/ sensitivity test

Scenario / sensitivity test	Preferred option (year 0)	Benefits of preferred option (£M)	Costs of preferred option (£M)	Switching cost at which 5a becomes preferred option (£M)	Benefit cost ratio of preferred option
Standard analysis (50% climate change estimate applied)	5b (medium channel and defences)	1,112.4	111.2	133.4	10.0
Risk to life damages and benefits omitted	5b (medium channel and defences)	1,049.4	111.2	132.5	9.4
Non-residential property damages and benefits reduced by 33%	5b (medium channel and defences)	1,063.7	130.8	130.8	8.1
Costs increased by 30%	5b (medium channel and defences)	1,112.4	144.6	162.9	7.7

Table 3-10: Summary of preferred option under each scenario/ sensitivity test

Scenario / sensitivity test	Preferred option (year 0)	Benefits of preferred option (£M)	Costs of preferred option (£M)	Switching cost at which 5a becomes preferred option (£M)	Benefit cost ratio of preferred option
Non-residential property damages and benefits reduced by 33% and costs increased by 30%	5b (medium channel and defences)	1,063.7	144.6	160.4	7.4
Lower (10%ile) climate change estimate applied	5b (medium channel and defences)	941.8	111.2	112.7	8.5
Higher central (70%ile) climate change estimate applied	5b (medium channel and defences)	1,188.4	111.2	146.2	10.7

Table 3-10 above demonstrates that large changes to the variables which define the scheme do not significantly change the selection of the preferred option. Under the test the 'changes to costs of implementation or the benefits to non-residential (commercial) properties by up to 30%', resulted in the largest changes to the benefit:cost ratio. However, even with these changes the benefit:cost ratio still remains above 7.

The column of switching costs indicates the overall scheme cost at which option 5a (small channel and defences) could become viable. All the cost differences between columns 4 and 5 are in the order of £20 million or more with the exception of the lower (10%ile) climate change estimate applied sensitivity test. This is to be expected for this particular scenario as the climate change flows are decreased and hence the smaller channel would become as effective as the medium channel. Similarly for the non-residential properties damages and benefits reduced by 33% test, the reduction in commercial benefits could result in the smaller channel being as effective as the medium channel option.

The results of the economic and sensitivity analysis demonstrates a robust and sound Economic Case for taking forward the implementation of the preferred option, option 5b (medium channel and defences).

4. Commercial Case

4.1. Introduction and procurement strategy

4.1.1. Introduction

The Commercial Case outlines the proposed deal in relation to the preferred option, detailed in the Economic Case. The Commercial Case is supported by a Procurement Strategy for the delivery of the project, including commercial management of market engagement, sourcing and contract delivery. This Procurement Strategy is included in Appendix O, peer reviewed and endorsed by Clare Marsden, Head of Defra Group Commercial.

This Commercial Case is for the provision of design, construction, maintenance and other support services for the delivery of the Oxford FAS.

Main works

The main works include the design and construction of a 5km, 2-stage flood channel, incorporating various bridges and structures. The major earthworks required to construct the flood channel comprise the excavation, transportation and disposal of 400,000m^3 of topsoil, alluvium and gravels. The bridges and structures comprise numerous small scale bridges and three large culverts, the most complex being the twin box culverts under the A423 Oxford Southern Bypass. These measure 8m wide by 4m high (internal diameter) and are approximately 100m in length.

The construction value is estimated at £55 million based on the preferred option outline design. The earthworks and culvert works represent more than half of overall construction cost. The Commercial Case focusses on these elements given their complexity and value.

The Environment Agency Water and Environment Management framework (WEM) will be the vehicle by which separate design and construction contracts will be awarded to deliver the project. This decision is justified in section 4.4. Detailed design started in October 2016 and will be complete in order to allow a construction tender exercise in January 2018, with Full Business Case (FBC) approval following in autumn 2018. Construction works are programmed to commence in October 2018. Construction works will take 3 years to complete based on current estimates from the contractor providing Early Supplier Engagement (ESE) services.

Operation and maintenance

Annualised maintenance cost estimates for the wider Oxford flood risk management system once the scheme is implemented are £270,000 per annum (excluding major works on the Thames weirs). Maintenance on the scheme will comprise mainly vegetation management within the flood channel, accounting for approximately 50% of the maintenance cost. The design of the Oxford FAS will rely upon passive operation, and ensure limited active intervention is required in times of flood, minimising operational costs.

Whilst regarded as relatively low risk and low value from a commercial perspective, the maintenance work offers the project an opportunity to create a legacy and continued successful partnership working through various maintenance options. These options, with appropriate consideration of the commercial options, are presented in the Management Case.

4.1.2. Overall approach to the procurement strategy

The Programme Board recommended that the contracting authority for this procurement will be the Environment Agency, subject to the Public Contract Regulations 2015. We discussed other options, including the appropriateness of a formal partnership or other project partners taking this lead role. These discussions concluded that the Environment Agency has the appropriate project

management and commercial expertise, combined with access to and familiarity with the flood risk management supply chain.

The Oxford FAS project will be procured and delivered in line with the Government Construction Strategy (GCS) and the Environment Agency's Sustainable Engineering Procurement Strategy, 2010 to 2020 (SEPS). SEPS has adapted relevant principles of GCS to successfully deliver the Environment Agency's flood risk management programme with supply chain partners. SEPS was the driving force behind the implementation of the WEM framework, through which this project will be procured.

Reasons for recommending the use of the WEM framework

- The WEM framework was established to be the primary vehicle for delivery of all flood risk management projects. It has fixed, best value, commercially efficient terms for the award of contracts to deliver projects, programmes and services for customers across the Environment Agency.
- The WEM framework provides suppliers a long term, 6-year commitment. The Environment Agency benefit from collaborative working and strategic supply chain management, whilst driving efficiency through performance management and an appropriate level of competitive tension.
- Familiarity of the existing supply chain is beneficial for us as behaviours are known and expectations are aligned from the outset. We are taking an outcome focussed approach to scoping work to make suppliers accountable for delivering project outcomes and using sectional completion and delay damages to bind key project milestones into the contract.
- The ability of WEM suppliers to deliver works of this nature for us is tried and tested.
- Lower procurement costs. The WEM framework is already established with terms and conditions agreed, offering a quicker route to market than OJEU which supports achievement of the programme objectives.

The WEM framework provides suppliers a long term, 6-year commitment. It is structured into 4 lots, comprising modelling and mapping, environmental services, engineering and related services and asset delivery. It is managed to support delivery of the Environment Agency's 6-year FCRM capital programme, with strategic supply chain management and collaborative working driving improvements in quality, innovation and health and safety, whilst maintaining an appropriate level of competitive tension.

The project team considered a range of options for the procurement of the Oxford FAS, including use of Official Journal of the European Union (OJEU), WEM and other frameworks. Whilst all options have their own advantages and disadvantages, a bespoke procurement was not considered necessary as the works are considered to be within the core capability of the WEM suppliers. A bespoke procurement would likely result in a programme delay as it would take longer to procure than using WEM due to timescales required to deliver an OJEU tender. Such an approach will be more costly and resource intensive, with potential for the successful supplier to be unfamiliar with the Environment Agency culture and processes, and possibly result in a more commercially challenging relationship.

Other frameworks that were investigated included the civil engineering and infrastructure framework with Balfour Beatty, offered by Scape Group. Scape Group are a public sector owned organisation offering OJEU compliant frameworks. This model developed by Scape presents us with the following risks:

- there is a significant risk to our programme if we were unable to come to an agreement on the overall contract value with Balfour Beatty.

- given the size and nature of the scheme we have no like-for-like benchmark for the scheme as a whole and we would lose the benefit of the innovative approaches driven by competitive tension.
- we have confidence in our project benchmarking tool to assist in negotiating costs for earthworks, however the A423 twin culvert works are so unique that we do not have sufficient confidence to determine a contract value for this work as it will be driven by specialist construction methodology and programming.
- we would remove the opportunity of working with contractors with whom we have a long-established relationship.

The Oxford FAS benefitted from an Infrastructure and Projects Authority (IPA) Routemap workshop in early 2016. The overall approach to the Commercial Case and Procurement Strategy builds on the recommendations identified in this review. The review highlighted the need for in depth market analysis and engagement, together with an efficient Materials Management Strategy. Early identification in the IPA review of the need for targeted market sounding has brought significant value to the commercial approach. We have consulted WEM suppliers in detail and they have confirmed their ability and capacity to deliver the project. Through this engagement we have shared our thinking in relation to the commercial model and sought detailed feedback to help shape our approach.

Face to face discussions with tier 2 suppliers highlighted the technical and commercial risks relating to earthworks and A423 culvert construction. Our commercial approach has been shaped by talking to suppliers and has led to:

- the selection of a design and build approach for the A423 twin culvert works, an approach adopted successfully by Network Rail on similar works
- targeted ground investigation designed by the supply chain to mitigate tunnelling risks
- a different approach to contractual risk allocation on works relating to constructing the flood channel. Summer flooding will remain with the Environment Agency to maximise construction productivity.

We recognise the value to be gained from early engagement with suppliers and we will continue to target this dialogue on earthworks and culvert construction during detailed design. These 2 activities represent more than half of construction cost, as a result we believe targeting our efforts here will deliver the greatest return and ensure construction activity is planned efficiently and with key constraints identified to optimise construction programming.

We considered using Public Private Partnership (PPP) models as part of the commercial approach. We compared the Oxford FAS to the key attributes from lessons learnt on the Pevensey coastal defence PPP project.

This comparison is summarised in Table 4-1 below which demonstrates Oxford FAS lacked 3 of the 4 key attributes required to enable successful PPP. We have therefore concluded that this approach is inappropriate on this occasion. The success of partnership working, securing partnership funding to close the funding gap and minimal maintenance costs also influenced this decision.

Table 4-1: PPP decision matrix

Enablers to appropriate and successful delivery of PPP	Oxford FAS attributes	Appropriateness of PPP for Oxford FAS
The contractor has the opportunity to employ innovative methods to reduce whole life costs.	The contractor's ability to reduce whole life cost on Oxford is restricted to asset build costs. The passive nature of operation minimises post construction operation and maintenance costs.	Does not meet criteria
Contract risks must be the responsibility of the party best able to manage them. Thus the contractor will take on some risks usually borne by the employer to absorb costs in the overall payment system.	This approach would be possible on the Oxford FAS however the appropriateness of PPP is limited by other factors detailed in this table.	Meets criteria
In order for the contractor to be able to innovate and assume risk, a project needs to comprise a suitable asset/operational split for value for money to be achieved.	As a general rule at least 50% of the Present Value (PV) costs of a PPP project need to be made up of annual operation and maintenance. Oxford FAS build costs are estimated at £55m with PV annual operation and maintenance costs estimated at £270k.	Does not meet criteria
If risk transfer and opportunities for innovation are to be achieved, a PPP contract must be based on an output specification.	Complexities of partnership working and funding, together with the potential for change in landowner requirements, mean that such an approach would not be possible at the time of going to market.	Does not meet criteria

4.2. Key contractual terms and risk allocation

This section identifies key projects risks and details a risk mitigation plan that will be employed through the procurement of the remaining phases of the project. Following OBC approval, commercial risk will continue to be addressed through pre-tender risk workshops and market sounding exercises. This approach will aid risk quantification and presents suppliers with an opportunity to influence the approach at an early stage.

Risk probability, consequence and our ability to quantify risk has been key to commercial risk allocation. The key risks that need to be managed through the design and construction phase of the project are considered below.

Planning approval / Compulsory Purchase Order (CPO)

Obtaining planning permission with minimal conditions, together with gaining acceptance of the design from statutory consultees, is a key risk and desired outcome of the detailed design. A key activity being run in parallel to obtaining planning permission is the CPO process. The CPO process is required to run in parallel to both the planning process and regular land negotiations to provide programme certainty, should land negotiations fail and could result in a 12 month delay to project delivery if a Public Inquiry is required. The impact of a delay of this length would mean we

could not let the construction contract under the WEM framework and we would need to review our commercial model. Costs for a Public Inquiry and any delays are included within the detailed risk register. Our commercial team are reviewing alternative options for delivery in this scenario.

The project extent lies within 3 local planning authority administrative boundaries which potentially presents a more complex approach to securing planning permission. Working with project partners and planning authorities, we have agreed that Oxfordshire County Council will be the lead planning authority, minimising the need for the Environment Agency to submit multiple planning applications and resulting in only 1 decision notice with 1 set of planning conditions.

CH2M, the supplier providing detailed design services, will work closely with project partners and the Environment Agency to ensure the design incorporates measures that will result in a successful planning application and minimise whole life cost. The commercial risk of achieving planning approval and providing evidence to secure a successful CPO application clearly sits within the scope of the contract with CH2M for detailed design. This approach will ensure buy in from the supply chain to key project outcomes. In turn, it will drive efficiency and a right first time approach to these 2 elements. Sectional completion and delay damages have been used at suitable points to drive programme performance.

Addressing a planning inquiry and inquiry to the CPO process is classed as a low probability, high consequence event. These 2 risk events will remain with the Environment Agency. This was tested with the supply chain who confirmed the anticipated price to accept this risk would be disproportionate.

Earthworks (including inclement weather)

General:

The earthworks section of the project comprises the construction of a 5km, 2-stage flood channel, resulting in the excavation and disposal of 400,000m^3 of material. An efficient methodology for material excavation, transportation and disposal will be key to driving efficient delivery. Assessing this will form a key part of tender evaluation.

Noting the cost, potential risks and programme implications regarding this element of work, targeted engagement of prospective tier 1 and tier 2 suppliers was sought to inform our approach and ensure that any detail within our pre-planning consultation does not overly constrain construction methodology.

Data and investigations:

Market sounding exercises highlighted a need for confidence in survey data and investigations to assist contractors in determining the most efficient construction methodology. Consequently, we have worked closely with suppliers from across the supply chain to scope appropriate and accurate surveys and investigations. The information detailed in Table 4-2 below will be used to mitigate, allocate and quantify key risks.

Table 4-2: Data and investigations (earthworks and inclement weather)

Data and investigations	Application	Supplier input

Ground investigation, performed by geotechnical engineers to obtain information relating to the physical properties of conditions below the surface.	This is key to the Environment Agency and suppliers in establishing material types to be excavated and determining appropriate construction methodology. This information will also enable the supply chain to confidently quantify the risk of ground conditions during construction.	Ground investigations (including archaeological) have been designed by the design consultant, with input from both tier 1 and tier 2 suppliers.
Topographical survey identifies and maps the contours of the ground and existing features on the surface.	These are used to establish with greater accuracy the material quantities requiring excavation and disposal.	A detailed survey designed and completed by the appraisal consultant is complete and will be used to further inform the detailed design and construction tender process.
Flood history data to determine frequency and impact of historical flood events for the site.	This is used to quantify and allocate the risk and impact (cost and time) to construction works from flooding.	Detailed data analysis carried out by the appraisal consultant provides 100 years of detailed flood history. Significant input received from both tier 1 and tier 2 suppliers on how best to allocate and manage with flood risk.
Weather events, frost, snow, but more importantly rainfall history will be used to determine frequency and volume of historical weather events.	This is used to quantify and allocate the risk and impact (cost and time) to construction works by heavy or sustained rainfall, snow and frost.	Weather data was provided by the Met Office. We have completed detailed data analysis to determine the approach to weather risk.

Providing unambiguous survey and investigation data will allow the supply chain to propose an offer with a clear understanding of key constraints relating to the flood channel construction. It will allow suppliers to develop an approach that maximises productivity and result in bids that do not contain caveats or heavy risk contingencies. The supply chain will be responsible for assessing the data and residual risk. We do not warrant the information correct under the NEC Engineering and Construction Contract (ECC) Clause Z1 as this ensures supplier assures information on which they are reliant.

A substantial amount of upfront work will be completed by the project team as per the material management plan as outlined in the Management Case, to enable tenderers to propose innovative and efficient methodologies for the flood channel construction.

Inclement weather:

The nature of earthworks at Oxford makes them susceptible to inclement weather, floods and ground water. Lessons learnt from previous projects together with input from the supply chain has driven our approach. The construction work at Oxford will be delivered over a number of seasons, involving excavation within the existing floodplain of the River Thames.

Weather risk will be allocated as defined in the standard NEC ECC Contract. This industry standard is well known by the supply chain and presents a fair and quantifiable share of risk.

Flood risk will be shared between the Environment Agency and supply chain as detailed below.

Winter floods, up to an appropriately defined level on site, will remain the risk of the contractor to incentivise appropriate seasonal working and flood risk management. Summer flood risk will be held by the Environment Agency. This decision was based on evidence of the rarity of summer floods and jointly agreed with the supply chain. This approach will enable tier 2 suppliers to take greater commercial risk by being able to commit larger numbers of resources onto the project during the summer earthworks season, to maximise productivity on site between 1 April and 31 October. This approach to risk allocation benefits both parties as historic evidence confirms summer flooding in Oxford has occurred only once since records began.

Ground investigation works highlight that we will encounter groundwater during the construction of the scheme. We will pass this risk to the contractor following recommendation from the supply chain that it can be mitigated by appropriate construction methodology, to be determined by suppliers at the time of tender. Dealing with groundwater will form a critical part of tender evaluation.

Major structures

The design of the Oxford FAS incorporates various structures to facilitate the flow of flood water through the 2-stage flood channel before returning to the River Thames. The largest and most complex structures are the twin culverts underneath the A423 Southern By-pass.

The project team have taken the opportunity to seek the views of tier 1 and 2 specialist tunnelling contractors to refine the commercial approach. These market-sounding exercises highlighted various technical challenges and opportunities relating to the design and construction of these culverts.

We have concluded a slightly different approach for the construction of the A423 culverts is required. Market sounding with both tier 1 and tier 2 suppliers highlighted:

- the sheer size of the culverts (8m wide x 4m high clear opening) will require significant input from tunnelling specialists to determine options, construction methodology and temporary works to mitigate key risks.
- there are limited specialist contractors in the market with the capability to construct the culverts.

Whilst noting the benefits of separate design and construction contracts for the wider scheme (section 4.4), to overcome the specific technical challenges of constructing the culverts, together with the limited supply market that is able to construct them, a ‘design and build’ approach is being adopted. This approach will ensure:

- the designer of the wider scheme is responsible for the required performance specifications of the culvert so that the culverts meet the desired requirements for the scheme as a whole.
- responsibility for detailed design will rest with the tier 1 contractor within the main works contract. It is anticipated this work will be sub-contracted to specialist tier 2 suppliers.

This approach was agreed in consultation with the detailed design consultant and wider supply chain and accepted by the Oxford FAS Programme Board on the following basis:

- this approach will ensure specialists lead on the elements of the design process in which they can add real value, and it will reduce construction time through minimising constraints.
- the ‘design and build’ approach will not require re-work in detailed design as might be the case under an alternative approach, saving time and reducing cost.

- a ‘design and build’ approach is more attractive to tier 2 suppliers, enabling them to differentiate themselves from competitors by employing specialist construction techniques.
- as the culvert works are predominately about temporary works, the tier 2 supplier can be commissioned to finalise detailed design as soon as we have completed the construction tender in April 2018. FBC sign-off is currently programmed for August 2018 and therefore this brings significant programme benefits on such a crucial element of the project.
- Network Rail have designed and constructed a similar size culvert at Newton-le-Willows in the North West using the same Procurement Strategy.

Contaminated land

Design risk relating to containment and/or disposal of potentially hazardous waste, particularly in the known landfill site at Redbridge, will be managed by the consultant. Investigations completed during the appraisal stage indicate the landfill contains non-hazardous domestic waste. Some material will need to be removed to landfill sites, but this needs minimising. The consultant also needs to demonstrate how we will avoid creating new pollution pathways.

Archaeology and heritage

We have held discussions with Historic England, the county archaeologist and Oxford city’s archaeologist during the appraisal of the scheme. Their requirements for archaeological investigations were taken into account during the archaeological investigations in the appraisal stage. The detailed design consultant will support the management of the archaeology risk for the detailed design stage and will liaise with Historic England and others throughout the design, but the responsibility for the archaeological risk to the project will be held by the Environment Agency.

Services

There are several known services running across the site which have been positively identified and where necessary, diversion has been proposed in the design. The Environment Agency will be responsible for any unknown services and the impacts they have on the project throughout detailed design and construction. This has not removed the responsibility for the consultant or contractor to look for unidentified services during any proposed site works.

4.2.1. Contractual terms

Contractual terms will be the Option C Target Costs model from the New Engineering Contract (NEC) suite of contracts, as modified under the WEM Framework Deed of Agreement. We have evaluated the risk transfer provisions available under these contracts for their appropriateness. We have taken a proportionate approach to project specific risk, we have held risks that are of low probability but high consequence, and in key areas we have taken more risk on the basis of obtaining a greater return from the suppliers, specifically:

- Public inquiry for planning or CPO is held as an Environment Agency risk, and the pricing of this risk by suppliers will be disproportionate to the probability of occurrence.
- Appropriate allocation of flood risk and inclement weather, e.g. earthworks summer flood risk will remain with the Environment Agency to maximise productivity, whilst the risk for dealing with groundwater will remain with the contractors as they are best placed to manage this risk through construction methodology.
- A design and build contract model for the construction of the A423 culverts was selected to drive efficiency, this will require contract drafting to deliver the best result.

There is a possibility that risk allocation agreed between the Environment Agency and main contractor is not applied by the successful contractor with their supply chain. This could limit

opportunities to deliver greater efficiency throughout the whole supply chain by tier 1 suppliers using it to their advantage.

We will look at appropriate options to ensure risk allocation is distributed throughout the supply chain in line with our contract. We believe appropriate contract drafting will achieve this. In doing so we will be conscious that contractors may use different commercial models to deliver the works, with some choosing to use in-house capability to deliver works. Others will sub-contract the work. We will ensure our approach does not limit the different commercial approaches contractors may take.

Key contractual terms will be agreed between the commercial manager and Project Executive in order to manage key risks set out in the procurement strategy. Key clauses are described in Table 4-3 below.

Table 4-3: Contractual clauses for design and construction

Design and supervision	
Conditions of contract	NEC Professional Services Contract (PSC) (as modified by the WEM Deed of Agreement).
Pricing mechanism	Option C Target cost contract with activity schedule, used to incentivise efficient delivery.
Secondary option clauses	X2 (Changes in the law), X5 (Sectional Completion), X7 (Delay damages), X9 (Transfer of rights), X11 (Termination by the Employer).
Z clauses	Environment Agency specific clauses as determined in the WEM Deed of Agreement.
Sub-contracts	Key sub-contracts will be awarded on back to back contracts to ensure a fair and equitable share of commercial risk.
Construction	
Conditions of contract	NEC Engineering and Construction Contract (ECC) (as modified by the WEM Deed of Agreement).
Pricing mechanism	Target contract with activity schedule, used to incentivise efficient delivery.
Secondary option clauses	X2 (Changes in the law), X5 (Sectional Completion), X7 (Delay damages), X11 (Termination by the Employer), X16 (Retention).
Z clauses	Environment Agency specific clauses as determined in the WEM Deed of Agreement.
Sub-contracts	Key sub-contracts will be awarded on back to back contracts to ensure a fair and equitable share of commercial risk. The tender assessment for the construction works will focus on the selection of sub-contractors for earthworks and A423 culvert works. The terms under which they're employed will be assessed to ensure SMEs and sub-contractors are treated in a fair and consistent manner.

4.3. Procurement route and timescales

4.3.1. Procurement route

Contract strategy

We will use individual lots within the WEM framework to deliver the different elements of the project: Lot 3 (Engineering & Related Services) for detailed design and Lot 4 (Asset Delivery) for construction.

Reasons for selecting this approach:

- A design and build approach for the wider scheme would have left a disproportionate amount of risk with either the supplier or employer. Neither of these outcomes would deliver value for money, nor would such an approach present a fair and equitable allocation of risk.

- At the time of needing to go to market, funding for the project was not secured. This would have resulted in a significant lack of confidence from potential bidders. Taking the recommended approach is enabling funding to be secured and other risks to be managed in parallel with the commencement of the detailed design.
- The project life cycle had not reached the point at which clear outcomes could be determined and constraints identified. This is key to delivering best value through a design and build approach and driving efficiency in the supply chain by minimising change. A key lesson from previous design and build contracts.
- The time taken to address the issues listed above under a design and build approach would have significantly delayed the delivery of the project, noting the required programme constraints.

Tender process

We will continue to employ an open, transparent tender process to engage with suppliers, in a way that reflects market engagement carried out to date. We have designed an approach based on feedback from the supply chain on the positive aspects of the Environment Agency's approach to previous high value tenders:

- We will provide detailed tender timescales to suppliers with the issue of a detailed tender programme, well in advance of the tender process.
- We will appoint the ECC Project Manager during drafting of the contract and Works Information to ensure a smooth transition between tender and contract management.
- Following the issue of tender documentation, we will hold a site visit and tender workshop, led by the Environment Agency project team, with representation from across the project team, all tenderers, design consultant and ECC Project Manager.
- We will hold regular tender query meetings (a mix of both face-to-face and teleconference) with suppliers. The focus during the tender process will be based on open dialogue to ensure effective communication between all parties.
- Tender query meetings will be supported by the development of a tender query log to document and answer queries raised. We will share this information with all tenderers to ensure fairness and transparency. The aim is to reduce the need for suppliers to include caveats within tender submissions.
- We will form a multi-disciplinary tender evaluation team including representation from project partners.
- Pre-arranged post-tender clarification meetings will be held following initial tender evaluation. Our aim is to clarify aspects of the bids that are ambiguous to ensure a like-for-like, fair and transparent tender process.

To ensure potential benefits of risk allocation are optimised throughout the wider supply chain, assessment of tier 1 sub-contract procurement and contract management approaches will form a critical element of the tender evaluation.

4.3.2. Timescales

The procurement timetable for the Oxford FAS works contract is detailed below in Table 4-4. Implementation milestones are presented in Table 4-5.

Table 4-4: Procurement timetable

Activity	Start	Complete
Market sounding	Ongoing	Ongoing
OBC approval	April 2017	September 2017
Completion of Works Information and tender documents	December 2017	
Tender issue	January 2018	
Tender return	March 2018	
Tender evaluation	March 2018	April 2018
Award recommendation and approvals	April 2018	
Instruct A423 culvert detailed design	April 2018	
FBC approval (OGC Gateway 3)	September 2018	
Contract award	September 2018	

Table 4-5: Implementation milestones

Activity	Start	Complete
Commence detailed design	October 2016	September 2018
Secure planning	November 2017	May 2018
Commence construction	October 2018	
Completed construction	August 2021	
Defects period for engineering contract	August 2021	August 2022

4.4. Efficiencies, opportunities and commercial issues

Managing risk at this early stage will ensure we can reduce risk contingency and drive competitive supplier pricing by agreeing a fair and proportionate risk share. This approach is the most appropriate way to drive efficiency and is supported by the supply chain.

Within our commercial approach we will take measured risks to deliver benefits. Key decisions taken to drive efficiency are:

- Selection of the WEM framework will reduce tender timescales and costs, driving efficiency through the long term, 6-year commitment. The WEM framework is the most efficient route to market resulting in earlier delivery of construction work.
- We have awarded the detailed design contract in parallel with the development of the OBC, reducing overall programme duration considerably. Using WEM provides us the additional benefits of being able to use suppliers for ESE who have a guarantee that they will be bidding for the contract.
- We will do targeted, informed market sounding on those ‘strategic critical’ sub-contract areas that represent greatest cost and complexity to the Environment Agency. With regards to earthworks, we will manage flood risk to maximise productivity, delivering work more quickly will reduce programme duration and cost.

- We will have appropriate contract strategy development, including separate design and construction contracts for the wider scheme, modified to incorporate a design and build approach specifically for the delivery of the A423 twin culverts.
- We will carry out appropriate ground investigations, designed by the supply chain to enable tier 1 and tier 2 suppliers to propose accelerated programmes of work. The recommendation from the specialist tunnelling contractor is to undertake horizontal boreholes to both quantify and mitigate programme risk taken by the supply chain to maximise construction productivity.
- Informed risk allocation will allow suppliers to optimise delivery as we have removed low probability, high consequence risk events from the supply chain. This approach will provide a greater return on investment through increased productivity and ensure greater cost certainty. We will ensure that the contract reflects this approach.

In addition to the commercial approaches listed above, below are 3 areas in which a risk based approach to project delivery has delivered significant efficiency. As well as these larger efficiencies, smaller efficiencies have been captured, including those made by working collaboratively with partners. The project team will continue their approach to realising innovative and creative opportunities to make further savings.

4.4.1. Network Rail culvert works

The appraisal of the Oxford FAS highlighted the need for the design of a structural measure (new culverts or similar) to improve flood flow capacity under the railway line.

During the development of the appraisal, Network Rail were planning to carry out works in the study area as part of their electrification programme. These works required a closure of the main railway line in mid-2016 to locally raise the tracks. This presented an opportunity to align this work with the Oxford FAS and were seen as an opportunity to 'spend now, save later'. This approach was supported on an evidenced based decision by the Sponsoring Group.

These culverts have now been installed and will be maintained by Network Rail and form an integral part of the proposed scheme. We can demonstrate that by working with Network Rail and providing a contribution of £1 million towards culvert works, that would have cost us at least £4 million if installed separately by our contractor, we have an efficiency saving to the project of £3 million.

4.4.2. Critical review of the preferred option

During the hydraulic modelling of the river system carried out throughout the outline design process, we tested the various elements of the scheme proposed in the SOC for effectiveness. The original SOC proposal included a section of new conveyance channel from Rose Isle to just south of Sandford Lock on the River Thames, intended to improve capacity through the system and draw down water upstream in the flood risk area of New Hinksey and Grandpont. This section was proposed to be a deep and wide two-stage channel, 1400m long, through low-lying agricultural floodplain.

During the development of the outline design, we identified a number of physical restrictions which reduced the depth and width of the channel which would be achievable, including the height of banks on the River Thames, the need for a control weir to maintain navigation depths, location of overhead and buried services, the need to build a new bridge to cross Sandford Lane, and the influence of groundwater.

When we modelled this narrower and shallower channel the reduction in water levels in the flood risk area of interest was less significant. This prompted the team to review alternatives to this element of the design. We discovered that a raised defence between the River Thames and New

Hinksey, combined with the remainder of the channel, provided a greater reduction in flood risk than the original option, particularly to Abingdon Road, a key infrastructure link. We therefore removed the proposed downstream section of channel around Sandford Lock. This revised design meant that the quantity of material needed to be removed during construction could be reduced by 200,000m^3. The raised defences on the scheme can be constructed from alluvium material generated elsewhere on the scheme, reducing the use of primary material and the volume of material which needs to be removed from site, a further efficiency.

This has been valued as an efficiency saving of £8.1 million.

4.4.3. Materials management

At the SOC stage, the baseline assumption for materials management was for all excess material generated on site to be taken to landfill. During the OBC stage we have investigated this further, as detailed in the Management Case. We are now assuming that all appropriate material will be removed to restoration sites, and only a small amount of material which is known to be contaminated is now assumed to be taken to landfill.

This change in the baseline has resulted in an efficiency saving of £2.2 million.

This will be further investigated during the FBC stage where the following areas will be looked into for greater efficiencies:

- creation of a new landfill adjacent to the site, to reduce the amount of material that needs to be taken to restoration sites.
- how to deal with the contaminated land coming from an existing landfill site and whether there is an opportunity to replace the material back in the existing landfill and recap it.
- re-use of as much material on the site as possible, i.e. creation of bunds.
- re-use of as much material as possible on other projects or sites in the local area.

4.4.4. Project bank account (PBA)

PBA's are a ring-fenced bank account. The sole purpose is to act as a channel for payment on construction projects to ensure that contractors, key subcontractors and key members of the supply chain are paid on the contractually agreed dates. Given the potential scale of sub-contracting and number of tier 2 suppliers, the Oxford FAS will be able to demonstrate efficiencies in line with Cabinet Office guidance.

5. Financial Case

5.1. Introduction

The Financial Case considers the detailed affordability of the scheme. It translates the funding profile used in the Economic Case into a real cash profile including inflation and a greater allowance for risk. The year-by-year overview of likely costs is then compared to funding available in order to provide a position on affordability. This considers the capital cash available for construction and the commuted sum towards future maintenance costs.

Costs are considered over the same period as in the Economic Case, 100 years from 2016/17. This period is termed the 'whole life'. Costs are broken down over the construction and maintenance period with appropriate levels of optimism bias, Monte Carlo risk allowance and inflation applied separately.

The scheme is jointly funded by Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA) and third party contributions. This case describes how funding from different sources is available over a period of time as well as the ongoing work to secure further contributions towards delivery of the scheme.

5.2. Financial summary

5.2.1. Standard cost profiles

The cost profile used as the basis for this Financial Case is the same as in the Economic Case for design, construction and maintenance post scheme completion. Differently to the Economic Case however, it does not consider the costs required to maintain the current assets and river system prior to completion of the scheme. This is because such costs are already factored into Environment Agency budgets. The financial consideration for the Oxford FAS are maintenance costs burdened after completion of construction (from 2022/23 onwards).

The cost profile assumes costs baselined to 2016/17 prices and exclusive of VAT. The delivery programme has construction beginning late 2018 and finishing in the 2021/22 financial year, with readiness for service in July 2022. It also assumes a baseline position whereby the majority of excavated material is taken off site to restoration sites and the cost to acquire land under a Compulsory Purchase Order (CPO). Costs were developed by workstream leads and then benchmarked against industry standards and comparable projects, to ensure they were as accurate an estimate as possible.

Future maintenance costs assume the requirement to maintain the new asset and existing associated system so as to continue to deliver benefits throughout the whole life. This includes regular revenue activity and capital works on assets.

Where existing assets are River Thames weirs, the amount included in the Oxford FAS funding profile is 50% of the full cost of maintaining this asset. This allows for the flood risk management function. When future work is required, these assets will need to find contributions from other beneficiaries, such as the boating community, towards this work.

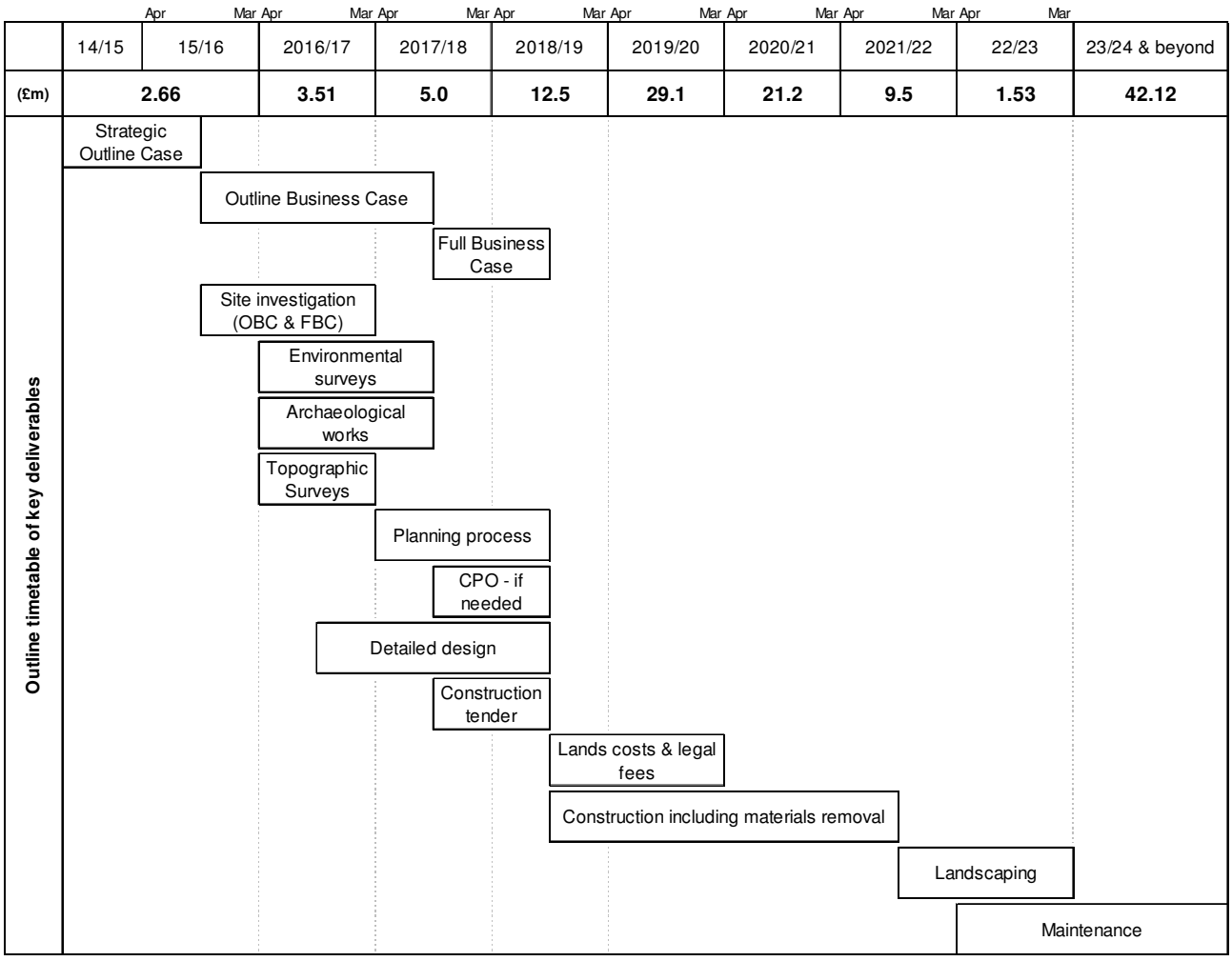
The estimated core project costs are broken down in Table 5-1 below:

Table 5-1: Breakdown of costs over the programme - excludes all risk and inflation.

Cost type	Estimated expenditure (£m)
Previous years - pre 2016	2.66
Construction	52.57
Survey work	3.41
Staff costs	5.30
Detailed design and professional services	7.54
Environmental mitigation and enhancement	4.06
Lands budget and other fees (inc utility diversions)	9.36
Sub-total to design and construct	**84.90**
Future maintenance (from 2022/23 to whole life)	42.12
Total	127.02

How this is split across financial years is based on the likely timing of the expenditure within the delivery programme. Table 5-2 below shows the high level programme of work used to support financial analysis.

Table 5-2: Programme of work vs cost



In order to assess affordability, the profile of expenditure has been increased to take into account risk and inflation.

5.2.2. Allowance for risk

At SOC stage, detailed risk could not be quantified so the allowance for risk was included as optimism bias and increased costs to the end of the construction period by 38%. There are still a series of unknowns that could affect the project that cannot be quantified, and so an element of optimism bias remains. However for OBC, as there is a detailed risk register a more specific assessment of risk costs can be made, this is included as Appendix M.

As described in section 2.7, the updated optimism bias percentages for OBC stage are 12% for construction and 5% for the maintenance period, the calculation for this is included in Appendix N.

From the detailed risk register, a Monte Carlo (MC) statistical analysis has been used to produce risk cost profiles for the 50th percentile (P50) and 95th percentile (P95) scenarios. These represent the likely cost increases in 50% and 95% of scenarios respectively. Table 5-3 shows how these risk values combine with the costs in table 5-1 to produce the P50 and P95 costs.

The P50 figures are used in the Economic Case and are shown in Table 5-3 below for reference only. Within this Financial Case, the P95 costs are considered.

Table 5-3: Summary of risk cost (all figures in £ millions)

	Sunk costs	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023 onwards	Total £m
Basic costs	6.17	4.95	12.45	29.1	21.2	9.5	1.53	42.12	127.02
Optimism bias (12%)		0.59	1.5	3.49	2.54	1.14	0.19	-	9.45
Optimism bias (5%)		-	-	-	-	-	-	2.10	2.10
MC risk profile (P50)		0.25	2.24	4.38	3.4	1.46			11.73
MC risk profile (P95)		0.34	2.9	5.95	4.66	2.08			15.93
Total cash (P50)	6.17	5.79	16.19	36.97	27.14	12.1	1.72	44.22	150.28
Total cash (P95)	6.17	5.88	16.85	38.54	28.4	12.72	1.72	44.22	154.5

The total cash P95 profile has then been further increased to take account of inflation. This produces a profile against which affordability of the scheme is assessed.

5.2.3. Consideration of inflation

At SOC stage, inflation was applied compound based on the government recommended Gross Domestic Product (GDP) deflator forecast[2] for the period up to 2019/20 and with a 2% per annum estimate to the remainder of whole life costs beyond this.

For OBC, consideration of inflation is already included in the construction cost estimate and within the Optimism Bias allowance. As such a uniform inflation rate of 2.5% has been applied across the

[2] Gross Domestic Product (GDP) deflator can be viewed as a measure of general inflation in the domestic economy.

whole profile as part of this Financial Case. This is a standard rate used for appraising Environment Agency FCERM projects.

Inflation has been applied compound from a baseline year of 2017/18. Inflation has not been applied for 16/17 or 17/18 as the costs for this years are either fixed already under contracts or take into account current market prices.

Table 5-4: Inflated scheme costs – 2.5% inflation rate (all figures in £ millions)

Costs in £m	Sunk Costs	17/18	18/19	19/20	20/21	21/22	22/23	2023 onward	Total
P95 profile	6.17	5.88	16.85	38.54	28.40	12.72	1.72	44.22	154.50
Inflation factor 2.5%	-	1	1.025	1.051	1.077	1.104	1.131	-	
Inflated P95 profile	6.17	5.88	17.26	40.49	30.58	14.04	1.94	173.22	286.92

The updated whole life cost profile considering inflation is therefore shown to be £286.92 million of which £116.36 million is for design and construction.

If a higher inflation rate is realised for this construction period, for example an additional 2% on top of current estimates, then the design and construction cost could rise by just over £4 million. In this scenario, the Sponsoring Group would need to consider whether to enact the funding contingency plan actions and either seek further contributions from beneficiaries or work to reduce overall cost through value engineering or efficiencies.

5.2.4. Commuted sums for maintenance

A commuted sum is the calculated sum of money needed in present day amounts to cover future costs associated with the asset. The ADEPT (Association of Directors of Environment, Economy, Planning and Transport) National Bridges Group guidance "Commuted sums for the relief of maintenance and reconstruction of bridges"[3] has been followed to calculate this figure. This is guidance used by one of the main partners in the project, Oxfordshire County Council. The commuted sum considers the breakdown of future costs used in the P95 profile prior to the addition of inflation estimates. Costs consider the management, inspection, maintenance and replacement of a structure and the dates at which these costs are predicted to occur. If a structure is in poor condition, and is in need of refurbishment in the near future, these costs are also included.

As outlined in section 5.2.3, the inflated whole life funding need for the Oxford FAS has been identified as £286.92 million. This includes £173.2 million for future maintenance. As a commuted sum, this amount is £18.15 million - providing that all the cash can be secured up front by the start of the maintenance period.

Securing cash to this amount on top of contributions for construction is a challenge given the current economic climate and pressure on local council funding in particular. At SOC stage it was therefore proposed that the Oxford FAS initially secure funding for a shorter period of maintenance, for example up to 10 years post construction, and establish a clear administrative structure that would support the maintenance of the scheme beyond this.

[3] ADEPT guidance http://www.adeptnet.org.uk/documents/adept-bridges-group-commuted-sums-guidance-2015 - suggests a discount rate of 2.2%

This principle has been discussed with, and is supported by, Defra and HM Treasury. This approach is similar to that taken by other infrastructure projects such as road and rail.

The commuted sum for the first 10 years maintenance is £4.75 million.

5.3. Funding approach

Flood risk management projects are delivered by the Environment Agency under the Defra flood and coastal erosion resilience partnership funding policy[4], also known as partnership funding. The scheme will be funded in part by the Environment Agency's FCERM GiA. Based on the outcomes[5] the scheme is forecast to deliver, it will be eligible for an FCERM GiA contribution (present value) towards the overall costs over its intended life span.

The policy follows that any remaining scheme costs need to be found from local partners and beneficiaries. These costs can either take the form of a capital contribution or contribution in-kind, based on the value of lands or value of work done by others on behalf of the project.

In order to oversee the management of funding for the Oxford FAS, the Environment Agency has a dedicated team leading on this work stream. This team works with a funding sub-group established by the Sponsoring Group prior to SOC stage. The sub-group includes senior representatives from the 2 main local councils and the Chief Executive of Oxfordshire Local Enterprise Partnership. It works to review sources of funding and negotiate with beneficiaries to secure contributions under the Funding Strategy.

5.3.1. Flood and Coastal Erosion Risk Management Grant in Aid (FCERM GiA)

The amount of FCERM GiA the project is eligible for is determined using the partnership funding calculator. Based on the data used in the Economic Case, the Oxford FAS is eligible for £61.9m (Present Value) FCERM GiA allocation.

When reviewing the FCERM GiA amount against the present value of the P95 cost profile, this achieves a raw partnership funding (PF) score of 54%. This score indicates the maximum percentage funding that the scheme is eligible for from FCERM GiA. In present value terms, £53.4m of contributions are needed to achieve a score of 100% and demonstrate an affordable scheme.

The allocation of FCERM GiA is overseen by a national Environment Agency team. The inclusion of the Oxford FAS within the £2.5 billion 6-year investment programme in 2014 showed commitment from the Environment Agency to deliver the scheme. FCERM GiA allocation is reviewed annually and detailed project expenditure tracked to ensure the balance remains right with contributions.

When comparing FCERM GiA to the cash profile, the present value discounting factor has been removed. Even in cash terms though, FCERM GiA should not form more than the raw PF score percentage (54%) of the total cost.

5.3.2. Partnership contributions

Contributions are secured using legal agreement based on a set of pre-established Environment Agency standard terms. Any exceptions to this or the standard legal terms must be approved by Environment Agency Executive Directors.

Partnership contributions are paid to the Environment Agency and held for the project in a dedicated partnership funding account. They are drawn upon as needed to balance FCERM GiA

[4] https://www.gov.uk/government/publications/flood-and-coastal-resilience-partnership-funding

[5] Outcomes are assessed using the Partnership Funding Calculator https://www.gov.uk/government/publications/fcrm-partnership-funding-calculator

with annual expenditure. This is in line with standard Environment Agency practices. The legal and payment status of currently identified contributions can be found in Appendix Q.

5.3.3. In-kind contribution of maintenance, assets and known incurred costs

In-kind contributions represent the provision of goods or services to the scheme by a partner, valued in monetary terms and accounted for as part of the partners' contribution to the cost of the scheme.

An in-kind contribution can consist of:

- the direct provision of a tangible asset such as land that will form part of the scheme
- the waiving of known expenditure incurred directly by the partner such as staff time
- the adoption of assets with future maintenance liabilities, which benefits the scheme

The in–kind contributions are regarded as necessary to carry out the tasks and achieve the scheme objectives agreed by our partners. An example of this is maintenance of the scheme so it continues to function into the future. They are tasks or costs that would have to be paid for if they were not provided by the partner. The amount of the contribution will be valued and used to show commitment to the scheme and help prove the schemes affordability.

5.4. Secured contributions towards the scheme

This business case identifies a funding need of £121.11 million to design, construct and maintain the Oxford FAS for the first 10 years.

Around 54% of this funding, £65.7 million, will come from central government, and the remaining £55.41 million from third party contributors.

The project team have successfully negotiated and secured contributions to the value of £51.05 million as outlined in Table 5-5. Further details outlining the status of negotiation with investors is outlined in Appendix R.

Table 5-5: Agreed contributions summary

Driver for investment	Contributor	Amount	Status
Local choices FCRM	Thames Regional Flood and Coastal Committee	£14.00m	Confirmed
Future economic growth	Oxford Local Enterprise Partnership	£25.85m	Confirmed
Local economic and social benefits - transport resilience (roads)	Oxfordshire County Council	£6.5m	Confirmed
Local economic and social benefits - transport resilience (roads)	Oxford City Council	£1.5m £1m	Confirmed Agreed in principle (lands)
Utility resilience	Thames Water	£2.2m	Agreed in principle
		£51.05m	

This contributes around 8% to the national Environment Agency target of £600 million for contributions over the 6 year investment period.

Negotiations remain in progress with a number of local beneficiaries to secure further contributions. These are summarised below and detailed in Appendix Q and Appendix R.

Table 5-6: Ongoing negotiations

Driver for investment	Contributor	Amount	Likelihood of contribution
Economic Growth redevelopment opportunity	University of Oxford	£3m	High – OFAS is required to deliver longer term redevelopment plans. May require scheme enhancement. University of Oxford have secured £6.2 m of LGF3 funding for enabling works including flood risk mitigation works.
Utility resilience	Thames Water (additional negotiation)	£1.2m	High – commitment to increase their contribution as the detailed design is finalised and final benefits confirmed.
Economic Growth development opportunity	Four Pillars Hotel	£0.15m	High – OFAS is required to deliver longer term development plans. Site directly benefits from OFAS and removes historic flood risk reasons for previous planning applications being refused.
	Sub total	*£4.35m*	
Utility resilience	Scottish and Southern Energy	£1m	Moderate – appetite from initial meetings will depend on aligning delivery timescales.
Transport infrastructure resilience	Network Rail	£1m	Moderate – OFAS will increase network resilience.
Operational resilience related to transport	BMW	£0.5m	Moderate – OFAS will increase export network resilience.
Economic Growth	Land Securities Ltd/ John Lewis Partnership	£0.5m	Moderate – there is a strong business case but more follow up is needed
Transport infrastructure resilience	Oxford Bus Company	£0.02m	Moderate – OFAS will increase road network resilience. But limited financial benefit.
Transport infrastructure resilience	Stagecoach	£0.02m	Moderate – OFAS will increase road network resilience. But limited financial benefit.
Utility resilience	BT Openreach	£0.01m	Moderate – OFAS will increase broadband network resilience.
	Total of all potential contributions	£7.4m	

In securing these contributions, the intention is to bring them into the project as soon as possible in order to maximise the value of them to the project.

The current approach to securing funding has been focused on parties who will benefit from the primary purpose of the scheme, the reduction in flood risk. Looking at the strategic investment objectives and the benefits map, there are a number of outcomes which have not been fully explored with investors as this element of the design is not sufficiently developed.

A number of early discussion with parties such as Woodford Investment Fund, TOE2 (Trust of Oxfordshire's Environment) and Thames Water have backed the desire of investors to support Green Legacy from the scheme. This would not only support the realisation of environmental, education and recreation benefits but also help to fund ongoing maintenance work. This will be explored following submission of this OBC.

5.5. Balance sheet and affordability position

Considering the contributions already secured, and the remaining amount likely within the next 3 months, the balance sheet of the project is presented in Table 5-7.

A number of key principles are used in developing this table:

- FCERM GiA and Local Levy amounts are allocated on request from annual programmes managed centrally within the Environment Agency.
- Third party contributions into the Partnership Funding account[6] can be carried over from one financial year to the next. The balance of income for the Oxford FAS will need to be carefully monitored to maximise the potential to carry forward funds.
- Only highest likelihood contributions from Table 5-6 are profiled.

[6] A dedicated financial account used solely to manage partnership funding contributions
*[a] – assumed contribution based on Land agreement
*[b] – total assumes in kind value of land

Table 5-7: Project Balance sheet (all figures in £ millions)

	Sunk costs	17/18	18/19	19/20	20/21	21/22	22/23	Commuted sum - 10 years	Total (£m)
Funding need	6.17	5.88	17.26	40.49	30.58	14.04	1.94	4.75	121.11

FCERM GIA	3.61	4.0	5.62	16.63	24.59	7.15	1.50	2.61	65.71
Thames RFCC Local Levy	0.78	1.05	1.0	4.0	3.75	3.42			14.00
Growth deal funding (SEP)			7.5	18.35					25.85
Oxfordshire County Council contribution	1.05	0.45	5.0						6.5
Oxford City Council contribution	0.73	0.38	0.39	1.0*[a]					2.5*[b]
Thames Water				2.2					2.2
High likelihood contributions				1.35	3.0				4.35
Funding total	6.17	5.88	19.51	43.53	31.34	10.57	1.5	2.61	121.11
Cumulative balance of partnership funding account	0.0	0.0	2.25	5.29	6.05	2.58	2.14	0	0

When the present value of these contributions are entered into the partnership funding calculator, the project achieves an adjusted PF score of 100%. This can be found in Appendix E.

The progress that the project has made on partnership funding so far is a success with £51.05 million secured towards its construction and maintenance. Including the high likelihood contributions, the adjusted partnership funding score is 100%.

The project will therefore be fully funded when the high likelihood contributions are confirmed. This includes carrying forward £2.14 million in contributions to cover shared commuted sum financing of the maintenance period.

Given the strong performance to date by the team in both securing contributions and efficiency savings, the skills and expertise within the project team and the very strong partnership approach, we believe that continuing would only leave a small exposure to Grant in Aid funding within the 6 year capital investment programme. Continuing at this point with £4.35 million of high likelihood contributions pending final agreement is considered to be a low risk approach. This exposure is equivalent to 3.6% of the project cost which includes more than 30% in risk allocation.

6. Management Case

6.1. Introduction

The Management Case describes the project management structure and governance arrangements for the project. Project controls have been set up and are being used as described below to efficiently manage project risks, issues and quality control. This case also describes the arrangements in place to manage benefits, communications, and the assurance processes and activities.

6.2. Project management

6.2.1. Project structure and governance

In line with PRINCE2 standards, the project governance structure is set up to allow 'management by exception'. There are 3 distinct governance groups, each with Environment Agency and partnership representation. These are the Project Board, Programme Board, and Sponsoring Group. Each group has its own set of defined tolerances. The governance structure for the scheme is illustrated in Figure 6-1 below.

The Sponsoring Group consists of the Project Sponsor (Co-Chair), Oxfordshire County Council Cabinet Member for Environment (Co-Chair) and senior representatives from partner organisations. Their role is to ensure that the project, being of such a size and complexity, can be delivered successfully, ensuring that political and strategic risks are handled appropriately.

The Programme Board consists of the Project Director (Chair), EA senior flood risk and operations managers, an Infrastructure & Projects Authority (IPA) representative and technical officers from partner organisations. The Programme Board drives the programme forward and delivers the outcomes and benefits within the tolerances set by the Sponsoring Group.

The Project Board consists of the Project Executive (Chair), Senior User, Senior Supplier, Funding and Benefits Manager, NEAS representative and representatives from local authority partners. It is responsible for reviewing all issue reports before they are escalated to the Programme Board.

The Senior Responsible Owner (SRO) is the business sponsor for the Oxford FAS. They have the ultimate accountability, at board level, for the delivery of business benefits and success of the project. Furthermore, they are responsible for authorising external gateway reviews on the project and for resolving any instances of deadlock at the Sponsoring Group governance level. The SRO changed in October 2016 due to the previous SRO retiring from the organisation. This change involved a detailed handover period where both the previous and current post-holders occupied the role in order to best facilitate the handover of knowledge. The current SRO has also received in-depth briefing from the project team on the project and continues to receive monthly highlight reports to keep him appraised of progress. Additionally, the project team maintains close contact with colleagues in the current SRO's team, who form part of the project's corporate governance.

Figure 6-1: Governance structure

6.2.2. Project governance roles and responsibilities

The Sponsoring Group was set up following flooding in Oxford during winter 2013-2014. A flood summit was hosted by Oxfordshire County Council in March 2014 at which around 40 politicians and representatives of local and national agencies came together to consider reducing the long-term risks of flooding in Oxfordshire. There was strong local demand and potential funding sources identified for a scheme to be delivered as soon as possible.

The Sponsoring Group comprises senior managers, who have responsibility for setting the strategic direction of their respective organisations and are responsible for the investment decision, defining business direction, and ensuring the strategic fit of the project within their respective organisations. They have sufficient delegated authority to make decisions on behalf of their organisation.

The Sponsoring Group have the following responsibilities:

- provide direction for issues raised within the Sponsoring Groups tolerances
- secure high level partnership funding approaches for the project
- endorse and support the project business case through approval gateways
- facilitate partnership and collaborative working to deliver the scheme
- champion the project: leading by example, communicating the benefits to all stakeholders, and gaining local support and political will to progress the scheme
- provide continued commitment and endorsement in support of the project objectives at executive and community events
- provide a recommendation to the SRO for project closure when required

Partners in the Sponsoring Group have signed a memorandum of understanding which outlines their intent to work together to achieve the shared vision and objectives, identify opportunities to secure full funding for the scheme and establish efficient working practices to deliver the scheme as quickly as possible whilst driving down the costs and maximising efficiency savings. This was updated and re-signed in December 2016 to ensure that they are aligned to the next phase of delivery and to reflect the role of the project's new SRO who joined the group in October 2016.

The composition of the Sponsoring Group is shown in Figure 6-1. The Sponsoring Group meet approximately every 4 months. In between, key issues are dealt with by correspondence.

The Programme Board is the main decision-making board and its purpose is to drive the project forward and deliver the outcomes and benefits within the tolerances set by the Sponsoring Group. The Programme Board meet approximately every 2 months. In between key issues are dealt with by correspondence.

The Programme Board has the following responsibilities:

- advising the Sponsoring Group on issues that exceed the Programme Board tolerances
- providing direction on issues raised within the Programme Board tolerances
- advising the project on reputational and political risks for consideration in decision making.
- ensuring high priority red risks are being actively managed
- endorsing partnership and collaborative working to deliver the scheme
- endorsing and supporting the project through approval gateways

The composition of the Programme Board is shown in Figure 6-1.

The Oxford Flood Alleviation Scheme Project Board manages project issues and risks at a project level within tolerances set by the Programme Board and comprises the Environment Agency Project Executive, Senior User and external Senior Supplier. It meets by exception only.

All of the groups defined above have terms of reference in place.

6.2.3. Project team

Following on from the governance structure shown above, a summary of the key roles within the project team and their hierarchy is shown in Figure 6-2 below. Roles shown in blue are all performed by Environment Agency staff, roles in red are performed by contracted suppliers.

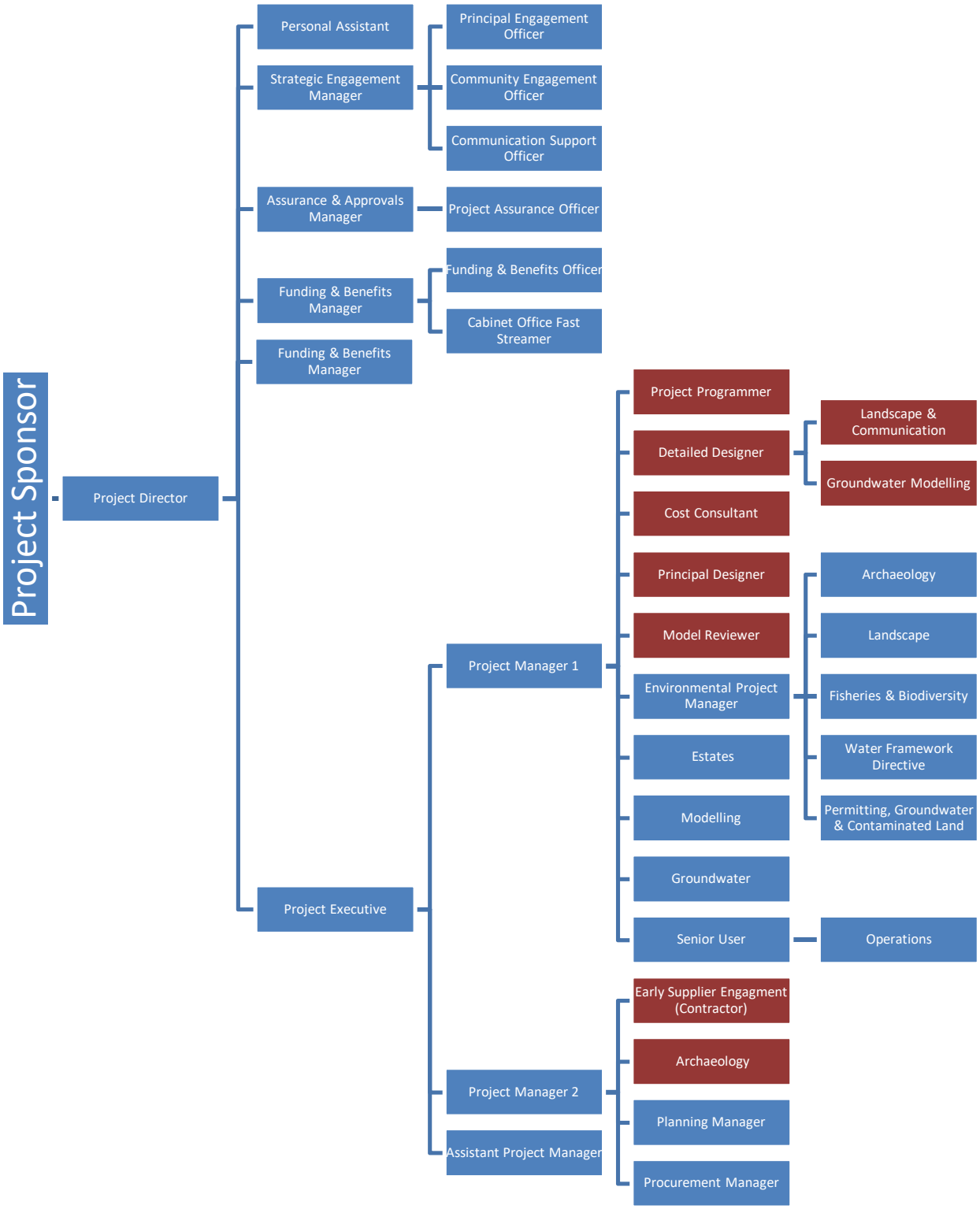


Figure 6-2: Project team hierarchy

Key persons in the management team from the above hierarchy are listed in Table 6-1 below.

Table 6-1: Management team

Role	Name
Project Director	Joanna Larmour
Project Executive	Richard Harding
Assurance & Approvals Manager	Christopher Savage
Funding & Benefits Manager	Emma Formoy
Funding & Benefits Manager	Jon Mansbridge
Strategic Engagement Manager	Helen Cukier
Environmental Project Manager	Penny Burt
Project Manager 1	Heather Taylor
Project Manager 2	Jane Birks

As seen in Figure 6-2 the Project Managers report to the Project Executive. The Project Executive and Project Managers are part of a separate internal project management team in the Environment Agency, whilst the majority of the remaining team members are directly employed to work on the scheme. Whilst these team members report to and are line managed by the Project Director, their areas of the project are overseen by the 2 project managers. The funding and benefits workstream falls under Project Manager 1, whilst the communications and engagement, and assurance and approvals workstreams fall under Project Manager 2. The other areas that the project managers are responsible for are as shown in the hierarchy of Figure 6-2.

The project is also currently hosting a civil service Project Delivery Fast Streamer and a graduate civil engineer from the Environment Agency's graduate scheme who assists the Project Managers whilst gaining valuable experience from the project team.

The Environment Agency has a co-location space for major projects teams, which also includes the River Thames Scheme. To aid communications and team-working, particularly as the team is geographically spread out, the core project team, including consultants and contractors, co-locate in this major projects area. This can also help to share lessons learnt, efficiencies and problem solving with the River Thames Scheme.

6.2.4. Resource management

The resource requirements of the project are captured in the project's resource management plan. This describes the change in project structure through future stages of the project through to project closure, the responsibilities of each workstream, and the project approach to recruitment, retention, transitions, and learning and development. The plan is owned by the Assurance and Approvals Manager, with any changes approved by the Project Director.

The current project team is made up of the following workstreams: funding and benefits, assurance and approvals, communications and engagement, delivery, planning, estates, National Environmental Assessment Service (NEAS), and commercial and procurement.

External contractors are used for certain specialist roles where the relevant skills are not available in the Environment Agency, including estates and specialist programme support.

We developed the resource plan using the master programme to carry out a task-based assessment of resource requirement. This created an initial resource profile over the course of the project, which was further refined through discussion with the workstream leads.

Full Business Case (FBC)

As set out in the resource management plan, the project team structure for the FBC will be broadly similar to that of the OBC, but will require some extra resource due to the shift in focus to detailed design, planning, and procurement. The team full-time equivalent (FTE) will increase from the current 20 FTE to a peak of 21.9 FTE during FBC, of which 2 FTE will be new roles. These will be recruited through the Environment Agency.

Delivery

Moving from FBC to delivery is the first major transition point in the project. The key resource changes will be the handover of commercial responsibilities to the delivery workstream, a reduction in the funding, estates and planning workstreams, and the creation of construction-specific roles for project management, communications and environment. These are set out in more detail in the resource management plan.

The change in project structure during delivery will be developed in more detail by September 2017 through use of the master programme and discussion with workstream leads. The updated plan will include updated strategies for the retention of staff and transition management, and an analysis of the outputs of the skills assessment. The approach to the recruitment of new staff during delivery will also be set out. This will be approved by the Project Director.

Business readiness

A Business Readiness Manager will be recruited in January 2018 to allow a 6-month recruitment and handover process before the first project transition point. This role is to bridge between the project and business operations, and they will be responsible for ensuring that the completed scheme can be managed and embraced by individuals within the organisation as well as managing project transitions. The key responsibilities of this role will be: establishing business readiness workstreams, preparation of business areas for receipt of the scheme, integration of the scheme into business as usual operations, and transition management between FBC and delivery and at project closure.

6.2.5. Use of specialist technical advisors

Specialist technical advisors, outside of the WEM framework, have been used to aid the project team up to the submission of the OBC. Table 6-2 below shows who has been used since the SOC, during the appraisal period. The need for specialist technical advisors will be reviewed, identified and allocated at each gateway. It is expected that specialist technical advisors will be required in Compulsory Purchase Order (CPO), earthworks movement, culvert construction; where known, these are shown in Table 6-2.

Table 6-2: Specialist advisors

Specialist area	Advisor
Compulsory Purchase Order – Solicitor	Mark Brumwell
Archaeology	Oxford Archaeology
Modelling – groundwater, low flows	ESI Consulting (via CH2M)
Site investigation	WYG

Multi-Coloured Manual – flood risk management economics	Professor Edmund Penning-Rowsell (via CH2M)
Earthworks strategy	Kelston Sparks (Earthworks Contractors)
Culvert construction	Delta Civil Engineering

6.3. Change management and project control

The project is managed in accordance with PRINCE2 methodology. PRINCE2 is an approach already well embedded within the Environment Agency and is used throughout our supply chain.

As shown in Figure 6-3, we have developed a number of project control documents from the PRINCE2 management structure, all with the emphasis on the approvals process and key milestones depending on the audience. These have been developed or updated during the OBC stage.

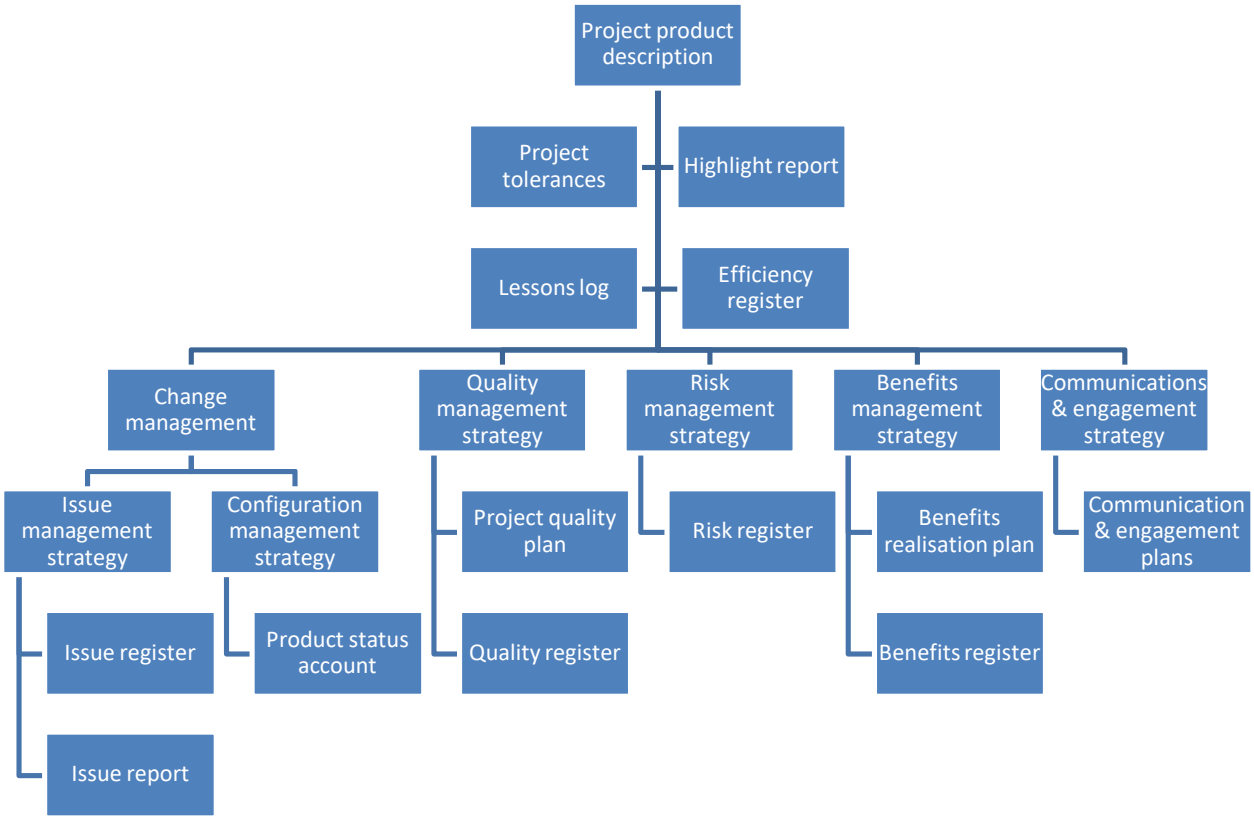


Figure 6-3: Project control documents

We have set up and are using project control documents relating to change. These documents form the framework shown in the left hand side of Figure 6-3 above.

6.3.1. Issue Management Strategy

The Issue Management Strategy outlines the approach to managing issues on the scheme, providing clear roles and responsibilities, a detailed process and standard templates to guide the team.

A risk is an event which has not yet happened and is not guaranteed to happen. An issue is a concern that is either current or will definitely occur in the future, which will adversely impact the

project if not dealt with. Once a risk has been realised it becomes an issue. However, an issue cannot become a risk. The approach to risks is dealt with in the Risk Management Strategy.

The responsibility for the creation, maintenance and periodic review of the issue management strategy lies with the Project Manager. This is overseen by the assurance lead and is reviewed at the start of a new stage or other significant change in the project and changes agreed with the Project Executive.

Issue register

Issues are raised by anyone on the project and everyone has access to the issue register on which the issues are recorded. The project team review the issue register on a regular basis during team progress meetings and other relevant team meetings. The issue register is owned by a Project Manager whose responsibility, along with additional support staff, is to ensure that the issues are reviewed and action taken are recorded on the register. This ensures that the team stay alert and aware of on ongoing issues, and that action is taken to resolve them in a timely manner.

Where necessary to investigate more complex options and to enable the approver to make a decision, an issue report is written by the issue owner. This gives further detail about the issue which has also been recorded on the issue register.

Issues are escalated and decisions are made at levels appropriate to the priority classification of each issue.

6.3.2. Configuration Management Strategy

A Configuration Management Strategy was produced during the OBC stage to ensure a strategy was in place for management of the large volumes of data produced and shared between multiple parties on a major project.

The Configuration Management Strategy is owned by the Project Executive who will also agree any changes to the strategy. A Project Manager has been delegated responsibility for managing and reviewing the strategy at changes in project stage or other significant relevant change points. It has most recently been updated to reflect the requirements of Building Information Modelling (BIM), described below, and the start of the detailed design stage.

The strategy has 2 main purposes:

- to describe how project information is stored, approved and versions controlled
- to describe how change and issues are managed more widely on the project, to its expected scope, timescales, cost, quality and risk

As with other project control documents, the strategy links heavily to the Issue Management Strategy and Project Quality Plan.

Building Information Modelling (BIM)

Since the start of the detailed design stage onwards the project will be utilising BIM, aiming to reach level 2 compliance within Environment Agency system restrictions.

When BIM was being introduced to the Environment Agency an issue report written by a Project Manager was put to the Project Executive for approval. This put forward a programme of training to ensure that the project would meet its internal and government targets for BIM compliance. The issue report was approved by the Project Executive and the programme has been followed to ensure the team have the right skills in order to use BIM correctly and to maximise the efficiencies of the methodology.

The key tools and systems that we have introduced are described in Table 6-3 below along with how they are likely to benefit the project.

Table 6-3: BIM tools and systems

Tool/ system	Description	Benefit
Asite – employer common data environment	A shared online workspace for storage of project files. This is a controlled environment with a naming convention, information status and information managers to control the flow and sharing of information. The information manager is the project manager and they perform a security role, ensuring that only people who need to see information can.	This will enable the project to more efficiently transfer information between different organisations. It should also make it easier to find information if the file name is used correctly, reducing lost time searching for information saved on the system.
Information delivery plan	A list of headings for all information deliverables created during the scheme. It links to the file naming convention and forms part of the scope.	It enables a full record of the information available and due to be understood by all parties on the project. It can be beneficial during changes in staff.
Naming spreadsheet	The team has created its own project specific naming spreadsheet with macros to take information from the information delivery plan and input from the user to automatically rename files.	It reduces human error in using the naming convention. It makes it easier and quicker for people to name files increasing the uptake of the new system. It has also been shared with other projects at the Environment Agency for them to adapt and use.

The use and efficiencies of BIM will be assessed periodically by 2 BIM champions within the project team to see how well we are meeting the Environment Agency and project specific goals for its implementation.

6.3.3. Quality management

The PRINCE2 mechanism for managing projects allows the management tools and methodology to be scalable to the size and requirements of the project. The project team, including the Project Executive and Assurance and Approvals Manager made the decision not to produce a quality management strategy. Instead the Project Quality Plan (PQP) has been extended slightly to cover a summary of quality management procedure, planning and control, which all links back to existing Environment Agency quality management guidance.

We have significantly updated the PQP since the SOC stage to account for many new deliverables which required associated quality plans. The current PQP accounts for key deliverables both since the project start up and through to FBC approval.

The Project Executive owns the PQP, however the responsibility for the maintenance of the PQP has been delegated to the Project Manager. The Project Manager reviews and updates the PQP at each project stage or at any other key points in the project. If there were a significant change to the scope, this may also be reflected in an update. Any updates are then reviewed and approved by the Project Executive.

6.4. Risk management

A Risk Management Strategy has been produced for the scheme and was updated at the end of the appraisal stage to reflect changes in the project team management structure.

The scheme's Risk Management Strategy is informed by corporate risk management policies from the Environment Agency and the partners on the project. It is owned by the Project Manager, with any changes approved by the Project Board.

The risk management strategy sets out the risk management procedure which is followed on the project as shown in Figure 6-4 below:

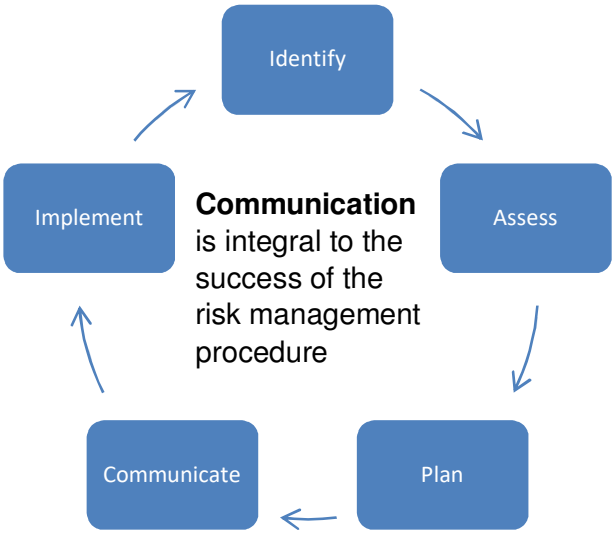


Figure 6-4: Risk management procedure

Risks can be identified at any time by any member of the project team, who must notify the Project Manager responsible for the strategy. Following the identification of risks, they will then be included in the risk register which will identify the risk owner and the steps being taken to mitigate the risk.

We hold a risk workshop quarterly to ensure that the risks are reviewed by the project team and that any new risks are added to the register.

Whilst the assessment of risk remains a judgement, the project has adopted a standard scoring approach that supports this judgement. By using a common approach the risks can be compared, prioritised and managed effectively.

For each risk identified the project considers a management response in order to reduce or remove the threat or to maximise the opportunity. Concentration is placed on the high (red) risks as these have the greatest chance of arising and are likely to impact the programme most severely. Consideration is also given to medium (amber) and low (green) risks in order to ensure they don't affect the red risks and that the project is prepared to respond to the risk should its severity increase.

This step in the procedure ensures that any risk responses are implemented. Each risk is assigned to a single member of the project team who is best placed to manage the risk.

During quarterly risk workshops the owners are reviewed and response strategies are reviewed.

As the risk register is complex and may continue to grow in complexity during the detailed design stage, the project plans to utilise existing project support resource to aid with management of the risk register, this will include ensuring that any agreed response strategies are implemented.

Risks are discussed in:

- progress meetings

- highlight reports
- exception reports
- assurance reviews
- quarterly risk workshops
- weekly team teleconferences
- in addition to the above procedure, if a new high priority (red) risk is identified this will be communicated to the Project Executive

6.4.1. Risk register

The project risk register includes all known risks covering the project as a whole. More accurate quantification of risks is carried out for the risks that may impact during the current stage and require more active management. Those that will potentially impact on future stages are included to plan future budgets and scope.

The risk register also allows for a quantification of the costs associated with each of the risks. Each risk is assessed for a minimum cost, most likely cost and maximum cost. These are estimated using time and resources estimates. The full risk register is then run through a Monte Carlo risk analysis to give a normal distribution of the risk costs. A 50th percentile (P50) and 95th percentile (P95) can be taken from the distribution and is used for budgeting and approval purposes.

The Project Manager reviews and updates the project risk register monthly. The risk register is a controlled document and subject to version control as per the Configuration Management Plan. Any amendments to the risk register will be authorised by the Project Manager. The project risk register is attached as Appendix M.

A summary of the management arrangements for some of the key, high risks is described in Table 3-9 in the Economic Case.

The risks are reported to the team in the monthly highlight report. The Programme Board and Sponsoring Group are made aware at their bimonthly meetings.

6.5. Communications and stakeholder engagement

6.5.1. Introduction

Communications and engagement are integral to the successful delivery of the Oxford FAS. Without public and partner support the scheme risks not getting through the planning process and receiving objections from members of the public. Communications and engagement has been integral to the scheme from the start and will continue to be throughout the development of the scheme.

We have a detailed communications and engagement approach that is being delivered by a dedicated team as set out in the resource management plan. The team manages day-to-day communications with a partnership communications group. Key scheme messages and high level approaches are agreed with the partnership programme board. By fully embracing the Environment Agency's 'working with others' philosophy, we are developing a scheme along with partners and stakeholders that meets the schemes objectives.

Good communications and engagement are imperative to building trust with downstream communities and those not initially supportive of the scheme. By doing this well we are taking the communities and stakeholders on a journey to create a scheme that enhances and improves the lives of those using this internationally important city. It will leave a positive legacy for years to come.

6.5.2. Communications and Engagement Strategy

We have a detailed Communications and Engagement Strategy that sets out the agreed methods and frequency of communication with internal and external stakeholders throughout the life of the Oxford FAS. It provides standard terminology, clear roles and responsibilities, a detailed description of the approved communication management process, and the standard templates used in that process. It is designed to guide the project team on engagement and communications with the scheme stakeholders. It adopts a 'working with others' approach.

This document covers both proactive and reactive engagement in terms of the required protocols, monitoring and staff resourcing. It takes into account the additional workload that is likely to be generated by ad-hoc queries and data requests at different stages of scheme development.

Overarching engagement objectives

- Throughout the development and construction of the scheme we build and maintain a good working relationship with all scheme partners, enabling them to protect and enhance the reputation of both the scheme and the Environment Agency.
- Throughout the development of the scheme, we make all those interested and affected aware of the scheme, that we are working in partnership, and how to get involved.
- By planning application submission, stakeholders understand the flood risk in Oxford and are supportive of the need for the flood alleviation scheme.
- By planning application submission, stakeholders feel that we have considered feedback on local concerns, issues and priorities, and are aware of what they can and can't influence, and why.
- By completion of construction we have maintained and enhanced Oxford's reputation as a thriving centre of commerce that is complimented by a flood scheme which enables the city to remain open through flood events.
- Throughout the development of the scheme we ensure all internal Environment Agency staff are well informed on the scheme and can act as advocates during any external engagement.

6.5.3. Stakeholder management

The stakeholders interested in and affected by the scheme will change throughout the life of the project as will their level of interest and involvement. The level of engagement we need to have with stakeholders depends on their interest and influence they have.

We analyse stakeholders using the 4-box grid methodology which groups stakeholders into inform, monitor, consult, and involve categories. We store this information in our stakeholder database.

We hold a stakeholder analysis workshop twice a year with both the project team and partners to ensure stakeholders are in the correct category and the project team are focussing their effort proportionately with them. The outputs from these workshops are used as a basis for engagement planning across the next 6 months.

6.5.4. Downstream communities

Following public event feedback requesting different engagement with downstream communities, we held small focus groups throughout summer 2016. The objectives of the focus groups were to find out what the concerns of the local communities were; to improve our understanding of what their knowledge of the scheme was; and to find out what communications tools they would like us to use when communicating with them.

The results confirmed that downstream communities are concerned that the scheme will move flood water around Oxford more quickly and return it below Oxford, increasing flood risk downstream, but even some of those who have concerns said that by engaging directly with them would help to increase trust and understanding of the scheme. We produced a report summarising the findings and have planned our further engagement accordingly.

Following the publication of the downstream model for the scheme and in the lead up to the public consultation in late spring 2017, we are engaging with members of the public in their communities, at local events, using bespoken communications tools. We are also including articles in their local publications and disseminating information through local groups about the scheme, engagement opportunities and the public consultation.

6.5.5. Communications channels

The communications channels used for the scheme vary from traditional to more modern and innovative methods. These include newspapers and magazine articles', newsletters, radio coverage, a scheme webpage, blogs, public events, press releases and events, posters, flyers and Twitter and Facebook accounts. The partnership supports the scheme communications by helping at events, sharing social media posts and messages, and adding information to their websites and newsletters.

The choice of communications channel(s) used for each communications and engagement plan is tailored depending upon the engagement objectives and the demographic of the audience we are targeting.

6.5.6. Communications and engagement plans

We produce communications and engagement plans for specific pieces of work that deliver the proactive engagement objectives, such as public consultations.

Each plan includes the business objective; specific, measurable, achievable, realistic, timely (SMART) engagement objectives; milestones; key messages; key stakeholders; and an action plan.

The team will evaluate these plans throughout delivery and at completion to ensure the objectives have been met and that any lessons learnt are fed into current and future plans. The status of plans are listed in Table 6-4 below:

Table 6-4: Status of communications and engagement plans

Delivered plans		
Plan	**Date complete**	**Objectives met**
Public consultation on the route of the scheme	January 2016	✓
Announcing the preferred option	June 2016	✓
Old Abingdon Road archaeological works	October 2016	✓
Archaeological investigations and trial pits	December 2016	✓

Plans being delivered		
Plan	**Date to be completed**	**RAG status**
Landowner workshops	February 2017	Green
Engaging with a wider audience	May 2017	Green
Pop-up shops	August 2017	Green
Downstream communities	May 2017	Amber
Plans being developed		
Plan	**Date to be drafted**	**Lead**
Detailed design	December 2017	Principal Engagement Officer
Engagement with communities most affected	December 2017	Principal Engagement Officer
Planning application	June 2017	Principal Engagement Officer
Construction start	August 2017	Principal Engagement Officer

6.5.7. Communications and engagement feedback

We have received very positive feedback about the communications methods and approaches we are using, and there is widespread support for the scheme overall. We will continue to ask for this feedback and use it to shape the communications and engagement for the next stage of the project. Examples of this feedback are listed below.

"I think this floor map is great and very informative" Agi MacKeith, Old Botley Road resident.

"Video was good to see how we'll be affected during flooding and very easy to understand. Glad we came" Maria and David Radford, New Hinksey residents.

Figure 6-5: Photo from public event – June 2016

From feedback and evaluation we have identified the key issues the public have about the scheme. These include concerns about downstream impacts, construction and impact on trees. From previous public engagement we are also aware that local communities are interested in

opening the scheme area up to more public access. We are currently discussing this with landowners. An update on public access will be included accordingly in the detailed design public consultation in spring 2017.

Our next steps for future engagement will be based on lessons learnt from past engagement and we have developed a number of principles for these, including:

- presenting material in a range of visual ways has been a success; we received great feedback about the floor map and videos
- social media has allowed us to reach a much wider audience but needs time and effort invested to increase engagement
- treating downstream communities separately has reduced the amount of negative enquiries and feedback on this issue
- we still need to look at how we can reach more diverse audiences
- there is still some confusion about the scheme, how it will work and roles; we need to ensure all team are giving consistent messages

6.6. Planning and consents

We have discussed and consulted on the outline design developed during the OBC with the local planning authorities and interested parties, so that the planning application and other consents and authorisations can proceed smoothly leading up to the FBC.

Planning permission for the Oxford FAS will be sought through the Town and Country Planning Act 1990. We have held discussions with the 3 local planning authorities (LPAs) involved (Oxfordshire County Council, Oxford City Council and Vale of White Horse District Council) and they have agreed to the submission and determination of one planning application. Oxford City Council and Vale of White Horse District Council have agreed to hand planning decision making powers to the County Council under Section 101 of the 1972 Local Government Act. Memorandums of Understanding between the district councils and the county will be established to aid this process. There is ongoing discussion regarding the feasibility and desire for a separate planning application for the materials management aspect of the scheme.

The design of the scheme does not enter into land within the administrative boundary of South Oxfordshire District Council. This means that they will not be part of the decision making for the planning application however, they will still be consulted as a statutory consultee in the process.

There is always a possibility that a public inquiry may be instigated through the call-in process, but through engagement with stakeholders, interested parties, landowners and the public we are reducing the risk of successful challenge.

We have held meetings with the LPAs to ensure the planning process is robust and to scope the depth and breadth of application content and the supporting information required. A pre-application consultation submission is scheduled for spring 2017 to finalise the requirements and planning justifications for the scheme prior to formal planning application submission.

The detailed design consultant will be responsible for attending and presenting at meetings with the LPAs, statutory consultees and those organisations from which consents and authorisations are needed, to achieve their formal support for the scheme, and achieve any necessary consents and authorisations for the project.

A consents and authorisations register has been developed as a plan of all consenting requirements needed to facilitate the scheme until construction is completed. This is a living document and is updated as the design evolves.

The consultant will also advise on the submission of planning applications as appropriate, in order to secure permissions where possible for all elements of the work that are suitably developed. We do not anticipate that any of the proposal will be secured under the Environment Agency's Permitted Development rights.

Ongoing baseline surveys will help determine what other works, if any, might need to be completed in advance of the FBC sign off, to ensure that the project can be delivered to its current programme.

We have also engaged with all landowners since the project was initiated and have always been up front that we would deliver the project by CPO to bring programme certainty. This does not preclude reaching negotiated settlement in which case we would not enforce the CPO on that particular landowner. We regularly review and update our lands strategy which is available on request.

6.7. Early works and preparatory works

We are proposing to carry out various preparatory works, for the period when the design is substantially complete and before the contractor starts on site. This includes environmental mitigation for the works themselves which must be carried out before we damage existing habitats. Exact details of the preparatory works will be defined during the detailed design stage in collaboration with the Early Supplier Engagement (ESE) contractor. This will not include construction of haul roads or compounds, this will be accounted for at the start of construction. Confirmation will be sought from the project sponsors before any of these works are progressed. The preparatory works will broadly cover the following areas:

- Environmental mitigation:
    - preparation of possible translocation sites and/ or translocation of species
    - planting of trees in mitigation areas not affected or required during construction
    - trial scrapes for establishing planting regimes – already excavated and being monitored to understand how vegetation will re-establish
- Services diversions:
    - diverting services (particularly lowering those that cross the proposed channel alignment) in advance of the main works starting to give the contractor free access to the main earthworks site
- Pre-booking of critical plant and equipment:
    - the majority of the proposed works involve standard equipment and industry approaches, but if specialist equipment is needed it might be necessary to pre-book it

6.8. Benefits realisation

Benefits are defined as outcomes of the scheme that are perceived as positive by one or more stakeholders. Benefits realisation is the process by which the positive outcomes of the scheme take effect. Disbenefits are defined as outcomes of the scheme that are perceived as negative by one or more stakeholders.

At the end of the appraisal stage of the scheme, we produced a Benefits Management Strategy to demonstrate how benefits and disbenefits will be managed during the detailed design and delivery stages. It also describes how benefits realisation will be monitored after project closure.

The strategy captures the recommendations from the Infrastructure and Projects Authority (IPA) routemap. It describes the scheme's approach to the identification, analysis, tracking and reporting of benefits and disbenefits realisation. It also describes the benefits management products that will be used by the scheme.

The Benefits Management Strategy is informed by corporate benefits management guidance from the Environment Agency and the partners on the project. All benefits management products are owned by the Funding and Benefits Realisation Manager. The benefits management products and process have undergone regular review by the Programme Board and Sponsoring Group, and have been peer reviewed within the Environment Agency and by the IPA benefits and savings lead.

A brief summary of the benefits management approach is described below:

Identification

We have identified the benefits of the scheme through an unconstrained economic assessment, returns from public events, and an Ecosystems Services Assessment (ESA). Benefits and disbenefits were also identified in consultation with the project team.

Analysis

We have analysed the identified benefits in 2 benefits management products.

- Benefits dependency map: a visual document to show how the benefits are interlinked and deliver against the strategic objectives. It also shows the indirect benefits of the scheme, which are defined as positive outcomes that arise as a consequence of the strategic objectives. This is attached as Appendix H.
- Benefits register: captures the direct benefits and disbenefits identified in the map. This will include key information for each benefit and disbenefit, including the prioritisation, timescale for realisation, measurement metric and values, owner, and any necessary actions or business change for the benefit to be realised or the disbenefit to be mitigated.

The prioritisation of benefits for monitoring and realisation was conducted in collaboration with the scheme partners and agreed by the Sponsoring Group.

Table 6-5 describes the management arrangements for the primary benefits of the scheme. It expands on Table 2-2 in the Strategic Case.

Table 6-5: Benefits realisation

Ref	Benefit	How measured and with what frequency?	Measure target	Benefit owner	When will benefit start and when will it be fully realised
P1	Residential properties suffer less flood damage	Modelling at design changes. Flow rates measured during full flow events.	1000 properties at lower flood risk band.	Heather Taylor, Project Manager	Benefit will start and be realised at readiness for service.
P2	Commercial properties suffer less damage	Modelling at design changes. Flow rates measured during full flow events.	100 properties will no longer flood in a 1 in 100 (1%) annual flood event.	Heather Taylor, Project Manager	Benefit will start and be realised at readiness for service.

P3	Lower frequency of flooding to Abingdon and Botley roads	Modelling at design changes. Flow rates measured during full flow events.	Roads will not flood in a 1 in 20 (5%) annual flood event (currently at 1 in 5 (20%) risk).	Heather Taylor, Project Manager	Benefit will start and be realised at readiness for service.
P4	Fewer electricity disruptions as a result of flooding	Modelling at design changes. Flow rates measured during full flow events.	30 substations at lower flood risk.	Heather Taylor, Project Manager	Benefit will start and be realised at readiness for service.
P5	Improved resilience of high-speed broadband network	Modelling at design changes. Flow rates measured during full flow events.	16 assets at lower flood risk.	Heather Taylor, Project Manager	Benefit will start and be realised at readiness for service.
P6	Lower frequency of flooding to railway line	Modelling at design changes. Flow rates measured during full flow events.	Trains are able to run in a 1 in 75 (1.33%) annual flood event (currently at 1 in 20 (5%) risk).	Heather Taylor, Project Manager	Benefit will start and be realised at readiness for service.
P7	Less likelihood of subsequent sewer flooding	Modelling at design changes. Flow rates measured during full flow events.	88 properties at lower risk of sewer flooding from fluvial event.	Heather Taylor, Project Manager	Benefit will start and be realised at readiness for service.
P8	Creation of WFD habitat	Ecological surveys annually 2022 to 2027, and 5-yearly until 2037.	5ha net WFD-criteria habitat created.	Penny Burt, NEAS lead	Benefit will start at readiness for service and be realised by 2037.

Benefits tracking

The Benefits Realisation Plan is a document that acts as a detailed guide for the project team and benefit owners to aid benefit and disbenefit tracking and realisation. It expands on the analysis from the map and register with more details on the prioritisation of benefits and benefits management checkpoints. For each benefit it will contain a profile with a detailed plan of action for its measurement and realisation. The benefits realisation plan is attached as Appendix I.

Risks that benefits will not be realised or that disbenefits will be worse than expected are included in the project risk register and addressed as described in the Risk Management Strategy.

Progress updates are reported to the project team and senior management in the monthly highlight report. The Programme Board and Sponsoring Group are made aware of any issues with benefits realisation in their meetings and these are escalated as necessary.

6.9. Contract management

Water and Environment Management (WEM) will be the contractual vehicle to deliver the design and construction works. WEM is built on effective framework management processes to align Environment Agency and supplier objectives.

Framework management

Framework management under WEM operates at both strategic and operational levels and includes representation from the supply chain. The aim of WEM framework management is to foster greater collaboration between the Environment Agency and suppliers, encouraging exemplar standards in performance, health & safety and sustainability.

Delivering the Oxford FAS within a framework that seeks to collaborate and get the best out of the supply chain will be of significant benefit and will support contract management.

Contract management

The Project Manager will manage the detailed design contract with commercial support provided at key decision points. External cost management will also support this approach.

Construction contracts will be managed in line with the roles identified in the ECC Contract. An ECC Project Manager and ECC Supervisor will be appointed. These key roles will be provided by specialist bought in services. Appointment to ECC Project Manager is instructed following an in-depth interview by the Environment Agency's contract and risk manager. This process ensures only a competent and qualified individual undertakes this role.

Given the scale of the Oxford FAS it is important that we appoint the ECC Project Manager early to secure the best person for the role and ensure a smooth transition between tendering and contract management. National Cost Management Framework (NCMF2) suppliers will be contacted early to agree the most suitable time to tender this opportunity.

Wider contract management support will be provided in line with Environment Agency's commercial assurance programme.

Dispute resolution

Z25 of the WEM Deed of Agreement details the process to dispute resolution. The escalation route above this process is adjudication, followed by litigation in the courts.

6.10. Programme

The 2 project managers are responsible for the production and monthly update of individual workstream programmes; for the communications, assurance, planning and funding and benefits workstreams. These individual workstream programmes all come together to feed into a master programme for the scheme by the project programmer. This programme also includes the consultant's detailed design programme and an outline construction programme. This is then quality checked by the assistant Project Manager before being issued for use by the project team.

Key milestones from the master programme are listed in Table 6-6 below. The latest high level programme, which summarises the key activities, is shown in Figure 6-6 overleaf. A copy of the full programme is shown in Appendix S. Key milestones beyond OBC approval are subject to change as the detailed design progresses and any risk to the programme is realised. The construction timescale in particular is likely to change as it will become better defined.

Table 6-6: Milestones

Task	Milestone
Outline Business Case Submission	22 February 2017
Pre-Planning Application Submission	10 April 2017
Outline Business Case Approved	8 September 2017
Full Planning Application Submitted	2 November 2017
Detailed Design Complete	23 November 2017
Construction Tender Issue	22 September 2017
Planning Application Approved	25 May 2018
Construction Tender Evaluation Complete	17 April 2018
Full Business Case Submission	14 June 2018
Full Business Case Approved / Contract Award	13 September 2018
Construction Start	12 October 2018
Construction End and Gateway 4	25 August 2021
Defects Period End	9 July 2024

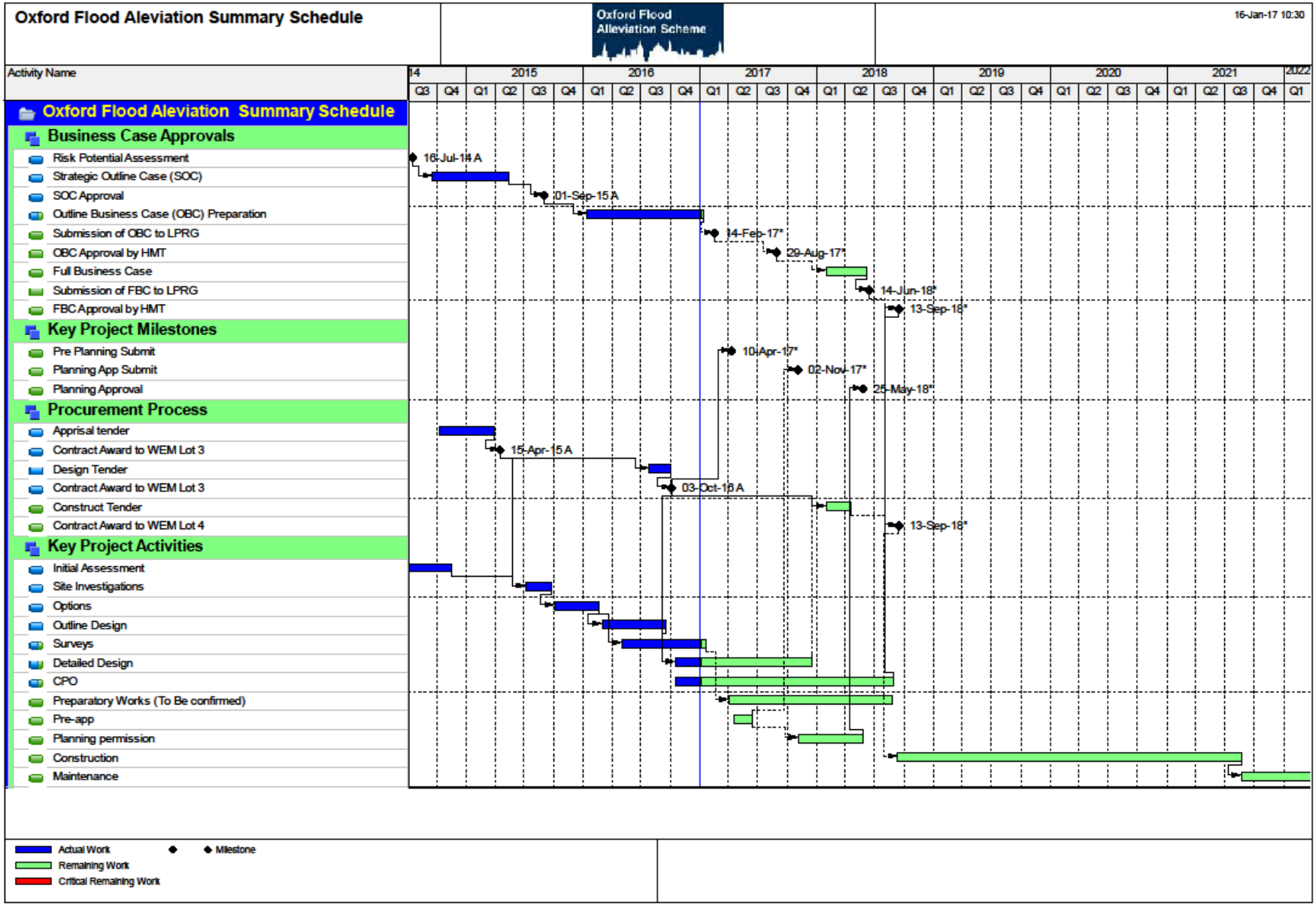


Figure 6-6: High level programme

6.11. Maintenance Governance

The Oxford FAS will require maintenance and funding of that maintenance for the life of the scheme. The scheme has to be maintained in order to secure the outcomes set out within our strategic objectives and critical success factors that justify the original capital investment into the scheme. It is the intention to continue to do this in partnership and complimentary to local land use in order to extend the affordability case beyond the first 10 years. Ongoing discussions with local partners are considering the options outlined in table 6-7 below. The current preference is for a form of Trust to oversee at least a section of the scheme. Our agreed approach to future maintenance will be set up prior to the submission of the FBC.

Table 6-7: Maintenance governance options

Maintenance governance option	Pros	Cons
Environment Agency takes 100 % responsibility for scheme maintenance with no third party involvement other than financial support through commuted sum contributions.	Provides whole life solution Simple internal governance. No partners involved so no risk of dispute. Significant amount of work that will help maintain Operational management capabilities. Future opportunity to create a revenue stream for maintenance work.	No local ownership of the scheme. 100% of responsibility/financial liability on one organisation.
Environment Agency lead but subcontract out specific tasks to willing partners and other local stakeholders – still funded as a commuted sum.	In kind work will help future scheme costs. Local ownership of the scheme and shared responsibility.	Environment Agency still seen as main responsible party. Contracts with in kind work may have limited timescale – could only be short term solution (10-20 years).
Profit share commercial deal with Oxford City Council or other maintenance provider.	Profit share would help fund future costs. Innovative competitive approach to maintenance that should reduce costs.	Future management and administrative burden of reviewing and letting future commercial deals.

Partners take on 100% responsibility for scheme maintenance. Environment Agency manage administration of GiA funding through to our partners only.	100% local ownership of the scheme. Interested local parties and landowners have more control over what is done.	Environment Agency would have to maintain an overview of the scheme as there will be elements of the scheme's maintenance which will be suitable for our field teams general or specialist skills and other tasks that would be more suitable for our partners. Environment Agency may be liable to pay a commuted sum to a Third party for the asset.
Maintenance Trust – Oxford FAS Sponsoring Group and Programme Board governance built into the trust with further local community, land owners and wider charity input.	A maintenance trust set up of local stakeholders will ensure local ownership of the scheme. Multiple stakeholders would ensure continued delivery of local benefits. Competition between trust members will help keep maintenance costs competitive. The inclusion of wider charity based groups such as BBOWT and the Fresh Water Habitats Trust would facilitate and enhance our green legacy ambitions.	Governance will require long term commitment from a number of organisations. Potential for dispute between multiple partners. May have a limited certainty lifespan (10-20 years)

6.12. Post project evaluation

The outline arrangements for post implementation review (PIR) and project evaluation review (PER) have been established as follows. These will be refined during the FBC stage against best practice approaches.

6.12.1. Post implementation review (PIR)

These reviews ascertain whether the anticipated benefits have been delivered. They are timed to take place when the project achieves Gateway 4 (readiness for service) and then subsequently at 5-yearly intervals for the first 15 years of the asset's operational life.

This will enable sufficient time for landscape-related benefits to establish in the environment and for operational testing of high flows through the scheme. The details for these reviews will be developed during the FBC by the Funding and Benefits Realisation Manger, as they will be informed by the benefits realisation strategy, plan and register.

The longer term post-implementation review schedule will form part of the handover documentation at project closure. The accountability for delivering this will rest with the Thames Area Flood and Coastal Risk Manager which is reflected within the resource management plan.

6.12.2. Post project monitoring for EIA and benefits realisation

Post EIA monitoring will compare the impacts predicted in the Environmental Statement (including the WFD Assessment) with those that actually occur implementation, in order to ascertain whether

the impact prediction was satisfactory and whether environmental benefits are being delivered. The details for the monitoring programme will be developed during detailed design by the senior Environmental Project Manager in consultation with internal Environment Agency specialists and the design consultants (CH2M).

6.12.3. Project evaluation reviews (PERs)

PERs appraise how well the project was managed and delivered compared with expectations and are timed to take place once the OBC and FBC approval milestones have been achieved, at Gateway 4 (readiness for service) and at project closure.

These will be completed in the spirit of continuous improvement and at this stage will be conducted by a combined questionnaire and facilitated workshop approach. The reviews will have 2 key aims: firstly, to identify any areas of best practice, innovation or efficiency, and secondly, to identify any areas where things did not go as planned and how these were overcome. The Assurance and Approvals Manager will be responsible for initiating the reviews and will be supported in carrying these out by trained facilitators from the Environment Agency's national Business Improvement team.

The project team will use findings of project evaluation reviews to inform the planning for subsequent stages of the project and enable us to be the best we can be. The project team's response to recommendations will be discussed with the scheme's Programme Board and Sponsoring Group.

Outputs from project evaluation review will also be added onto the Project and Programme Management Tool lessons learnt database and shared at the Environment Agency Major Projects Community of Practice. This will help support continuous improvement in the wider project delivery profession.

6.12.4. Asset performance evaluation

Otherwise known as a post occupancy evaluation. This comes from the Government Soft Landings subset of BIM and is another recommendation of the Government Construction Strategy. The asset performance evaluation, as it has been renamed due to the differences between buildings and infrastructure, is an evaluation of how well the asset is performing against criteria set out during the appraisal and design stages.

Collecting performance data on assets allows trends to be identified in both design methodology and mechanical performance. Once a picture is built up of these assets over time we will be able to learn which assets perform better than others, why, and then ensure the learning can be carried through to other projects in the Environment Agency and across the industry.

On the Oxford FAS the plan is to carry out performance evaluation on the aspects of the scheme listed in Table 6-8 below. As it is a major new asset to the area we plan to carry out these evaluations over a 1-3 year post-completion timescale and will revisit the frequency during the evaluations.

Table 6-8: Asset Performance Evaluation topics

Topic	Description
Maintenance frequency	How often does the channel have to be dredged? How often does the grass need to be cut? How does the cost compare to the allowed budget during design?
Maintenance access	Is the maintenance access actually accessible at all times access is required? Is the maintenance access provided suitable for the vehicles, is it wide enough and does it have the correct bearing capacity for the machinery?
Walls and bunds	Have the earth bunds settled within allowable tolerances? Are the bunds suitably protected from badgers? Are the walls still to the required standard required for protection? I.e. are there any plants/ trees starting to grow through them, causing cracks.

The above details of the performance evaluation will be refined during the detailed design period up to FBC.

6.13. Contingency plans

We will continue to monitor flows and clear blockages during future floods. There is a chance however that future flooding could be more severe and properties that will benefit from a reduction in their flood risk from the scheme, will be at risk again in the future. The flood warning model will be updated after the scheme has been built, allowing us to give appropriate warnings and possibly deploy temporary barriers and pumps, as we do at present.

6.13.1. Fall back option

The Economic Case highlighted 2 other options which were economically justifiable: option 3 (defences) and option 5a (small channel and defences). However, these options fail to deliver all the project objectives and/ or the critical success factors agreed with the project partners. As such, the focus has remained on delivering the preferred option.

Whilst these options have not been explored in further detail the project governance is in place that would allow us to revert to either of these options if we are not able to continue to deliver the preferred option.

6.13.2. Planning

For a scheme of this size and complexity there is always a risk of a planning inquiry resulting from 3 scenarios: appeal for non-determination, appeal of a refusal, or call-in. The first scenario is extremely unlikely as we are working with the LPAs to ensure smooth running of the planning application and we accept that the determination period may extend beyond the statutory timescale.

The second scenario is extremely unlikely as we are addressing issues as they arise and will negotiate and amend the application to reflect any outstanding issues.

The third scenario could occur as any third party can request a call-in to the Secretary of State (SoS). The risk of successful challenge is being reduced through ongoing consultation but is never removed, and the SoS may not agree to call the application in even if a request is made.

If an inquiry is required we would need to establish a team to facilitate, prepare for, attend and give evidence. This will be resource intensive, will require legal involvement, expert witness preparation and training, and procurement of counsel to represent the Environment Agency.

If the development proposal is subject to a planning inquiry it could be conjoined with an inquiry for the Compulsory Purchase Order and we estimate it may extend the programme by 12 – 18 months.

6.14. Assurance

The impacts and risks associated with the project have been scored against the Risk Potential Assessment. The scores are attached at Appendix L with an overall medium risk being assigned, following a medium classification for the consequential impact assessment and a high classification for the complexity assessment.

Due to the value of the project, HM Treasury approval is required. At project initiation it was confirmed in discussions with Defra that the scheme would not join the Governments Major Projects Portfolio and external assurance reviews will be managed by Defra as the lead government department.

In order to gain HM Treasury approval the business case will undergo internal assurance reviews through the Environment Agency and Defra. It will also gain the support of the Flood and Coastal Risk Management Committee of the Environment Agency's Board and Defra's Executive Committee.

A detailed Integrated Assurance and Approvals Plan (IAAP) has been produced for the scheme which adopts the requirements of the Environment Agency's Integrated Assurance and Approvals Strategy. The key milestones are included within the schemes master programme. The detailed IAAP is included with this submission as Appendix U.

The partnership completed the IPA routemap review in March 2016. This structured approach helped explore the timing and interdependencies of the actions that we had already identified were needed to further strengthen the likelihood of successful delivery. This culminated in the production of an enhancement action plan with an overall objective of 'committed partners working collaboratively to achieve the scheme objectives with engaged communities'. The full report and progress delivering the actions is included in Appendix V. Oversight of delivery has been via the scheme's Programme Board.

6.14.1. Gateway review arrangements

An external Gateway 1 review was completed in April 2015 as part of the assurance and approval of the SOC submission. The review team found that it is likely the project will achieve its objectives and can be delivered successfully. They also added that the scheme is being delivered using an exemplar and innovative partnership approach that not only covers funding but is also achieving public and political support. They gave the project an amber rating with 9 recommendations to consider. This was considered to be a good outcome at the stage of the project. These recommendations have all been addressed prior to the submission of this OBC. The full report and details of how the recommendations have been addressed are included in Appendix W.

A joint meeting was held with the Infrastructure and Projects Authority, Defra and the Environment Agency in January 2017. It was indicated that an external Gateway 2 review is not required for the Oxford Flood Alleviation Scheme. The requirements of the review will be covered by the enhanced Large Project Review Group scrutiny of the business case.

The project's Sponsoring Group supports the submission of the OBC at this stage in order to submit the planning application and commence the procurement activities for the construction contract. Approval of the OBC will set some political expectations of continuing through to delivery even if tender prices come back above the affordable partnership funding profile. This may put pressure on Government departments to fill any shortfall that could arise. The need for continued local public and political support, and maintaining momentum on finalising partnership funding legal agreements, are key to successful delivery.

The FBC will procure the value for money solution, set out the contract for the deal and set out the detailed management arrangements for the delivery and operation and maintenance phases. This will be the final control point before entering into a delivery contract.

In order to deliver the scheme to the schedule, a 12 week assurance and approvals approach for the FBC will need to be agreed. This is seen as achievable as this timeline was achieved on the FBC for the Thames Estuary Phase 1 Programme. Engagement with reviewers and approvers about other aspects of the Full Business Case which are not reliant on the final agreed tender price, would be scheduled prior to this 12 week period. Approval of this OBC will agree in principle the commitment of the Defra Group and HM Treasury to achieve this timeline. The Assurance and Approvals Manager for the Oxford FAS will hold the responsibility for agreeing the detailed schedule to achieve this with the Environment Agency, Defra and Treasury.

I confirm that the documentation is ready for submission to LPRG.

I, as Project Director, have ensured that relevant parties have been consulted in the development of this project and the production of this submission in particular the Project Sponsor and Senior User.

Name	Joanna Larmour
Job Title	Project Director
Emailed approval	Yes
Date	22/02/2017

A. Appendices

Appendix	Name
Appendix A	List of Reports Produced
Appendix B	Outline Design Drawings
Appendix C	Economic Report
Appendix D	Multi-Criteria Options Appraisal Report
Appendix E	Partnership Funding Calculator
Appendix F	Expenditure Profile and Cost Break Down
Appendix G	Modelling Report
Appendix H	Benefits Dependency Map
Appendix I	Benefits Realisation Plan
Appendix J	Preliminary Environmental Information Report (PEIR)
Appendix K	Carbon Modelling Tool
Appendix L	Risk Potential Assessment
Appendix M	Risk Register
Appendix N	Optimism Bias
Appendix O	Procurement Strategy (on request due to commercial sensitivity)
Appendix P	Efficiency Register
Appendix Q	Funding Evidence Table Funding Gap Contingency Plan
Appendix R	Investor summary detail Funding agreement evidence
Appendix S	Project High Level Programme (Detailed programme available on request)
Appendix T	Materials Management Plan
Appendix U	Integrated Assurance & Approvals Plan (IAAP)
Appendix V	Infrastructure and Projects Authority Project Initiation Routemap Review
Appendix W	OGC Gateway 1 Delivery Confidence Review Report by Cabinet Office
Appendix X	Maintenance Model
Appendix Y	Natural England letter of support
Appendix Z	Resource Management Plan

7. List of Abbreviations

ABCR	Average Benefit Cost Ratio
AEP	Annual Exceedence Probability
AQMA	Air Quality Management Area
BCA	Benefit Cost Assessment
BIM	Building Information Modelling
CFMP	Catchment Flood Management Plan
CPO	Compulsory Purchase Order
CSF	Critical Success Factor
ECC	Engineering and Construction Contract
EIA	Environmental Impact Assessment
ESA	Ecosystems Services Assessment
ESE	Early Supplier Engagement
FAS	Flood Alleviation Scheme
FBC	Full Business Case
FCERM	Flood & Coastal Erosion Risk Management
FCERM GiA	Flood & Coastal Risk Management Grant in Aid
FCERM-AG	Flood and Coastal Erosion Risk Management – Appraisal Guidance
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan
FSoD	Financial Scheme of Delegation
FTE	Full Time Equivalent
GCS	Government Construction Strategy
HGV	Heavy Goods Vehicle
HMT	Her Majesty's Treasury
IAAP	Integrated Assurance and Approvals Plan
IAAS	Integrated Assurance and Approvals Strategy
iBCR	Incremental Benefit Cost Ratio
IPA	Infrastructure and Projects Authority
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authorities
LPRG	Large Project Review Group
MCA	Multi-Criteria Analysis
MCM	Multi Coloured Manual
MEV	Mean Estimated Value

NAFRA	National Flood Risk Assessment
NEC	New Engineering Contract
NVC	National Vegetation Classification
OBC	Outline Business Case
OFA	Oxford Flood Alliance
OFAS	Oxford Flood Alleviation Scheme
OGC	Office of Government Commerce
OJEU	Official Journal of the European Union
OM	Outcome Measure
OxLEP	Oxfordshire Local Enterprise Partnership
PCT	Project Cost Tool
PEIR	Preliminary Environmental Information Report
PER	Post Evaluation Review
PI	Planning Inquiry
PIR	Post Implementation Review
PPP	Public Private Partnership
PQP	Project Quality Plan
PV	Present Value
RBMP	River Basin Management Plan
RFCC	Regional Flood & Coastal Committee
RMA	Risk Management Authority
RPA	Risk Potential Assessment
SEPS	Sustainable Engineering Procurement Strategy
SMART	Specific Measurable Achievable Realistic Timebound
SME's	Small and Medium Enterprises
SOC	Strategic Outline Case
SoS	Secretary of State
UKCP09	UK Climate Projections 2009
UKCP18	UK Climate Projections 2018
VFM	Value For Money
VoWH DC	Vale of White Horse District Council
WEM	Water Environment Management
WFD	Water Framework Directive