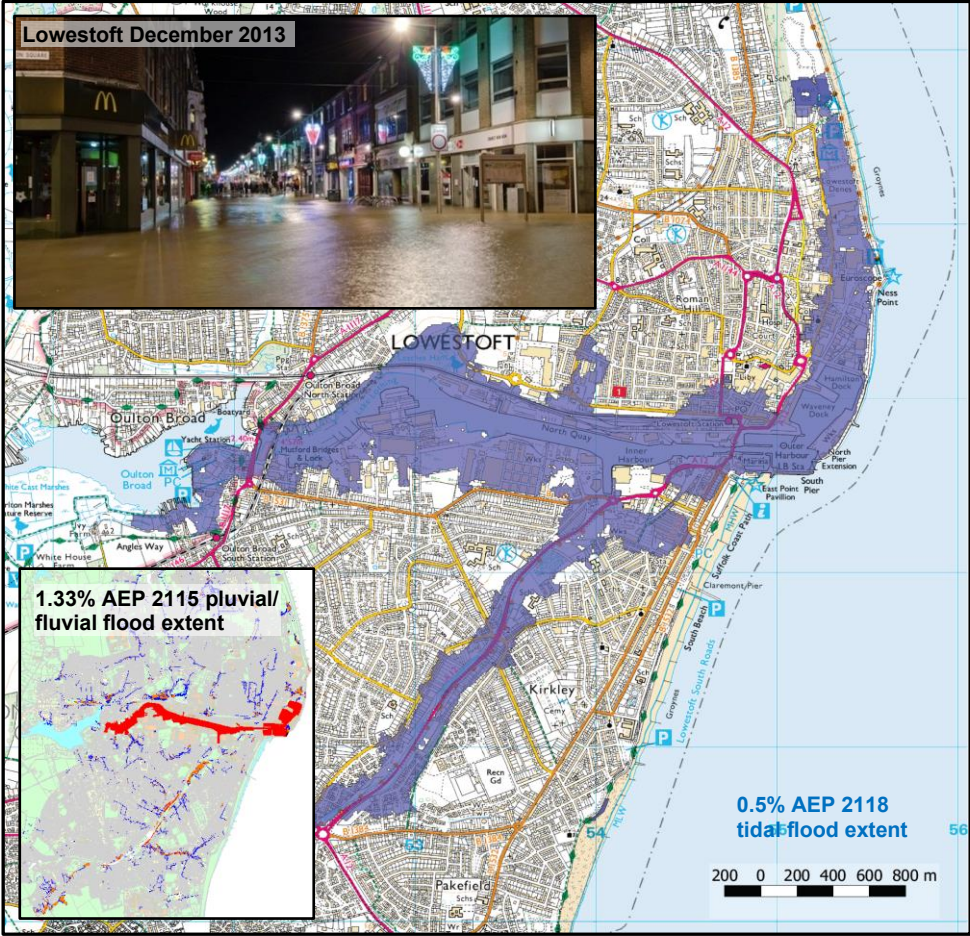


Lowestoft Flood Risk Management Project

RMA Outline Business Case



Version No: 2.3

Date: 8-11-22

Note: Updates to the body text of this OBC since the 2018 submission are coloured in blue text

BUSINESS CASE APPROVAL SHEET

1 Review & Technical Approval				
Project title	Lowestoft Flood Risk Management Project			
Authority project reference	57302/1301/30019	EA reference	AES503E/008A/006A	
Lead authority	East Suffolk Council	Date of submission	08-11-2022	
Consultant	Jacobs	Document stage (SOC/OBC/FBC)	OBC	
Previous document	Lowestoft FRMP SOC	Previous doc ref	V1.3	
Job title	Name	Signature	Date	
<p style="color: blue;">'I confirm that this project meets our quality assurance requirements, environmental obligations and Defra investment appraisal conditions and that all internal approvals, including member approval, have been completed and confirm we do not wish to apply for Grant in Aid or local levy funding for the tidal works at this stage.'</p>				
Authority Project Executive	Karen Thomas			
<p>'I have reviewed this document and confirm that it meets the current business case guidelines for local authority and Internal Drainage Board applications.'</p>				
Business case reviewer	Tamzen Pope			
<p>'I confirm that the project is ready for assurance and that I have consulted with the Director of Business Finance'</p>				
Area Flood & Coastal Risk Manager	Mark Johnson			
NPAS Assurance <input type="checkbox"/> Projects £100k - £10m (Tick the appropriate box)		Large project review group <input checked="" type="checkbox"/> Projects >£10m (LPRG)		
Recommended for approval				Date
NPAS or LPRG Chair				
Stage 1* project total as approved (£k)		Version number	V2	
Stage 1* project total made up of:	Capital Grant (£k)			
	Levy (£k)			
	Other Contributions (£k)			
2 Project Financial approval				
Financial scheme of approval	Project total	Name	Signature	Date
Director of Business Finance	All >£100k			
Director of Operations	£1m -£10m			
Executive Director of Operations	>£10m			
Chief Executive	>£20m			
3 Defra approval				
Date sent to Defra (or N/A)	NA	Version number (if different)		
Date approved by Defra (or N/A)	NA			

<p>Comments</p>	<p>Due to the change in the preferred option to a 40m Tidal Barrier through the Local Choice framework since the submission of the 2018 OBC and the resultant funding gap, the project team understand LPRG cannot provide financial assurance until a complete funding package is in place. Therefore ESC are requesting technical assurance from LPRG to allow ESC to pursue further discussions with other government departments and potential funders of the project.</p> <p>High level assessment of the additional costs with the 40m tidal barrier indicates that the total capital project cost is likely to be £171M compared to the current approved budget of £66.3M. This cost is subject to further detailed design development which is programmed to conclude in August 2023. Of the total £171M there is a large risk and contingency allowance as per national Treasury guidance for all capital flood risk schemes. There is also a significant inflationary allowance due to the economic climate. As such our current scheme costs excluding risk and inflation are £101M leaving a £43-113M funding gap.</p> <p>Despite the increased cost of delivering the local choice option - the barrier costs are considered to be comparable with similar barrier projects around the country and reflect the complexity and challenge of delivering a major infrastructure scheme in the centre of a fully operational port.</p> <p>The 2022 OBC is being submitted now following discussions with Environment Agency staff at Area and National level. ESC have an opportunity to work with key stakeholders (Associated British Ports and the Royal Norfolk and Suffolk Yacht Club) to realise efficiencies in the delivery of the local choice option and technical assurance of the approach will assist in pursuing this opportunity.</p> <p>With regards to the current funding situation, specifically the availability of funding – your attention is drawn to Section 1.7 and the Financial Case.</p> <p>A significant element of environmental assessment is currently under way for the 40m tidal barrier and is currently in draft format and not at a suitable stage of development to be shared outside of the project team. Further details of these environmental assessments (including EIA and HRA) can be found in the 'Next Steps' detailed in Section 3.4 of this OBC</p>
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For FSoD Coordinator use only:

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Glossary / acronyms

Annual Exceedance Probability (AEP): The probability associated with a return period (T), e.g. event of return period 100 years has an AEP of 1/T or 0.01 or 1%.

Benefit Cost Ratio (BCR): BCRs are used to identify the relative worth of one approach over another. It is the ratio of the PV benefits to the PV costs for each option.

Business case report: A business case including a programme of works that supports a recommendation to implement a flood risk management project. The project is approved by the Environment Agency under the Financial Scheme of Delegation from Defra. The project plan is supported by technical appendices.

Do Minimum: An option where the Operating Authority takes the minimum amount of action necessary to maintain an asset. For many places, this means patch and repair works of existing defences with no replacement should the defences fail.

Do Nothing: An option used in appraisal to act as a baseline against which all other options are tested. It assumes that no action whatsoever is taken. In the case of existing works, it assumes for the purposes of appraisal that Risk Management Authorities cease all maintenance, repairs and other activities immediately. In the case of new works, it assumes that there is no intervention, and natural and other external processes are allowed to take their course.

Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG): Defra guidance to Risk Management Authorities on the process for appraising flood and coastal defence projects to ensure best use of public money.

Flood & Coastal Risk Management Grant in Aid (FCRM-GiA): Government money allocated to Risk Management Authorities (Environment Agency, Local Authorities, Internal Drainage Boards) for capital works which manage and reduce flood and coastal erosion risk.

Flood Defence Asset: Any structure with the prime purpose to provide flood defence, e.g. culvert.

Fluvial: Relating to the flow in the river that originates from the upstream catchment and not the sea.

Flood Risk Management (FRM): By Risk Management Authorities to manage flood risk.

Gross Value added (GVA): Gross value added is the value of output less the value of intermediate consumption; it is a measure of the contribution to GDP made by an individual producer, industry or sector.

Incremental Benefit Cost Ratio (IBCR): Ratio of the additional benefit/cost for two options.

Lead Local Flood Authority: After flooding in 2007 the government commissioned a review, which recommended that "Local authorities should lead on the management of local flood risk, with the support of the relevant organisations" (The Pitt Review, 2008). This led to the Flood and Water Management Act (2010) and the set-up of Lead Local Flood Authorities (LLFA) who have new powers and duties for managing flooding from local sources, namely **Ordinary Watercourses**, surface water (overland runoff) and groundwater.

Maintain: Active intervention to keep defences at their current crest level.

Multi-coloured Manual (MCM): Provides techniques and data that can be used in benefit assessments.

National Government Departments': As listed in Section 2.7

New Anglia Local Enterprise Partnership (NALEP): Local Enterprise Partnership working to drive growth and enterprise in Norfolk and Suffolk.

Net Present Value (NPV): Stream of all benefits net of all costs for each year of the projects life discounted back to the present date.

National Planning Policy Framework (NPPF): Sets out the Government's planning policies for England and how they should be applied

Present Value (PV): Monetary value of ongoing or future costs, discounted to provide equivalent present-day costs.

Property Level Protection (PLP) – Measures installed at individual properties to provide resilience against flooding. Includes flood board, air brick covers and flood gates.

PV Benefits (PVb): Those positive quantifiable changes that a project will produce over its lifetime.

PV Costs (PVc): The cost for implementation of a particular scheme over its lifetime.

PV Damage Avoided: The economic damages avoided once an option has been implemented.

Scape: The National Civil Engineering and Infrastructure framework, managed by the Scape Group Ltd public partnership. An OJEU compliant framework open to any public body in the United Kingdom.

Standard of Protection (SoP): The design event standard, measured by Annual Event Probability (AEP), that an existing asset or proposed scheme provides.

Water Framework Directive (WFD): European Directive 2000/60/EC setting out approaches to river basin planning to help to protect and enhance the quality of surface freshwater (including lakes, streams and rivers), groundwaters, groundwater dependent ecosystems, estuaries and coastal waters out to one mile from low-water. Sets environmental objectives related to ecological, physico-chemical, chemical, morphological and hydrological quality.

Executive Summary

1.1. Introduction

In 2018 Waveney District Council as lead RMA partner with Suffolk County Council presented EA assurers with the Lowestoft Flood Risk Management Project (LFRMP) Outline Business Case (2018 OBC) as an integrated business case for the management of tidal, fluvial and pluvial flood risk for the town of Lowestoft.

The OBC followed the Strategic Outline Business Case (SOC) for the project that received a recommendation for approval from LPRG in May 2017 and approval from Waveney District Council's Cabinet in June 2017.

Technical assurance was sought from the Environment Agency's LPRG for the 2018 OBC which defined the preferred approach for management of tidal, fluvial and pluvial flood risk in Lowestoft. The 2018 OBC provided East Suffolk Council (ESC, previously Waveney District Council and Suffolk Coastal District Council) with this technical approval for the tidal walls work but not financial due to funding shortages at the time of the 2018 OBC. ESC have since sourced the funds to do the work however we also face the additional challenges of increasing costs and inflation associated with the pandemic and post-pandemic/Brexit/Ukraine-related supply chain and material cost increases.

As an RMA-led project, the OBC also sought to secure FCERM – GiA funding for the project. However, it was acknowledged that GiA funding would be conditional and subject to securing other regulatory consents/orders, legal and financial agreements. Financial approval was given for the fluvial and pluvial elements of the project but not granted for the tidal elements as the latter required a further, more detailed OBC. The pluvial fluvial elements of the project were completed in 2021 and therefore no further approvals are required for these elements of the project.

In support of the initial SOC, a Strategic Approach (Appendix M) was prepared to set out the strategic interactions between the different sources of flood and erosion risk to Lowestoft, establishing the approach to apportionment of benefits where they are shared between the sources of risk. This strategic approach document has been refreshed as part of the development of the 2022 OBC. The recommendations of the Strategic Approach remain substantially unchanged as a result of the review.

Technical assurance is now being sought from the Environment Agency's LPRG for this 2022 OBC which provides an update to the approach for management of tidal flood risk in Lowestoft through the identification of a local choice 40m tidal barrier option and updates to the economic assessment of options taking into account changes in appraisal guidance since the previous submission in 2018. Due to the increased material costs and inflation the preferred solution is unlikely to meet LPRG financial approval. As we have a significant funding gap of £113M as a worse case. We are undertaking additional Monte Carlo analysis to gain a more realistic risk allocation. We are also progressing an opportunity to deliver the Local choice Option on an accelerated consenting and construction programme (Option 9LCU) which will realise program savings resulting in cost savings of in the region of £10m in cash terms reducing the funding gap when compared to Option 9LCC. The cost of the 'local choice' option at £172M (Option 9LCC with AOB and 95%ile Risk allowances) is comparable with similar recent barrier projects around the UK. However, in this case there is a greater cost certainty due to the stage we are at in barrier design at this point in OBC submission. The 'local choice' option is not cost beneficial under current Treasury rules. It is, however the only workable option that will deliver flood risk reduction to complete the integrated flood scheme for Lowestoft and is the also agreed

in principle with the key landowner stakeholders, including ABP, allowing this project to progress at an accelerated rate from April 2024 for delivery in 2027.

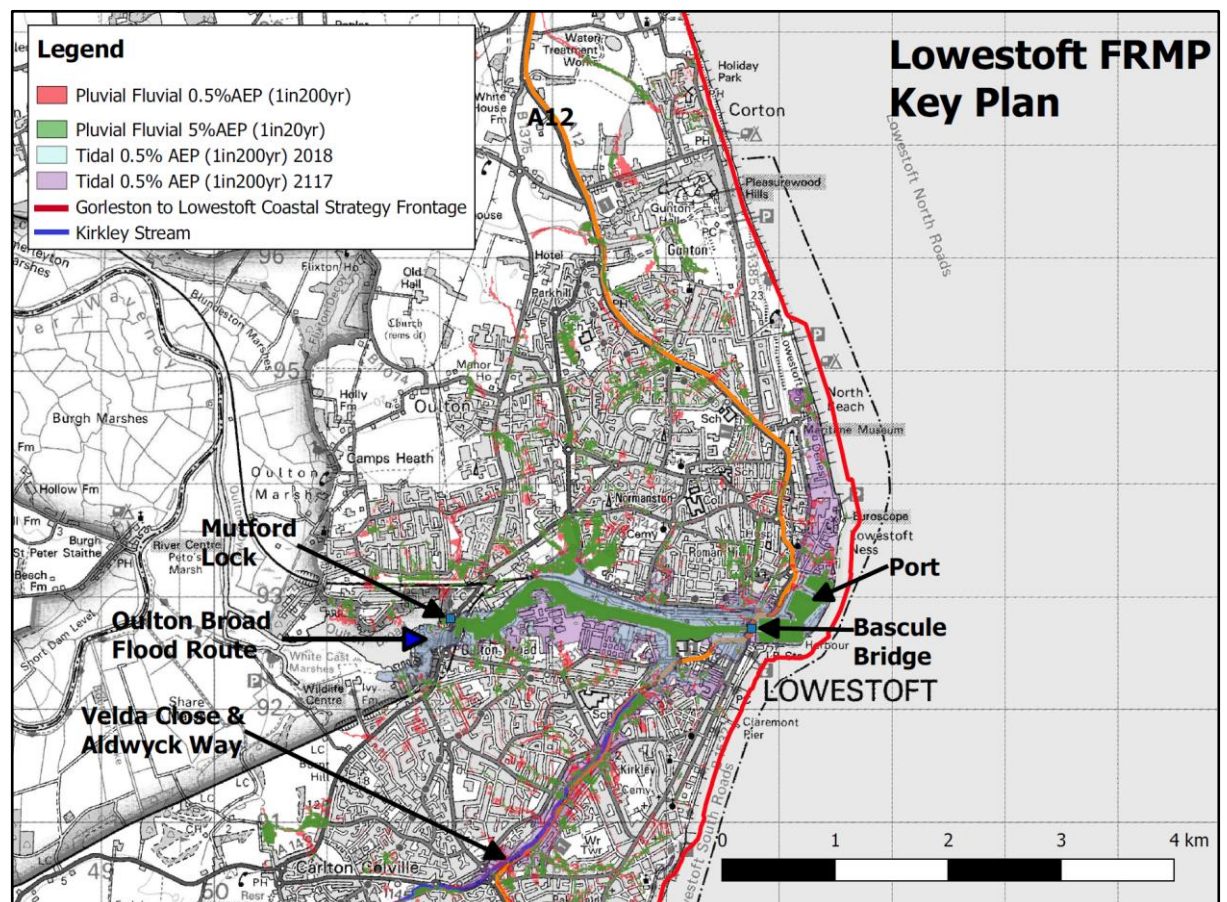
In addition to addressing the risk of all forms of flooding to vulnerable homes in a coastal town with no formal flood defences, a core outcome of the project is to support economic growth and regeneration by reducing the risk of tidal flooding to infrastructure, commercial land and businesses. An innovative approach is also required to deliver the project while minimising disruption to the Port of Lowestoft that serves the nationally important offshore and other energy sectors of national importance.

As a result, the majority of funding required for the preferred options is expected to come from partnership and other national funding sources. A comprehensive funding strategy has been further developed to secure the remaining partnership contributions required to deliver stage two.

The LFRMP is being developed by the following strategic partners:

- East Suffolk Council (ESC) – lead partner
- Suffolk County Council (SCC) – pluvial/fluvial lead
- Environment Agency (EA)
- Associated British Ports (ABP)
- New Anglia Local Enterprise Partnership (NALEP)

Key Plan



1.2. Strategic case

Strategic context

The main driver for investment is to reduce the risk of flooding (tidal, pluvial and fluvial) to residential and commercial property in Lowestoft. The December 2013 tidal surge event caused significant damage and disruption to the Lowestoft community/economy and it is considered that without intervention to manage these risks Lowestoft will not be able to develop and will probably go into decline.

Investment to manage tidal flood risk in Lowestoft is supported by the SMP2's policy of hold the line for the coastal frontage. The proposals are compatible with the recommendations of the Gorleston to Lowestoft Coastal Management Strategy.

The case for change

[Lowestoft is a town of multiple deprivation that has become increasingly vulnerable to flooding from all sources for many decades.](#)

At present Lowestoft does not have any formal tidal defences protecting the town and without intervention, it [has](#) become increasingly vulnerable to tidal flooding due to climate change. Lowestoft is currently considered to be at risk from the onset of flooding from tide levels with around a 1in5 (20%) to 1in10 (10%) Annual Exceedance Probability (AEP). A 1in200year (0.5% AEP) event (2018) would put approximately 221 residential and 373 commercial properties at risk of tidal flooding in addition to a number of locations earmarked for future development within the Lowestoft Local Plan

This situation gets significantly worse when the impacts of climate change are considered with the low standard of protection restricting the growth potential of the local economy with a 1in200 year (0.5% AEP) SoP being the standard considered by developers and the Local Planning Authorities to enable the majority of new developments.

The December 2013 storm surge event was between a 1in100 (1%) and 1in150 (0.67%) AEP event) and approximately 158 residential and 233 commercial properties were flooded in Lowestoft. The tidal flooding also resulted in the closure of key transportation links including Lowestoft railway station and the A47 through Lowestoft.

[To effectively manage risk of flooding from all sources in Lowestoft, ESC have developed a integrated Lowestoft Flood Risk Management Project. In 2021 we completed the fluvial and pluvial elements of this project and we have begun work on tidal defences as set out in our 2018 OBC. However, we now need to deliver a 40m tidal barrier to complete the integrated package of works. The lack of defences are suppressing the ability of Lowestoft to develop and grow and are not allowing the deprived areas of the town to "Level Up" as per wider Government outcomes. The lack of certainty of tidal flood risk is holding Lowestoft back and allowing social deprivation to remain a key issue for the town.](#)

[Construction of tidal walls have commenced along Hamilton Road \(completed 2022\) and Waveney Road \(still in progress\) with funding that was not contingent of the financial approval of the 2018 OBC. The submission of this 2022 OBC is aimed at securing the technical approval for the revised options and refreshed appraisal. This OBC has been developed using the guidance set out in the FCERM-AG \(Environment Agency 2021\) and Treasury Green Book guidance \(HMT 2020 with 2021 amendments\). Due to the fact the scheme is already well underway making it different to a standard OBC extensive consultation has taken place between the ESC and EA at both Area and National levels to inform this OBC and the development of the overall project.](#)

[The Lowestoft Flood Risk: Economic Footprint Impact Report \(Appendix F3\) REF 8 assessed the potential impact of flood risk on Lowestoft's current and future economic footprint. The study concluded that for a tidal event with a 1in200yr return period \(0.5% AEP which is similar to the 2013 surge event\) 30% of Lowestoft's](#)

existing Gross Value Added (GVA) is at risk of flooding and this rises to 62% with climate change if it remains undefended. This is discussed further in Section 3.7 of this OBC.

Including the notional FDGiA allocation, the project has secured commitments for £69,266,893 of funding to date. £62,176,439 is from partnership funding sources and includes;

- £10M from NALEP Growth deal
- £43,486,000 from HMG Green Recovery Fund

The GRF contribution was the largest capital allocation made nationally from the fund. Both allocations highlight the significant role the LFRMP has to play in supporting and enabling economic growth locally and nationally.

As evidenced in Appendix N1, a comprehensive funding strategy has been developed but a fully resourced plan is **no longer in place** due to the need for the 'Local Choice' barrier option and the rising inflationary cost of materials, supplies and resources that has happened globally in the last 2 years.

As the majority of the partnership funding requirement has related to the cost of delivering the tidal barrier while enabling the port to remain fully operational – the focus of our funding strategy now is to secure funds from other national sources by demonstrating the value of the scheme to at least 6 Government departments and their national outcomes.

Working with ABP's LEEF (Lowestoft Eastern Energy Facility) project team we have developed a unique programme opportunity to support their outer harbour expansion to allow greater green energy growth with wind and marine sector and meet the marine transportation needs of the national nuclear infrastructure project at Sizewell C (S₂C) to remove road transport pressures and reduce carbon through that route (in line with Government national policy).

The port is therefore poised for a significant economic shift and ABP have granted us full access to the navigational channel for 2 years if we can accelerate the LFRMP barrier project to commence in April 2024. Further cost reductions will likely be made as a result of this unconstrained access to the channel to build the barrier infrastructure both through the reduced programme timing and oncosts as well as the opportunity to buy materials earlier. This opportunity is time limited as the LEEF project will progress from 2024 regardless of the LFRMP.

The fast moving nature of this opportunity to build the barrier and support the LEEF project and EDF in the delivery of S₂C is therefore presenting the LFRMP project team with a unique opportunity to reduce flood risk to the town earlier and make cost savings. However we cannot commit to this accelerated programme fully without closing the funding gap of £113M and in parallel having greater national Government Departments support to maximise funding opportunities that may arise from the wider infrastructure delivery.

Objectives

The main objective of the LFRMP is to reduce the risk of tidal and pluvial fluvial flooding to residential and commercial properties in Lowestoft in a sustainable way that promotes economic growth and development.

Works to manage the risk of pluvial and fluvial flooding have been completed and therefore this objective has been partially met. Works to reduce the risk of tidal flooding are ongoing.

The project will deliver National Government outcomes for at least six Government Departments and contribute significantly to the growth of the economy.

The scheme aims to underpin the wider development of Lowestoft port as a central hub for marine and offshore industry notably supporting an accelerated delivery programme for ABP's LEEF project and as a marine transport hub for the Sizewell C nuclear power station (national infrastructure project).

1.3. Approach to economic cases

This OBC presents two separate economic cases for the tidal and pluvial fluvial flood risk elements. This approach has been taken to maintain a clear distinction between these sources of flood risk which are considered to have a low probability of combined occurrence with an insignificant overlap in the benefit areas of the respective preferred options.

This approach also enabled a two-stage approach to delivery of the project and helped safeguard the delivery of pluvial fluvial OM2's within the last 2015-2021 FCERM six-year programme.

1.4. Economic case – Tidal

Options considered

Table 1.1 summarises the tidal options appraised in this OBC, identifying the options taken forward to the short list.

Table 1.1 Tidal options considered

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
1	Do Nothing	No Benefits – reduced SoP when informal defence along A47 is not serviceable, climate change impacts are considered and increased damages when no flood warning service provided. Does not promote growth.	Shortlisted as baseline economic case
2	Maintain - Do minimum	Some benefits – SoP reduces as climate change impacts, continued flood warning. Does not promote growth	Shortlisted as green book requirement.
3	Improve – flood walls only	Improves SoP to the majority of the strategy area – Mutford lock end still subject to flooding from the Broads' system in tidal surge event. Walls along inner harbour quays may restrict operational usage of some quaysides. Hydraulic modelling indicates some increase in flood risk to unprotected property at western end of Lake Lothing.	Shortlisted to test the feasibility of a non-barrier option.
4	Improve - Outer Harbour barriers and walls	Can provide the required standard of protection. Provides protection to the port area but also restrictions on the use of the port during a surge event.	Rejected due to: Significant cost of two large tidal barriers, significant improvement works to harbour arms, significant impact on ports operations during and post construction including losing its classification as a Safe Haven.
5	Improve – 28 metre Bascule Bridge barrier and walls	Improves SoP to the majority of the study area – Mutford lock end remains at risk of tidal flooding from the Broads' system. Issues include: likely ship impacts (and associated costs and environmental effects of repairs) due to a narrower navigation channel compared to Option 9, as predicted by navigation simulations completed in 2021.	Shortlisted. As a tidal barrier option seaward of the Bascule Bridge. Early indications from business and public consultation is that this option meets with public approval. Identified in the 2018 OBC as the preferred option.

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
6	Improve – third bridge crossing barrier and walls	Improve SoP to the majority of the strategy area – Mutford lock end remains at risk of tidal flooding from the Broads’ system. Issues include: timing of project implementation, costs and navigation impacts.	Rejected. Third crossing is already being built. The 2018 OBC concluded that even with the potential efficiencies of the combined approach, the capital expenditure associated with such a wide barrier structure far exceeded that of the Bascule Bridge barrier, and makes Option 6 unaffordable.
7	Temporary flood defences only	Improves SoP to limited areas of the strategy area. Will not enable growth nor significantly increase business confidence. Significant impact on business operations when deployed.	Rejected as a long-term solution due to: Low standard of protection (1in50 year (2% AEP) SoP in 2018) feasible, high long term operational costs, increased risk of failure or outflanking and lower levels of reliability when compared to permanent defences. Does not enable growth. Cannot readily keep up with climate change impacts and therefore cannot achieve the project objectives.
8	Property level resilience only	Limited benefits to individual properties where depth of flooding does not exceed 0.6m. Will not enable growth or significantly increase business confidence. Will not reduce the impact of flooding on transportation routes or other infrastructure.	Rejected as long-term solution due to: Depth of flooding means that for the majority of properties, this approach is not technically feasible, does not enable growth or protect infrastructure.
9	Improve – 40 metre Bascule Bridge barrier and walls	A new option with a wider barrier was introduced for the 2022 OBC to reduce risk of ship impacts (and associated costs and environmental effects of repairs) compared to the 28m barrier in Option 5. Improves SoP to the majority of the study area – Mutford lock end remains at risk of tidal flooding from the Broads’ system.	Shortlisted. As a tidal barrier option seaward of the Bascule Bridge. Due to similarity with Option 5, this is considered to have similar levels of public approval. The increased barrier width also contributes to greater resilience and is less restrictive on future development of the Lake Lothing entrance channel.

Key findings

The economic appraisal was undertaken in line with the requirements of the Flood and Coastal Erosion Risk Management – Appraisal Guidance (FCRM-AG). The key findings of the economic appraisal are summarised as follows:

- The do-minimum option delivers very little benefit and does not meet LFRMP objectives and was therefore rejected as a viable option.
- Options 3a to 3d (flood walls only) do not achieve benefit cost ratios of greater than 1 and were rejected from further consideration under the decision rule.
- Options 5a to 5d (28m Bascule Bridge Barrier and walls) considered differing standards of protection from 1in75 year (1.33% AEP) to 1in500 year (0.2% AEP), all of these option permutations have Benefit Cost Ratios of 1.2.
- Option 5c (28m Bascule Bridge Barrier and walls 1in200 year (0.5% AEP) has been selected as the national economically preferred option with highest NSPV.

ESC have selected a Local choice 40m tidal barrier option (9LCC or 9LCU) as the locally preferred option. This option has been selected as it brings additional benefits that are not fully captured within the economic appraisal, including:

- Enabling economic growth and adaptive pathways for future development of the port and Lowestoft,

- Increasing the resilience and reliability of the barrier.
- Introducing a significant efficiency and acceleration of delivering the barrier.

The local choice options both have BCRs of less than 1 at 0.9 with a NSPV of £21m for option 9LCC and £15m for Option 9LCU

The main technical aspects that need further consideration as the project progresses towards delivering the tidal barrier are summarised as follows:

- Continued consultation will take place to consider the impact of the tidal defence system (construction and operational) on local businesses and navigation links. This will be fully considered as part of the TWAO application.

The key findings of the environmental assessment presented in the LFRMP Environment Report (SOC stage) and PEIR are summarised as follows:

- The Do-nothing and Do-minimum options do not support most of the SEA objectives and result in adverse and neutral effects on the geology and landscape SEA objectives.
- Option 5 (28 m Bascule Bridge barrier and walls) is supportive of most SEA objectives and is the environmentally preferred option at this stage. Option 9 is considered to be broadly similar to Option 5 (40 m Bascule Bridge barrier and walls).in terms of potential environmental impact
- An EIA will be required for the Tidal Barrier and is currently being developed.

The Habitats regulation assessment (HRA) undertaken confirmed that the preferred option would have no likely significant effect on European sites, Natural England have been consulted and agree with these findings. Potential impacts on the works on harbour porpoise have been scoped in for further consideration in connection with noise and vibration associated with delivering the tidal works. The Water Framework Directive (WFD) assessment concluded that preferred option is compliant with the WFD.

Preferred way forward

The option appraisal identified that the nationally economically preferred option for reducing the risk of tidal flooding to Lowestoft is Option 5c – 28m Bascule bridge barrier with tidal walls with a 1 in 200 (0.5%) AEP standard of protection. However, to deliver an increased level of resilience and lessen restrictions on potential future development as mentioned in the key findings above, a Local Choice option (Option 9 – 40m Bascule bridge barrier with tidal walls with a 1 in 200 (0.5%) AEP standard of protection) has been selected as the preferred option for managing the risk of tidal flooding in Lowestoft.

1.5. Commercial case

Procurement strategy

The technical delivery of the LFRMP OBC has been procured through the SCAPE Procure framework by ESC who are acting as the lead partner in the LFRMP. This procurement route enables the continued delivery of projects arising from this OBC without the need for any further procurement of technical services by ESC.

ESC have procured a number of other technical services utilising the Scape Perfect Circle framework. These services include technical advisor, ECC project management, site supervision and cost management support.

Key contractual terms and risk allocation

The key commercial and legal agreements that need to be progressed to enable the development of the preferred options for the management of tidal and pluvial fluvial flood risk identified in this OBC are summarised as follows:

- Landowner agreements;
- Transport and Works Act Order (TWAO) application and associated agreements;
- SCAPE risk share arrangements;
- Risk share agreements with partnership funders.

During the development of the OBC work has commenced to develop and put in place a number of legal agreements with key stakeholders and landowners, these include a number of tripartite agreements where required. Legal agreements are required to following key areas:

Tidal works

- Access for construction and future operation and maintenance;
- Operation and maintenance agreements;
- Rights to site structures on privately owned land;
- Storage of demountable barrier and associated;
- Funding agreements.

[A number of the legal agreements relating to the tidal walls are already in place, with others in an advances state of development.](#)

Efficiencies and commercial arrangements

Project efficiency targets are aligned to the requirements of the partner organisations, the SCAPE framework and funding sources. An efficiency register (CERT) has been developed for the LFRMP.

1.6. Financial case

Summary of financial appraisal

Table 1.4 summarises the whole life cash cost spend profile for the tidal preferred option. The costs presented include 95% risk and adjusted optimism bias allowances. Option costs have been developed through detailed contractor costing exercises and use of the EA's whole life costing tool where appropriate. Costs are based on [detailed designs for the preferred Local Choices option. It should be noted that a small element of the future O&M costs associated with completion of the tidal walls, forecast for late 2023 is not currently shown in the table.](#)

Table 1.4 Preferred option whole life spend profile (cash)

Annualised spend profile (£k cash)	Sunk	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7 +	Yr 8 +	Total
	Pre 21-22	22 - 23	23 - 24	24 - 25	25 - 26	26 - 27	27 - 28	28 -29	29-30	30-31	
Stage 1 - Tidal Walls											
Authority staff costs - Stage 1	2,027	1,374									3,401
External fees - Stage 1											0
Construction costs - Stage 1 Tidal Walls		10,413									10,413
Risk contingency (95%ile) - Stage 1		458									458
Optimism Bias - Stage 1		1,882									1,882
Inflation - Stage 1		0									0

Stage 1 Subtotal	2,027	14,127	0	0	0	0	0	0	0	0	16,154
Stage 2 - Tidal Barrier											
Authority staff costs - Stage 2		1,639	397	397	397	397	397	397	397		4,419
External fees - Stage 2 (including TWAO)			1,217	1,217	977	977	977	977	977		7,316
Construction costs - Stage 2 Tidal Barrier					15,018	15,018	15,018	15,018	15,018		75,092
Risk contingency (95%ile) - Stage 2		847	847	847	10,166	10,166	10,166	10,166	10,166		53,371
Optimism Bias - Stage 2					751	751	751	751	751		3,755
Inflation - Stage 2		0	20	40	1,260	1,702	2,154	2,618	3,093		10,887
Stage 2 subtotal	0	2,486	2,481	2,501	28,570	29,011	29,463	29,927	30,402	0	154,840
Stage 1&2 sub total	2,027	16,613	2,481	2,501	28,570	29,011	29,463	29,927	30,402	0	170,995
O & M and Future Costs											
O&M and other future costs										59,951	59,951
Optimism Bias - future works										17,985	17,985
Future costs sub total	0	0	0	0	0	0	0	0	0	77,937	77,937
Total costs	2,027	16,613	2,481	2,501	28,570	29,011	29,463	29,927	30,402	77,937	248,932

Funding sources

Delivery of the LFRMP objectives requires further partnership funding contributions. The LFRMP Funding Strategy document (Appendix N1) sets out the planned approach to ensure sufficient funding is available for the project. Multiple sources have already been secured, which has enabled the progression of the project with funding secured / allocated for the project from the following organisations:

- East Suffolk Council
- Suffolk County Council
- Regional Flood and Coastal Committee (Local Levy)
- Environment Agency (administering FCERM-GiA and COVID cost impact funding)
- New Anglia Local Enterprise Partnership
- HM Government (Green Recovery Fund / 'Summer Economic Funding', 'Other Government Funding')
- Department for Education

The funding strategy had secured funding to enable the delivery of the Stage 1 tidal and pluvial fluvial elements of the LFRMP and the 28m barrier option. However, the 40m 'local choice' option and the cost uplift caused by Brexit impacts, inflation, the COVID-19 pandemic and extended landowner negotiations means that further funding is required to deliver the Stage 2 element (tidal barrier). Table 1.5 presents a summary of the funding status of each stage of the LFRMP, identifying funding secured and where further partnership funding is required.

Table 1.5 Funding summary table

Annualised funding needs (£k)	Pre 21-22 (sunk)	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	Total
Stage 1 – Tidal Walls										
New Anglia Local Enterprise Partnership (LEP)	10,000	-	-	-	-	-	-	-	-	10,000
East Suffolk Council	-	-	-	-	-	-	-	-	-	-
Green Recovery Fund	-	7,795	-	-	-	-	-	-	-	7,795
OGD Funding	-	-	1,400	-	-	-	-	-	-	1,400
COVID impacts funding	-	1,198	-	-	-	-	-	-	-	1,198
Stage 1 Tidal Walls - Identified funding	10,000	8,993	1,400	-	-	-	-	-	-	20,393
Partnership Funding Required	-	-	-	-	-	-	-	-	-	-
Stage 1 Tidal Walls- Total funding	10,000	8,993	1,400	-	-	-	-	-	-	20,393
Stage 1 – Pluvial Fluvial										
FCERM-GiA	1,492	-	-	-	-	-	-	-	-	1,492
Suffolk County Council (SCC)	3,000	-	-	-	-	-	-	-	-	3,000
Local Levy via RFCC	1,751	-	-	-	-	-	-	-	-	1,751
COVID impacts funding	385	-	-	-	-	-	-	-	-	385
Stage 1 Pluvial fluvial - Identified funding	6,628	-	-	-	-	-	-	-	-	6,628
Partnership Funding Required	-	-	-	-	-	-	-	-	-	-
Stage 1 Pluvial Fluvial - Total funding	6,628	-	-	-	-	-	-	-	-	6,628
Stage 2 – Tidal Barrier										
FCERM-GiA	-	-	-	-	-	4,186	-	-	-	4,186
Local Levy via RFCC	-	-	1,589	-	-	-	-	-	-	1,589
East Suffolk Council	-	-	250	250	250	250	-	-	-	1,000
Suffolk County Council (SCC)	-	-	-	-	-	-	-	-	-	-
Department for Education	-	-	-	-	-	-	200	-	-	200
Green Recovery Fund	-	2,500	656	2,266	28,494	1,775	-	-	-	35,691
Stage 2 Tidal Barrier - Identified funding	-	2,500	2,495	2,516	28,744	6,211	200	-	-	42,666
Partnership Funding Required	-	-	-	-	-	22,974	29,437	30,101	30,577	113,089
Stage 2 Tidal Barrier - Total funding	-	2,500	2,495	2,516	28,744	29,185	29,637	30,101	30,577	155,755

The funding requirements above are correct at the time of initial submission of the OBC (October 2022). Please note that the extract from the funding strategy above includes an allowance for construction costs associated with the Hamilton Road flood wall which is excluded from economic assessment included within this OBC. The construction costs for this flood wall were funded through the New Anglia LEP to provide flood risk reduction to the PowerPark enterprise zone with benefits attributed economic growth in the LEP business case (Appendix N2). Whilst the construction of the Hamilton Road flood wall falls within the scope of the LFRMP it has been removed from the FCERM economic assessment due to a disproportionate impact of the benefit cost ratio of all options. The limited FCRM benefits associated with this flood wall are separate and distinct from the FCERM benefits associated with the remainder of the tidal walls and barrier, it was therefore considered appropriate to remove this from the economic assessment.

Overall affordability

The delivery of the LFRMP is considered to be affordable **subject the securing additional partnership contributions** to support Stage Two of the project as set out in Table 1.5. The project team continues to develop the detail of the tidal barrier and this combined with detailed consultation with key stakeholders will enable the costs to be refined with the aim of reducing the funding gap. It is generally considered that the costs presented for delivering a tidal barrier for Lowestoft are comparable with other tidal barrier projects within the UK.

The project has applied a robust risk management approach to ensure that sufficient budget is allocated / funding is secured to enable delivery of the Local Choices

preferred option. Table 1.6 summarises the expenditure profile for delivering both stages of the **tidal flood risk management elements of the LFRMP**.

Table 1.6– Project initial capital spend profile (Cash)

Cash Cost (£k) (inc risk+inflation)	Sunk	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Total
	Pre 21-22	22 - 23	23 - 24	24 - 25	25 - 26	26 - 27	27 - 28	28 -29	29 - 30	
Stage 1 - Tidal walls	2,027	11,787								13,814
Stage 1 - Risk	0	2,340								2,340
Stage 1 - Inflation	0	0								0
Stage 2 - tidal barrier	0	1,639	1,614	1,614	16,392	16,392	16,392	16,392	16,392	86,827
Stage 2 - Risk	0	847	847	847	10,917	10,917	10,917	10,917	10,917	57,126
Stage 2 - Inflation	0	0	20	40	1,260	1,702	2,154	2,618	3,093	10,887
Total	2,027	16,613	2,481	2,501	28,570	29,011	29,463	29,927	30,402	170,995

1.7. Management case

Project management

The development of this OBC is being led by ESC as a Maritime Authority with responsibilities under the Coast Protection Act 1949 and their permissive powers under Section 14A of the Land Drainage Act (1991) as amended by the Flood & Water Management Act (2010). Support on the fluvial pluvial elements of the project will be provided by SCC as Lead Local Flood Authority under the Flood and Water Management Act 2010. ESC are supported by a number of partners and specialist suppliers in the delivery of this project. The Project is supported by four key groups:

- Project Board
- Strategic Steering Group
- Project Delivery Group
- Key Stakeholder Group

ESC will lead on the future development of this OBC with respect to the Tidal Barrier. SCC will continue provide support and resource for the delivery of the pluvial fluvial preferred option. Table 1.6 provides an overview of key project milestones.

Table 1.6 Key project milestones for Master programme with an unconstrained delivery approach (Actuals in Bold)

Activity	Date (DD/MM/YY)	Comment
SOC recommended for approved	04/05/17	By LPRG and submitted to ESC & SCC cabinets for information
Approval to proceed to OBC & TWAO	06/06/17	By ESC Cabinet
Tidal walls planning application submitted	10/07/19	By ESC to ESC Planning department
2018 OBC recommended for technical approval (tidal)	11/01/19	By LPRG followed by ESC cabinets
Tidal walls planning application granted	06/05/20	By ESC Planning department
TWAO - Issue draft Order to DEFRA	09/05/23	By ESC to DEFRA
TWAO - Order made	07/06/24	Assumes written representations only

Activity	Date (DD/MM/YY)	Comment
Tidal works		
Tidal walls work to start on site	08/04/21	Tidal wall construction commences in advance of tidal barrier, subject to planning permission
Tidal walls work substantially completed by	11/07/23	Excluding barrier tie in works
Tidal barrier work to start on site	01/07/24	Subject to TWAO
Tidal barrier work completed	31/03/27	Assumes 40m barrier –unconstrained construction approach

Benefits realisation

Tidal flood risk benefits are planned for realisation in 2028 when the tidal barrier works are completed, this will include 226 OM2's.

Pluvial fluvial benefits were realised in 2021, with 120 of the planned 264 OM2's delivered for PLR measures due to a lower than anticipated uptake from property owners and 7 OM2's for the fluvial wall works.

Risk management

The key risks associated with delivery of the project objectives and the mitigation measures being applied to manage these risks are summarised in Table 1.7.

Table 1.7 Key project risks

	Key Risks	Risk VH/H/M /L/VL	Owner	Mitigation	Risk Post mitigation VH/H/M/L/ VL
1	TWAO application / Legal agreements – Objections to the TWAO / contents of required legal agreements may delay the tidal barrier.	H	ESC	Extensive consultation with impacted parties is being and will continue to be undertaken prior to submission of the applications and during the development of legal agreements.	M
2	Unforeseen ground conditions – Extensive GI has been completed to inform the design and construction of the tidal flood walls with initial GI undertaken for the tidal barrier.	H	ESC	Further GI at barrier location will be undertaken to confirm design assumptions, risk allowance is included for a level of risk relating to ground conditions.	M
3	Funding – high level of additional partnership funding required to progress Stage 2 of project (tidal barrier).	VH	ESC	Funding programme in place – plan in place to source additional funding and provide regular formal updates to funders and stakeholders. Staged approach to delivery, risk of not completing second stage of tidal project	H
4	Inability to agree land access with key stakeholders	M	ESC	Include requirements as part of early consultation / development of legal agreements. Progress heads of terms and continue with TWAO development.	L
5	Delays in discharging TWAO consent conditions	L	ESC	Ensure conditions are included in programme and scope of works. Early liaison with stakeholders to reduce the risk of unknown conditions.	VL
6	Inflation – current levels of inflation result in increased delivery costs.	VH	ESC	Monitor inflationary pressures – work with supply chain to deliver efficiency. Include an allowance for a reasonable level of inflation as risk. Consider recommendations of Environment Agency guidance on managing cost uncertainty.	H

Quantitative risk registers have been developed by the project team including the Early Supplier Engagement Contractor and applied with residual optimism bias allowances

to inform the risk budget for the preferred options in line with current DEFRA/EA risk management guidance.

Assurance, approval and post project evaluation

Assurance of this OBC will be undertaken through the EA's Large Project Review Group (LPRG) following review and recommendation of the Project Board to proceed with document submission. Following a recommendation by LPRG to approve the OBC it will be submitted to the ESC cabinet for information.

A further OBC submission will be made to LPRG in relation to the Stage 2 tidal barrier element of the LFRMP for further assurance once full funding has been secured.

Post project assurance will be undertaken in line with the requirements of ESC and any additional requirements associated with the project funding sources.

1.8. Recommendation

It is recommended that this 2022 update to the OBC is given technical approval as the basis for delivery of Stage Two of the tidal elements of the Lowestoft FRMP incorporating the tidal flood walls and Local Choice tidal barrier elements. As there is a funding gap its recognised that the OBC will need to be resubmitted for financial assurance when the required funding has been secured. In the interim, this means that technically no funding related to the walls or barrier can be drawn down beyond studies related to the OBC. Guidance from LPRG is requested on these matters.

It is ESC's intention to claim FCERM-GIA funding towards costs incurred in developing studies relating to this and future updates of the OBC document as detailed in the recently submitted FCERM2 form and supporting BCUR document.

A further update to this OBC will be submitted for financial approval on securing the required funding to deliver the tidal Stage Two works with the aim of securing and releasing the FCERM-GIA funding attributed to both the Stage One and Stage Two tidal works.

The total estimated sum for approval for the overall 2022 OBC is £171.9m (cash cost), which includes a risk contingency of £54.7m and £10.9m inflation allowance over the anticipated construction period. The OBC Stage Two anticipated FCERM-GiA funding is £9.5m towards the tidal works. The costs for approval are based upon the local choices option with seasonally constrained delivery, the GIA funding allocation is based upon the nationally economically preferred option.

2. The strategic case

2.1. Introduction

This document is an OBC presenting the business case for the tidal flood defence elements of an integrated pluvial, fluvial and tidal flood scheme for the town of Lowestoft. This OBC is refreshing the information presented in the LFRMP OBC 2018 notably - the tidal defence and a 28m mitre gate barrier option which had technical approval from EA LPRG in 2018 but did not have financial approval at the time due to funding uncertainty.

This OBC will highlight progress made on the pluvial and fluvial aspects of the scheme which have now been delivered in Lowestoft. The OBC will demonstrate the progress made to date on the tidal wall delivery and set out the case for a new 'local choice' 40m mitre gate tidal barrier to complete the integrated flood risk plan set out in the previous OBC by East Suffolk Council in 2018.

The completed LFRMP scheme will reduce the risk of flooding to over 1085 families and 825 businesses for generations who are currently completely exposed to flooding from the sea, rivers and rain with no formal flood defence in place. The LFRMP will also significantly reduce the risk of flooding to key infrastructure including A roads, bridges, the rail network, water treatment, IT and energy assets.

The total project will enable 10,900 jobs and £499m of GVA per year to be resilient and support the generation of 3,500 additional direct jobs locally and 8,000 indirect and induced jobs nationally plus an additional £195m of GVA in the area per year.

This OBC will set out the costs and benefits of the 40m barrier option and demonstrate the unique challenges facing delivery of this solution in Lowestoft in relation to maintaining an operational port facility. The OBC will highlight the significant work that has already been done to engage key stakeholders to support the Transport and Works Act Order process along with the opportunity to accelerate the barrier project to align with wider economic opportunities with ABP ports and EDF energy, reducing construction, programme and costs.

This OBC shows that whilst we have a technically viable and cost beneficial 28m barrier solution we have needed to pursue a wider barrier option to maintain the operational port entrance to deliver wider stakeholder needs. This decision was agreed by the local ESC Members and wider LFRMP Project Board in October 2021 and shared with EA colleagues and some LPRG assurers in December 2021.

The cost of the 'local choice' option at £171M (with OB and Risk, excluding O&M) is comparable with similar recent barrier projects around the UK. However, in this case there is a greater cost certainty due to the stage we are at in barrier design at this point in OBC submission. The 'local choice' option is not cost beneficial under current Treasury rules. It is, however the only workable option that will deliver flood risk reduction to complete the integrated flood scheme for Lowestoft and is the also agreed in principle with the key landowner stakeholders, including ABP, allowing this project to progress at an accelerated rate from April 2024 for delivery in 2027.

The economic opportunities are set against the challenges of establishing Outcome Measures that meet Treasury Guidance for FDGIA despite the project contributing to national outcomes of six different Government departments and support the national objectives of levelling up deprived places, contributing to more resilient places, and supporting the green energy economy and carbon reduction targets by enabling offshore wind and nuclear delivery programmes.

This project has the full support of the Project Board, ESC Members and the local MP. The project has been fully discussed with EA Area, LPRG and National colleagues and the approach taken to date has been progressed with their full involvement and support.

The technical solution for Lowestoft is therefore to progress a 40m mitre gate barrier option under an accelerated programme as this is the only solution available from the long and short list that meets the needs of cross-government outcomes and supports the local community and business of Lowestoft. However, the funding required for this scheme is currently not available due to inflationary pressures impacting increased cost of suppliers, material and resources.

Location

Lowestoft is a major seaside town located on the north-east coast of Suffolk at the UK's most easterly point. Lowestoft has a population of approximately 57,000 residing in some 27,000 residential properties. (Lowestoft Town Profile, ESC 2014). Lowestoft is a town of multiple deprivation. Over 35% of the population are either unskilled, in casual work or unemployed¹ and over 25% of the population is over 65².

The town has become increasingly vulnerable to flooding from all sources for decades. Heavy rainfall events led to significant fluvial and pluvial flooding in 2015 and flooded 33 homes in the Aldwyck Way and Velda Close area of the town. Tidal flooding to 400 homes occurred in the East Coast surge of 1953 and this was replicated again in 2013 tidal surge when 158 residential and 233 commercial properties flooded in Lowestoft and Oulton Broad. Key transportation links such as the railway and A12 also flooded impacting on flood response, recovery and clean up. The town currently relies on a temporary barrier system which is deployed when flood forecasting triggers a surge warning. Defences were most recently deployed in 2017 when severe flood warnings were triggered and a 2.1m surge was predicted. Thankfully the surge diminished due to changing weather patterns. The town currently relies on the temporary barrier solution until a more permanent solution can be delivered.

Table 2.1 presents a summary of the sources of flooding, flood pathways, receptors and future climate change impacts directly considered in this OBC.

Table 2.1 Summary of existing (2018) flood risk

Source	Pathway	Receptors	Climate change impacts
Tidal – North Sea	East: Outer Harbour and into Lake Lothing. Flooding occurs when tide level overtops existing quaysides / through existing drainage network. West: Mutford lock via the Broads' system from Great Yarmouth	Existing residential and commercial properties. Future development areas. Local infrastructure including: roads (A12/A47 – Bascule Bridge), telecoms, electricity distribution, gas distribution, surface and foul water drainage systems.	Sea level rise will increase the impact and frequency of tidal flooding. Increased storminess will increase tidal surge events duration and intensity. .
Pluvial fluvial	Flash flooding from intense rainfall events. Capacity of existing drainage systems resulting in flooding where surface water cannot drain away or banks of drainage channels (including the Kirkley Stream) are overtopped.	Existing residential and commercial properties. Future development areas. Local infrastructure including: roads, telecoms, electricity distribution, surface and foul water drainage systems.	Increased frequency and duration of high intensity rainfall events.

¹ Office of National Statistics (ONS) 2021 Census

² Age group breakdown estimates - Lowestoft 2016, Suffolk Observatory – ONS data.

Lowestoft is particularly susceptible to flooding from tidal surges due to the small normal tidal range compared to other locations along the east coast of England. Lowestoft has a tidal range of approximately 2m. This is low when compared to locations along the outer Thames and Humber estuaries which have tidal ranges in excess of 5m. A consequence of this low tidal range is that a significant tidal surge (<2m) at Lowestoft could cause flooding at almost any state of the tide whereas at locations with a greater tidal range where the timing of the surge event compared to high water has greater influence and reduces the likelihood and/or severity of flooding from the surge.

Lowestoft's open coastal frontage is well defended to the north and south and management of the defences is set out in the Gorleston to Lowestoft Strategy with Hold the Line policies identified in the recent Suffolk SMP Refresh (SMP7) and Catchment Flood management Plan (Appendix F10 and F24 respectively) being viable for the future management of Lowestoft and the coast. An overlap in benefits across the open coast frontage and within the central Lowestoft harbour area have been considered and outcome measures have been reasonably apportioned in line with current appraisal guidance and the approach set out in the Strategic Approach document (Appendix M).

The need

Due to historical developments around the inner harbour and fluctuations in the success of the port industry in the town over time – central Lowestoft has remained 'open' to the tide with no formal defences in place to manage tidal flood risk. Discussions with national EA colleagues and wider coastal local authority networks suggest Lowestoft is the only coastal town of its size in the UK to remain undefended to this increasing risk.

The town is uniquely placed to support the offshore wind energy sector and new businesses are moving into Lowestoft to grow operations and maintenance roles in the sector. The latest Government announcements for the new nuclear power station – Sizewell C- to be given the go-ahead means Lowestoft will also now support marine-based operations for the delivery of this new national infrastructure. New housing and businesses premises are needed to support this new 'east coast energy hub' and Homes England have also visited the town recently and want to support Government investment in the Harbour and Oulton Broad areas.

The lack of defences as detailed in the strategic approach documents (Appendix M) are evidenced as suppressing the ability of Lowestoft to develop and grow and are not allowing the deprived areas of the town to 'level up' as per wider Government outcomes. The lack of certainty about tidal flood risk is holding Lowestoft back and allowing social deprivation to remain a key issue for the town. As an example - women in the Harbour & Normanston Ward area of Lowestoft will live 10 years less than other women in the same demographic in the rest of East Suffolk³.

Due to the historical prevalence of the port at the heart of Lowestoft – the lack of development of residential and business properties in the port area means low property numbers and therefore low OM2 values. The significant OM1 values are not valued in the same way under Treasury guidance and therefore a flood defence scheme has never gained traction for the town.

To deal with these issues, East Suffolk Council submitted an Outline Business Case for an integrated flood management scheme for Lowestoft in 2018. The OBC outlined a number of measures to reduce pluvial and fluvial flood risk in the Kirkley area and south of the harbour using both physical defences, new pumping regime and property level protection solutions in partnership with Suffolk County Council and

³ Source: ONS, 2015-2019 data. Accessed via localhealth.org.uk – featured in Lowestoft Community Partnership Profile - 2022 update

Anglian Water. In addition, the OBC recommended a phased tidal wall and tidal barrier project to give the town integrated flood risk resilience to 0.5% AEP.

The OBC was given technical approval and financial approval was granted for fluvial and pluvial works to progress due to the availability of partnership funding from Suffolk County Council and the Anglian Local Enterprise Partnership with Anglian Water. However, as further work on the design of a 28 m tidal barrier and adjoining tidal walls was needed the tidal works were only given technical assurance whilst funds were found.

As well as the FCERM benefits, the provision of tidal defences and improvements to the management of the pluvial and fluvial flood risk infrastructure will increase business confidence for investment in Lowestoft which is critical. An allocation of £10M NALEP funding has already been made to the LFRMP scheme and further discussions with the NALEP are in train. In addition, local businesses that would benefit from the proposed works have also made commitments to provide both benefits and funding 'in kind' towards the project. Project funding sources are discussed further in Section 5.2.

ESC through the Scape framework contracted Balfour Beatty to lead the design and build of the integrated defence scheme with Jacobs as designers. The project team successfully delivered the pluvial and fluvial elements of the project in 2021/22. We are also using the National Themes and Outcome Measures tool to ensure the project is delivering important local legacy and social value outcomes that directly benefit local people and place.

Construction of tidal wall works have commenced along Hamilton Road (completed 2022) and Waveney Road (still in progress) with funding that was not contingent on the financial approval of the 2018 OBC. The second submission of this 2022 OBC is aimed at securing the technical approval for the revised options and the refreshed appraisal.

This 2022 OBC sets out an updated business case for the investment required and reviews the strategic context of the tidal options, including a review of earlier long and short list options to ensure the barrier is solution is still the right solution. This OBC has been developed using the guidance set out in the FCERM-AG (Environment Agency 2021) and Treasury Green Book Guidance (HMT, 2020 with 2021 amendments). Due the fact that the scheme is already well underway making it different to a standard OBC, extensive consultation has taken place between the ESC and EA at both Area and National levels to inform this OBC and the development of the overall project.

Impacts on the local economy

The impact of tidal flooding on the local economy is significant. A port like Lowestoft can only exist in a coastal location arguably in a flood risk zone. The port is one of only a few east coast ports that are in a position geographically to support offshore wind energy development and contribute to our national economy and wider government outcomes for greener energy supplies and carbon neutrality. The damage and disruption that caused by flooding- like the 2013 surge -coupled with the lack of confidence for investors in the town that flood risk brings is stymying local growth. This in turn affects the local population due to reduced employment opportunities and diminishes the services available to them as taxable returns to ESC to offer such services are also limited. Whilst these impacts do not contribute to the amount of FCERM-GIA that is available to the LFRMP, it is a key measure for the NALEP business case who recognise the value of these benefits.

The lack of certainty on flood risk is preventing development opportunities at key sites in and around the Lake Lothing area of the town making land uneconomic for private development which is needed to stimulate growth and provide much needed housing for local people. Homes for England have recently visited Lowestoft and are keen to work with us on delivering improved housing offers in Lowestoft to meet local need and deliver their housing requirements nationally. This housing will also fuel the economic regeneration of large parts at the centre of the town. Whilst some of this housing will be in the floodplain it is inevitable that development in seaside towns at risk of flooding is needed if coastal seaside towns are to remain viable. This is clearly set out in the Government 'Regeneration of Seaside Towns report'⁴ which acknowledges that without resilient coastal defences we cannot have resilient places.

The UK relies on a number of key coastal towns for nationally important economic outcomes as gateways to the marine and offshore industries and arguably we cannot meet the needs of the offshore and marine industries without coastal towns – arguably all are at risk of coastal flooding due to their proximity to the coast- we therefore require them to become more resilient and the LFRMP project aims to do that for Lowestoft. Without this scheme the only alternative is to manage flood risk though the existing temporary barriers until such time they are overwhelmed. Our only other option is to not proceed with a barrier project and ESC is not prepared to effectively 'decommission' Lowestoft as a town, nor is there any precedent to do so given the size and scale of the place and the opportunities it presents to local and national outcomes.

The Lowestoft Flood Risk: Economic Footprint and Impact Report⁵ (Appendix F3) assessed the potential impact of flood risk on Lowestoft's current and future economic footprint. The study concluded that for a tidal event with a 1in200yr return period (0.5% AEP which is similar to the 2013 surge event) 30% of Lowestoft's existing Gross Value Added (GVA) is at risk of flooding and this rises to 62% with climate change if it remains undefended. This is discussed further in Section 3. Including the notional FDGiA allocation, the project has secured commitments for £69,266.893 of funding to date. £62,176,439 is from partnership funding sources and includes;

- £10M from NALEP Growth deal
- £43,486,000 from HMG Green Recovery Fund

The GRF contribution was the largest capital allocation made nationally from the fund. Both allocations highlight the significant role the LFRMP has to play in supporting and enabling economic growth locally and nationally.

As evidenced in Appendix N1, a comprehensive funding strategy has been developed but a fully resourced plan is no longer in place due to the need for the 'Local Choice' barrier option and the rising inflationary cost of materials, supplies and resources that has happened globally in the last 2 years.

As the majority of the partnership funding requirement has related to the cost of delivering the tidal barrier while enabling the port to remain fully operational – the focus of our funding strategy now is to secure funds from other national sources by demonstrating the value of the scheme to at least 6 Government departments and their national outcomes. We are still approaching local sources based on commercial development enabled by the project including contributions from infrastructure providers due to the significant reduction in risk to their assets and customers. In the last 6 months we have worked very closely with Homes England, DHLUC and BEIS

⁴ Select Committee on Regenerating Seaside Towns and Communities - The future of seaside towns: <https://publications.parliament.uk/pa/ld201719/ldselect/ldseaside/320/32002.htm>

⁵ Lowestoft Flood Risk: Economic Footprint and Impact Report, MML, May 2022.

and sought cross-government support through political discussions via our MP and EA Area team involvement with government officials. Working with ABP's LEEF (Lowestoft Eastern Energy Facility) project team we have developed a unique programme opportunity to support their outer harbour expansion to allow greater green energy growth with wind and marine sector and meet the marine transportation needs of the national nuclear infrastructure project at Sizewell C to remove road transport pressures and reduce carbon through that route (in line with Government national policy).

The port is therefore poised for a significant economic shift and ABP have granted us full access to the navigational channel for 2 years if we can accelerate the LFRMP barrier project to commence in April 2024. Further cost reductions will likely be made as a result of this unconstrained access to the channel to build the barrier infrastructure both through the reduced programme timing and oncosts as well as the opportunity to buy materials earlier. This opportunity is time limited as the LEEF project will progress from 2024 regardless of the LFRMP.

The fast moving nature of this opportunity to build the barrier and support the LEEF project and EDF in the delivery of SZC is therefore presenting the LFRMP project team with a unique opportunity to reduce flood risk to the town earlier and make cost savings however we cannot commit to this accelerated programme fully without closing the funding gap of £113M and in parallel having greater national agencies support in parallel from national Government departments to maximise funding opportunities that may arise from the wider infrastructure delivery.

ESC has already committed £1M contribution and significant resource to the project and is also under-writing circa £50M to insure the schemes delivery with Government Actuaries Department and Treasury. The ESC under-writing is because Coastal Protection Authorities are not underwritten for capital schemes in the same way as Environment Agency. It is ESC's intention to fund the operation and maintenance costs for the tidal barrier and tidal walls. In line with ESC's procedures a commitment of this level requires approval from by the Full Council. An update on expected O&M costs is being included in project briefing paper that will be presented to the Full Council on the 23rd November 2023. At an appropriate time, ESC will be taking the substantial operation and maintenance costs to Full Council to secure the required approval for the funding required for post construction expenditure.

2.2. Business strategies

In setting out the strategic approach (Lowestoft FRMP Strategic Approach, Appendix M) for the management of flood risk in Lowestoft the SOC drew on a number of existing plans and strategies to make an assessment of any overlap or conflict with the LFRMP. Where an overlap between the benefits areas was identified, a fair split of benefits has been proposed to ensure that the double counting of benefits/outcomes does not take place. A review of this assessment was undertaken as part of this OBC which concluded that this remained a valid approach.

The following plans and strategies were considered:

- Lowestoft Transport Infrastructure Prospectus (ESC, 2013)
- Broadland Rivers Catchment Flood Management Plan (CFMP, 2009)
- Anglian River Basin Flood Risk Management Plan (EA, 2015)
- Gorleston to Lowestoft Coastal Strategy (ESC/ Great Yarmouth Borough Council (GYBC), 2017)
- Kelling Hard to Lowestoft Ness Shoreline Management Plan (SMP) (adopted 2012)

- Suffolk SMP2 Sub-cell 3c (2010)
- A Flood Management High Level Review for the Broads Climate Partnership (Broads Authority, 2016)
- Lowestoft FRMP SOC (ESC, 2017)
- Lowestoft Fluvial / Pluvial Options Report
- Environment Agency's Norfolk, Suffolk and Essex Coastal Modelling Study ,2018 (Draft outputs)*

*These draft outputs were used to inform the hydraulic modelling used to inform the economic analysis. Whilst this analysis has not been updated for the 2022 OBC, a sensitivity assessment completed was completed using the latest Coastal flood Boundary data set which is further discussed in Section 3.9 and Appendix E1.

This LFRMP and the G2LS consider an area with potentially shared benefits. This overlap has been considered in the Economic Case to ensure that an appropriate split of benefits/OMs is applied to any projects that result from either strategy and that double counting of benefits is avoided. This is considered in detail and recommendations are made in the Lowestoft FRMP Strategic Approach document, Appendix M1.

SCC's proposals for a third road crossing of Lake Lothing have also been considered in terms interactions with flood risk management options and the potential for a combined bridge and flood risk management structure.

The provision of new flood risk management measures forms an integral part of the Lowestoft Infrastructure Prospectus (Appendix F4) which establishes ESC's framework of infrastructure improvements to enable economic growth in Lowestoft.

2.3. Environmental and other considerations

The development of options considered several environmental issues, regulatory requirements, legal and other obligations to be considered and addressed as options are taken forward. The key areas for consideration are as detailed below:

- Transport and Works Act Order (TWAO) – Barrier works within Harbour
- Environmental Permitting Regulations
- Marine Licence requirements
- Planning permission
- Heritage requirements
- Legal agreements – Landowners, tenants, highways and Port Authority
- Other highways agreements
- Environmental impact of options/EIA regulations
- Water Framework Directive
- Utilities diversions/wayleaves
- Habitats Regulations Assessment

Building upon the Strategic Environmental Assessment Environmental report⁶ (included in the PEIR Appendix H1) presented at SOC stage, the following environmental reports have been produced at OBC stage considering the preferred options:

⁶ Lowestoft FRMS - SEA Environmental Report Preferred options, CH2M 2017

- Preliminary Environmental Information Report ⁷
- Habitats Regulation Assessment ⁸
- Water Framework Directive Assessment⁹

The findings of the environmental assessments and associated consultation have been fully incorporated into the evaluation of options as presented in Sections 3 and 4 (tidal and pluvial fluvial economic cases respectively), with the environmental reports produced included in Appendix H1 to H5.

As development of the 40m tidal barrier option (local choice option) continues further environmental studies (EIA) are being undertaken to inform the development of this option and support the TWAO process. These studies are under development and will not be included in this OBC document. Section 3.4 of this OBC has been reviewed to take into account the current understanding of environmental impacts of both the 28m and 40m barrier options.

2.4. Investment objectives

The Lowestoft FRMP investment objectives were initially defined in the SOC and have been reviewed at OBC stage and remain broadly unchanged as presented below:

- To reduce the risk to residential and commercial properties from the combined effects of tidal and pluvial fluvial flooding.
- To reduce costs associated with developing and insuring property within areas of Lowestoft susceptible to flooding.
- Identify the most economically advantageous option in relation to the allocation of funding through FCERM-GiA.
- Provide a minimum standard of protection of 1 in 200 (0.5%) AEP against tidal flooding to residential and commercial areas of Lowestoft, to enable the release of growth funding from the NALEP and other forms of partnership funding.
- Provide businesses with the confidence to grow and invest in areas of the town which are currently not considered suitable for development (planning) due to the risk of tidal flooding.
- Target construction completion of the tidal walls in 2023 and the tidal barrier in 2031 (Local choice 40m barrier option – seasonally constrained delivery).
- The objective for implementation of the pluvial fluvial works was met in 2021.
- Clearly set out the approach to OM and benefits sharing between the sources of flooding (tidal, pluvial, and fluvial) and coastal erosion.

The NALEP business case which is included in Appendix F identified the following additional key project outputs:

- Supporting 10,900 direct jobs and supporting the generation of 3,500 additional direct jobs in the project area.
- Securing GVA for the local economy
- Supporting the future generation of additional GVA within the area.

⁷ Lowestoft FRMS – PEIR, CH2M 2018

⁸ Lowestoft FRMS – Habitat Regulations Assessment, CH2M 2018

⁹ Lowestoft FRMS – Water Framework Directive assessment, CH2M 2018

- Enabling the development of key sites through the alleviation of direct flooding and protection of essential infrastructure.

2.5. Current arrangements

Recent flood events highlighted the need for investment in flood risk management in Lowestoft. They also resulted in significant changes in the approach to managing the current level of risk from flooding (tidal, pluvial and fluvial). The following sections summarise the current situation.

Flood risk management structures

Currently Lowestoft has no completed formal tidal defences. Construction of tidal walls along Hamilton Road (which are common to all tidal options) is currently in progress and is forecast to be fully operational in 2023. An informal tidal defence is also provided in part by the foundation of a security wall along part of the port boundary with the A47. Construction of the remaining tidal walls around the perimeter of the outer harbour are forecast to be completed in 2023.

There are numerous drainage outfalls into Lake Lothing from the private and public drainage network (surface water and foul). The outfalls range in type from directly connected surface water gullies to combined sewer storm overflows. Where outfalls do not have a flap/non-return valve fitted to them, they provide a pathway for tidal flooding of infrastructure and properties. Where flap/non-return valves have been installed, they can only be considered effective if a regular inspection and maintenance regime exists to ensure they function as intended.

Whilst responsibility for these outfalls may lie with private companies and individuals, their impact on the effectiveness of the proposed tidal defence options could be significant and must be managed. Anglian Water has undertaken works (investment of approximately £2.3m) to address flood risk issues associated with their combined sewer and surface water drainage systems which contribute to the overall flood risk in Lowestoft. Further details of these works can be found in the strategic approach document in Appendix M1.

Flood warning

The EA's flood warning system provides forecasts and warnings to relevant authorities and to the general public enabling action to be taken in response to a forecast event.

Local media channels including radio, television, social media and internet news sites are also used to share flood warnings and provide advice/instruction in terms of what action should be taken.

Response to flood warning

When tidal flooding is forecast the response is managed through the multi-agency Suffolk Resilience Forum which includes representation from County and District Councils, Fire Service, Police, Highways England and the EA. The forum is provided with early indications of forecast extents to enable planning to take place prior to the higher confidence warnings issued to the general public.

For a significant tidal flood event affecting Lowestoft such as that experienced in December 2013, resources to respond to the incident need to be pre-positioned in advance of the event to ensure they are in place before transportation routes are affected¹⁰.

The Bascule Bridge (twin span lifting bridge) carries the A47 (trunk road) and is a key transportation route for Lowestoft and the wider region. The bridge remains down during a tidal surge event with any lifting operations suspended prior to the abutment

¹⁰ Lowestoft temporary defences Workshop June 2016 – general discussion point

chambers being flooded. Should the abutment chambers be flooded, the bridge would not be operable until they had been pumped out and the mechanical and electrical equipment used to operate the bridge dried, inspected and repaired as necessary. Any period when the bridge cannot operate has a direct impact on navigation between the inner and outer harbours and can have a significant impact on businesses within the inner harbour that are reliant on access to the North Sea. With regard to highway safety the A47 will remain open for as long as it is safe to do so as assessed by Highways England. However, during a tidal surge event it is more likely that the roads leading up to the Bascule Bridge would become impassable before the bridge deck itself is overwhelmed.

Temporary tidal defences

As an interim measure to reduce the risk/impact of tidal flooding the Regional Flood and Coastal Committee has funded the purchase of approximately 1.4km of temporary defences with the aim of reducing the impact of tidal flooding to key areas of Lowestoft. This investment has been funded through Local Levy with the temporary defence assets to be released to the EA for use elsewhere once a permanent solution is in place for Lowestoft. The temporary defences were purchased in late 2016.

The temporary defences were deployed in response to the forecasting of a significant tidal surge on 13 January 2017. Fortunately, the surge was not as severe as forecast and the water level did not reach the temporary defences. The water level was however very close to the toe of the temporary defences and their presence provided reassurance to project partners and the local community that active steps were being taken to manage tidal flood risk. Photographs of the January 2017 temporary defences deployment are contained within Appendix C2.

As part of the temporary tidal defence system and following the 2013 tidal surge, works have been undertaken to the surface and foul water drainage system to reduce the flood risk from the ingress of tidal water. These works undoubtedly reduced the inflow of tidal water into the drainage system and are likely to have reduced flooding via this route in January 2017.

Whilst the temporary defences provide a level of flood risk reduction they should not be considered as a long-term solution for the management of tidal flood risk in Lowestoft as they cannot provide the required standard or certainty of protection required to achieve the project objectives. Consideration is being given to how to adjust the deployment of temporary defences to account for the new tidal walls once they are complete. This is further discussed in Section 3.3 where temporary defences are considered in the long list of tidal options.

2.6. Pluvial fluvial flood risk

Pluvial Flood risk

Lowestoft is at risk of flooding from pluvial and fluvial flood sources. These risks are now managed through the work – as set out in the 2018 OBC for LFRMP- that was delivered by the project team and finalised in 2021. This has led to 127 homes being better protected against pluvial and fluvial flooding.

2.7. Main benefits

The proposed investments aim to provide the following strategic and operational benefits to Lowestoft:

- Provide a 1 in 200 (0.5%) AEP standard of protection against direct tidal flooding to residential and commercial areas of Lowestoft where economically justified by FCERM-GiA and NALEP funding considerations.

- Reduce the risk from tidal, pluvial and fluvial flooding to residential properties and businesses; contributing towards the FCERM six year investment programme targets.
- Reduce the current burden on emergency services and other organisations in responding to flood events in Lowestoft.
- Provide confidence to local businesses and encourage investment and growth in the local economy.
- Allow the development of brownfield sites within the Riverside Local Enterprise Zone and the Powerpark Local Development Order zone, not currently considered suitable for redevelopment due to the risk of tidal flooding in events with a probability of occurrence of less than 1 in 200 (0.5%) AEP.
- Reduce the impact of flooding on local roads and business infrastructure including the strategic A12 / A47 (including the Bascule Bridge), a key trunk road linking Norfolk and Suffolk and telecommunications infrastructure.
- Contribute to the objectives of the Lowestoft Transport Infrastructure Plan (Appendix F4) and the NALEP Strategic Economic Plan.
- Support the delivery of the LEEF project
- Support the reduction of land-based transport and subsequent pollution, carbon and disturbance levels through a marine-based transport hub the SZC development for a marine based hub in Lowestoft
- Contributes to the national outcomes of UK Government by delivering across 6 Gov departments including- Defra, BEIS, DHLUC, DFT, Homes England, Dept. Of Work and Pensions.

2.8. Main risks

A summary of key risks to achieving project objectives and mitigation measures are summarised in Table 2.2, pluvial fluvial risks have been removed from this table as these works have been completed.

Quantative risk registers for the preferred option represent the comprehensive project risk assessment for delivering the tidal works and are included in Appendix L.

Table 2.2. Summary of key risks and mitigation measures

Risk Theme	Description	Mitigation measure
Governance and communication	Differing objectives of partner organisations	Implement robust project management procedures and clearly defined responsibilities for partner organisations.
	Poor coordination of inputs from partner organisations.	
	Poor communication and consultation resulting in loss of confidence in the project.	Maintain a comprehensive communications' strategy to ensure continued engagement/ consultation with public, businesses, regulators, approvers, landowners and other stakeholders.
	Project acceleration opportunity	
Legal & Consents	Not securing Transport and Works Act Order (TWAO) and Marine Licence	Early engagement with key stakeholders, seeking to resolve any concerns in advance of TWAO and marine licence applications.
	TWAO programme - Missed opportunity to have unconstrained access to nav channel increasing project costs and lengthening programme and ongoing tidal flood risk to town	National discussions regarding the opportunity to use 'project speed' to accelerate the programme given the significant 'up front works' that have been done with stakeholders and agreements in principle with key landowners

Risk Theme	Description	Mitigation measure
	Not securing legal/access/other landowner agreements.	Early draft Head of Terms to be developed. Continued engagement with landowners and tenants.
	High costs for land purchase & compensation payments.	Develop options, construction methodologies and structure legal agreements with affected parties to minimise the impact of delivering options.
	Securing sufficient partnership funding.	Development of a comprehensive funding strategy and early, proactive, and continuous engagement with potential funders.
Funding	Insufficient risk allowance within the project costs.	Continuous assessment of risk throughout project development following robust risk management processes.
	Construction cost increases (change in scope, materials costs, ground conditions, delays).	Early engagement of specialists (contractors, consultant, barrier designers) to develop robust business case.
	Some planned elements of the project are not delivered impacting on the benefits realised	Tidal and pluvial fluvial elements are considered separately in economic terms. The approach to delivery ensures that FCERM-GiA expended delivers Outcome measures.
Design & Construction	Ground conditions along the defence alignment.	Early ground investigation undertaken to inform design development.
	Service diversions – cost and timing.	Appropriate levels of risk included in project costings. Working closely with utilities to develop options to accommodate existing services.

Strategic importance

The delivery of strategic flood risk management for Lowestoft is a high priority project for ESC and is a key element of delivering the Lowestoft Transport and Infrastructure Prospectus¹¹ which sets out the vision for enabling economic growth in the area through better infrastructure. The planned economic development of Lowestoft would be at risk if this element of infrastructure improvement was not delivered.

The risk of not delivering the preferred option outlined in this OBC needs to be considered in terms of the wider social and economic impact to Lowestoft including the LEEF project, renewables sector and areas identified as being essential to the delivery of other major energy projects of national significance. Whilst not a key driver for the FCERM-GiA funding allocation, a significant element of partnership funding (NALEP) is targeted at securing the future potential for social and economic growth. In addition not progressing the tidal flood risk management measures increases the risk to life for residents in Lowestoft.

As future predicted climate change takes hold in terms of sea level rise and increased storminess, Lowestoft will become increasingly susceptible to the impacts of tidal and pluvial fluvial flooding. As assessed in the Lowestoft Economic Footprint and Impact Report - May 22 (Appendix F3), the impact on the local economy will increase with climate change and limit the future economic growth of Lowestoft.

2.9. Constraints

A number of internally and externally driven constraints need to be considered in the further development of options; these are summarised in the sections below. This list has been refined following further detailed consultation undertaken for the OBC stage as discussed in Section 7.2 and documented in the LFRMP communication plan and engagement summary (Appendix G1). Constraints associated with funding mechanisms are discussed in detail in the Funding Programme Document (Appendix N1) with a summary included in Section 6.6 of this document. The constraints listed

¹¹ <http://www.eastsuffolk.gov.uk/business/regeneration-projects/lowestoft-transport-and-infrastructure-prospectus>

below relate to the delivery of the tidal element of the LFRMP only as the pluvial fluvial works have been completed:

- Availability of and any restrictions associated with partnership funding (NALEP, Local Levy, private sector)
- FCERM-GiA funding availability and requirements
- Environmental
- Geological
- Existing structures and infrastructure
- Port operations / future requirements
- Highways' assets (Bascule Bridge)
- RNLI and Coastguard
- Landowner/tenants' requirements
- Timing of works
- Construction impact on local businesses, community and other organisations

2.10. Dependencies

In order to deliver the project objectives, the following internal and external dependencies have been considered and are being actively managed by the project team (Tidal works only):

- Project approvals/assurance
 - ESC – internal approvals
 - EA – project assurance for FCERM-GiA allocation (LPRG)
- Funding arrangements – NALEP, Partnership, FCERM-GiA and Local Levy
- Legal agreements – Landowners, Port, Highways England, Royal Norfolk and Suffolk Yacht Club
- Licences, consents and orders
 - TWAO – Tidal Barrier
 - Marine Licences – dredging, permanent and temporary works
 - Planning permissions – Tidal flood walls
 - Environmental Permitting Regulations (EPR) consent (formally Flood Defence Consent)
 - Historic/listed building consent
 - Conservation area consent
- Existing coastal defences – considered in the G2LS

3. The tidal FRM economic case

3.1. Introduction

The tidal economic case summarises the approach taken to assess the options considered for the 2022 OBC. This has been further developed to account for:

- Feedback received on the 2018 OBC
- Better cost certainty
- The most recent partnership funding and appraisal guidance published in 2021&2022
- a change in the assessment of certain benefits
- Guidance provided by Environment Agency and LPRG [including the 'Dealing with Inflation' guidance note for RMAs.](#)
- Further detailed development and appraisal of the identified options as discussed below.

Key to ensuring an appropriate and proportionate split of benefits between tidal, coastal and pluvial fluvial flood risk is the Strategic Approach Document (Appendix M1) which considers the potential overlap in benefits areas and established the approach applied to avoid double counting of benefits. The Strategic Approach Document was developed at SOC stage and has been reviewed for this 2022 OBC, with assistance from Risk & Policy Analysts Ltd (RPA) in identification of benefits and damages. The document concluded:

- There remains minimal overlap between tidal and pluvial fluvial flood risk sources, with the probability of simultaneous occurrence considered very low.
- The assessment of overlap between the G2LS and the LFRMP remains valid for the coastal cell to the north of Hamilton Docks. [However as discussed below with the removal of the Hamilton Road works from this economic assessment means this is no longer of concern.](#)

In order to maintain a clear distinction between the pluvial fluvial and tidal flood risk management elements, the economic analysis of each is presented separately. This approach ensures clarity of the sources of benefits, the associated funding sources and different duration of benefits.

The economic appraisal and shortlisting of options has been undertaken in line with the requirements of the EA's FCERM-AG, with economic damage calculations undertaken based on guidance within the [Multi Coloured Handbook 2021 \(MCH\)](#).

[Following a review of the benefits provided by elements of the proposed tidal defences. It was identified that the Hamilton Road flood wall contributed relatively little to the FCERM Benefits through the coastal flood cell due to the reduced duration of benefits considered and no residential properties situated within the flood cell. This section of flood wall has now been substantially completed and was funded by the NALEP due to the reduction of flood risk afforded to the PowerPark Local Enterprise Zone. As such the costs and benefits/damages relating to this flood wall have been removed from this appraisal.](#)

[A navigation simulation was undertaken in early 2021 to simulate vessels transiting the proposed 28m tidal barrier. This simulation indicated that there was a risk of vessels making contact with the tidal barrier gates when in the open position which Multi Coloured Handbook 2021 \(MCH\) could increase the frequency of repairs required the gate structure. A thorough review of the location and sizing of the proposed barrier was undertaken involving key stakeholders to the project \(Appendix F20, Tidal Barrier – Technical review note\) This concluded that whilst the tidal barrier was located in the most suitable location and the type of barrier structure was also](#)

appropriate, it would be advantageous to increase the width of the barrier structure to 40m. This increased width reduces the risk of vessels making contact with the barrier improving its resilience. In addition, it provides greater flexibility for future changes to the Lake Lothing entrance channel. For this reason and as part of the design development and continued stakeholder engagement, a new 40m tidal barrier option has been introduced into the appraisal with the intention of selecting it as the preferred local choice option if it is not identified as the national economic option.

3.2. Critical success factors (Tidal)

The factors described in Table 3.1 have been used to assess the tidal flood defence options. These factors were developed for the 2018 OBC to consider delivery of the project objectives and the requirements of key partnership funding sources.

Table 3.1 Critical Success factors - Tidal

No	Critical Success Factor	Measurement Criteria	Importance (1-5)
1	Provide a minimum 1in200 year (0.5% AEP) SOP to comply with NALEP growth funding requirements.	SOP provided by option to areas driving NALEP funding allocation.	1
2	Provide the most economically justified SOP to other areas of Lowestoft – commercial and residential, safeguarding key transportation routes and infrastructure.	SOP provided by option to other areas at risk of flooding.	2
3	Provide a sustainable tidal flood defence system that is affordable.	Option cost with available funding in accordance with funding strategy, including whole life cost and O&M requirements	3
4	Not compromising the ability of existing businesses and infrastructure to operate and grow – Port, Industry, Railway, A47, and Bascule Bridge.	Impact of options on current operational regime of businesses and infrastructure.	4
5	Limit the impact of construction activity on the local economy and community.	Number and value of claims for compensation.	5

3.3. Long list options (Tidal)

The long list options considered for the management of tidal flood risk in Lowestoft are summarised in Table 3.2 including a brief description of why they were taken forward or rejected from the shortlisted options. The shortlisting process was undertaken with input from the Lowestoft FRMP technical steering group at SOC stage following an outline assessment of option cost and technical feasibility. This process was concluded with a workshop to agree the shortlist of options as identified in Table 3.3. A review of these options was undertaken for the 2022 OBC which concluded that the long list and shortlisting process remains valid. An additional tidal barrier option has been included for the 2018 OBC in the as discussed in Section 3.1.

All options involving the construction of a hard defence line required additional supporting works to be undertaken to outfalls from the local drainage systems to reduce the volume of tidal waters bypassing the defence line.

Table 3.2 – Tidal long list of options

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
1	Do Nothing	No Benefits – reduced SoP when informal defence along A47 is not serviceable, climate change impacts are considered and increased damages when no flood warning service provided. Does not promote growth.	Shortlisted as baseline economic case

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
2	Maintain - Do minimum	Some benefits – SoP reduces as climate change impacts, continued flood warning. Does not promote growth	Shortlisted as green book requirement.
3	Improve – flood walls only	Improves SoP to the majority of the strategy area – Mutford lock end still subject to flooding from the Broads' system in tidal surge event. Walls along inner harbour quays may restrict operational usage of some quaysides. Hydraulic modelling indicates some increase in flood risk to unprotected property at western end of Lake Lothing.	Shortlisted to test the feasibility of a non-barrier option.
4	Improve - Outer Harbour barriers and walls	Can provide the required standard of protection. Provides protection to the port area but also restrictions on the use of the port during a surge event.	Rejected due to: Significant cost of two large tidal barriers, significant improvement works to harbour arms, significant impact on ports operations during and post construction including losing its classification as a Safe Haven.
5	Improve – 28 metre Bascule Bridge barrier and walls	Improves SoP to the majority of the study area – Mutford lock end remains at risk of tidal flooding from the Broads' system. <i>Issues include: likely ship impacts (and associated costs and environmental effects of repairs) due to a narrower navigation channel compared to Option 9, as predicted by navigation simulations completed in 2021.</i>	Shortlisted. As a tidal barrier option seaward of the Bascule Bridge. Early indications from business and public consultation is that this option meets with public approval. <i>Identified in the 2018 OBC as the preferred option.</i>
6	Improve – third bridge crossing barrier and walls	Improve SoP to the majority of the strategy area – Mutford lock end remains at risk of tidal flooding from the Broads' system. Issues include: timing of project implementation, costs and navigation impacts.	Rejected. Third crossing is already being built. The 2018 OBC concluded that even with the potential efficiencies of the combined approach, the capital expenditure associated with such a wide barrier structure far exceeded that of the Bascule Bridge barrier and makes Option 6 unaffordable.
7	Temporary flood defences only	Improves SoP to limited areas of the strategy area. Will not enable growth nor significantly increase business confidence. Significant impact on business operations when deployed.	Rejected as a long-term solution due to: Low standard of protection (1in50 year (2% AEP) SoP in 2018) feasible, high long term operational costs, increased risk of failure or outflanking and lower levels of reliability when compared to permanent defences. Does not enable growth. Cannot readily keep up with climate change impacts and therefore cannot achieve the project objectives.
8	Property level resilience only	Limited benefits to individual properties where depth of flooding does not exceed 0.6m. Will not enable growth or significantly increase business confidence. Will not reduce the impact of flooding on transportation routes or other infrastructure.	Rejected as long-term solution due to: Depth of flooding means that for the majority of properties, this approach is not technically feasible, does not enable growth or protect infrastructure.
9	Improve – 40 metre Bascule Bridge barrier and walls	A new option with a wider barrier was introduced for the 2022 OBC to reduce risk of ship impacts and improved barrier reliability / availability. The costs and	Shortlisted. As a tidal barrier option seaward of the Bascule Bridge. Due to similarity with Option 5, this is considered to have similar levels of public approval. The increased

Option	Description	Benefits delivered /Issues involved	Reason for shortlist or rejection
		environmental effects of associated repairs would also be reduced compared to the 28m barrier in Option 5. Improves SoP to the majority of the study area – Mutford lock end remains at risk of tidal flooding from the Broads' system.	barrier width also contributes to greater resilience and is less restrictive on future development of the Lake Lothing entrance channel.

3.4. Shortlist options (Tidal)

Overview

The shortlisted options for reducing the risk of tidal flooding in Lowestoft are detailed in Table 3.3 with a summary description of each option. Plans illustrating the alignment of the shortlisted options are included in Appendix D2 as well as detailed design drawings for the outer harbour tidal walls in Appendix D3 and early design drawings for the 40m Tidal Barrier in Appendix D9.

From early feasibility studies it was identified that significant partnership contributions would be required to fund a tidal defence scheme for Lowestoft. The development of the shortlist of options therefore focused on options that would be able to attract the partnership funding required and achieve the project objectives. In particular the requirement for NALEP growth funding that the tidal defences provide a minimum of 1in200 year (0.5% AEP) SoP to enable commercial development and growth of areas protected by the proposed tidal defences.

All do something options taken forward for economic appraisal considered a range of SoPs to enable the determination of the most economically advantageous option as summarised in Section 3.5 with further detail in the Tidal Economic appraisal report (Appendix E1).

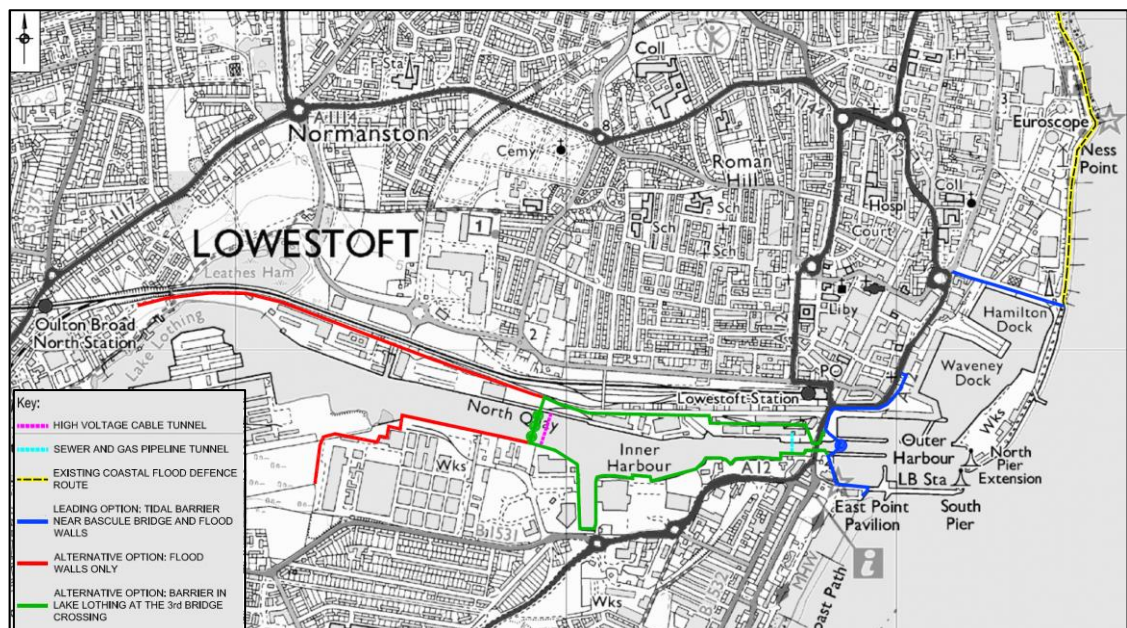
Table 3.3 – Tidal shortlist of options

Short listed Option	Option Description
1 Do nothing	No maintenance or improvements would be undertaken on the existing flood defences.
2 Maintain - Do minimum	Maintenance of the existing flood wall along the east side of the A12 Waveney Road would continue to provide an informal flood defence, preventing tidal flood waters up to a level of 2.90m AOD from reaching the town centre from the Outer Harbour. No new flood defences would be provided. Provision of the flood warnings would continue.
3 Improve – flood walls only	<p>Construction of approximately 5.5km of flood walls to the north and south of Lake Lothing and around the perimeter of the Outer Harbour. Where the defence line crosses the A47, lift-up/demountable flood barriers will be required from year 50. The Lake Lothing tidal walls tie into high ground towards the western end of Lake Lothing but do not continue all the way to Mutford lock. Continuing to the south in front of the Royal Norfolk & Suffolk Yacht Club, along the south pier access road tying into the existing Children's Corner sea wall. To the north of the Bascule Bridge, the tidal walls would be set back following the perimeter of the port estate, tying into high ground to the north of the main ABP port entrance. To accommodate an existing intermediate pressure gas pipeline, a section of demountable defences is required adjacent to the north west corner of the trawl dock, set to the east of the existing port security fence. A further wall with sections of demountable barriers providing access would be provided along Hamilton Road, tying into high ground in the west at the A47 and with the existing Hamilton sea wall to the east.</p> <p>A flood gate across the dual Norwich to Lowestoft railway line previously considered was ruled out due to technical and legal considerations.</p> <p>The tidal flood walls would be typically between 0.3m and 2.6m high including several sections of demountable defences, especially on the northern side of Lake Lothing to allow access to the port quaysides. A number of drainage outfalls would require adjustment to prevent the backflow of tidal water.</p>
5 Improve – 28m Bascule	Construction of a 28m wide (navigable width) tidal barrier across the Lake Lothing entrance channel on the seaward side of the A47 Bascule Bridge.

Short listed Option	Option Description
Bridge barrier and walls	<p>Approximately 1.0km of flood walls, flood gates and demountable barriers (0.3m to 1.9m high) would be constructed along the same alignment as Option 3 around the outer harbour with the flood walls tying into the tidal barrier structure, high ground and existing coastal defences to the north and south of the outer harbour.</p> <p>A number of tidal flap valves would also be required to seal existing drainage outfalls into the outer harbour. The existing tide gauge adjacent to the Bascule Bridge would need to be relocated to enable the construction of the tidal barrier.</p>
9 Improve – 40m Bascule Bridge barrier and walls	<p>This new option with a wider barrier was introduced for the 2022 OBC to improve barrier reliability by reducing the risk of ship impacts (and associated costs and environmental effects of repairs) when compared to the 28m barrier in Option 5. The increased width of the barrier improves the resilience of the barrier gates and reduces restrictions on the future development of the Lake Lothing entrance channel.</p> <p>The defence alignment of this option is the same as Option 5 except with a wider barrier and a shorter length of demountable defences.</p>

Figure 3.1 illustrates the relative alignments of the shortlisted tidal options. Alignment plans are included in Appendix D2 for each shortlisted option with detailed designs for the outer harbour walls which feature in all shortlisted options in Appendix D3. The tidal flood wall shown (blue line) to the north of Hamilton Dock is shown for completeness but does not form part of the works considered in the economic appraisal.

Figure 3.1 – Shortlisted options alignment plan





*The Lake Lothing Barrier option is no longer considered as a short list option following its removal in the 2018 OBC.

Technical assessment

Table 3.4 contains a summary of the technical assessment of options for the tidal flood defences. This table is supported by the Lowestoft Tidal Barrier feasibility study (Appendix F2) and the Tidal Options note (Appendix E3).

Table 3.4 – Technical description of tidal short listed options

Short listed Option	Option description and technical assessment
1 Do nothing	As Lowestoft does not benefit from any formal flood defences this option is not described further. The informal flood defence along the A47 forms part of the ports security fencing and is not maintained as a flood defence. It will therefore only provide a standard of defence for as long as it is in position. Should this structure deteriorate or be removed the standard of protection will be reduced accordingly.
2 Do minimum – maintain	Continued maintenance of the existing informal defence along the A47, no further improvements along the frontage. Existing standard of protection against tidal flooding will reduce as climate change impacts take hold in future years. Drainage system would become increasingly inundated by tidal waters at high tides that may result in flooding elsewhere if non-return devices have not been fitted.
3 Improve – flood walls only	<p>New flood walls would be constructed, tying into high ground. The walls will cross a number of existing wide vehicular and pedestrian access locations requiring demountable barriers to be installed. Some of the alignment adjacent to Lake Lothing is on top of the existing quayside. The suitability of the existing quayside to support the flood walls is a key area that would need addressing together with long term maintenance and replacement costs for the quaysides. Where flood walls do not follow the line of the quay they will typically follow existing land ownership boundaries.</p>  <p><i>Artist's impression of proposed flood walls adjacent to Station Square</i></p> <p>The existing Bascule Bridge presents a challenge. The configuration of the structure means that to secure flood protection above a level of 4.0mAOD and keep the bridge operational, cost prohibitive alterations to the structure would be required. The option considered is to tie flood walls into the abutments either side of the bridge. Install watertight doors to the abutment chambers and install lift up barriers across the carriageway on either side of the bridge. These demountable barriers would be required to be deployed when surge levels above 4.0mAOD were forecast and the A47 would need to be closed at this time.</p> <p>The key issues associated with this option include: service crossings, seepage under walls through existing quaysides, drainage system impacts, stability of existing quaysides, long-term maintenance of quaysides supporting flood walls, impact on port operations, impact on visual amenity, a tidal surge would still propagate through to the Broads' system at Mutford lock.</p> <p>Properties in the Oulton Broad and Mutford lock area would not benefit from any reduction in flood risk, hydraulic modelling suggests there would be an increase in residual flood risk. The use of property level protection would need to be considered for this community.</p>
5 Improve – 28m Bascule Bridge barrier and walls	<p>Option is the broadly the same as Option 3 for the flood walls located seaward of the Bascule Bridge. At the mouth of the channel the flood walls will tie into a tidal barrier structure. The barrier structure would prevent tidal surges from propagating into the inner harbour. With the barrier at this location the A47 would be able to remain open during surge events (up to the design event). The tidal barrier would reduce the impact of tidal flooding on the Broads' system. SOC stage hydraulic modelling indicated that localised ground raising would be required in Year 75 along South Quay to ensure the residual flood risk from the Broads did not overtop the banks of Lake Lothing. Revised hydraulic modelling at OBC stage indicated that these measures are not required, and the cost has therefore been removed from the economic analysis.</p>

Short listed Option	Option description and technical assessment
	<p>The tidal barrier needs to be a minimum of 28m wide to allow for future expansion of the inlet between the inner and outer harbour, with a barrier cill level that will not constrain the advertised dredge depth for the inner harbour. This option would involve demolition of a section of the southern pier that runs along the mouth of the entrance channel to Lake Lothing to accommodate the barrier structure.</p> <p>A feasibility study¹² identified that mitre gates were likely to be the most technically and economically viable option at this location, a thorough review was undertaken at OBC stage which confirmed this was still the case.</p> <p>Navigation simulations undertaken in 2021 confirmed that whilst navigation through the 28m barrier was possible, a risk of ship impacts with the barrier gates was highlighted. It is recognised that ship impacts with the existing quaysides do sometimes occur during navigation manoeuvres, particularly with the larger vessels that use the entrance channel when wind speeds are high. This would result in an increased frequency of repairs to the tidal barrier over its lifetime and in the worst case periods where the barrier is not able to operate. Mitigations for these events would include ABP placing temporary restrictions on the size of vessels allowed to transit the entrance channel when wind speeds exceed a certain threshold.</p>  <p><i>Artist's impression of proposed tidal barrier seaward of the Bascule Bridge in closed position</i></p> <p>Properties in the Mutford lock area will benefit from a reduction in tidal flood risk from the Lake Lothing side. However, tidal surges will still propagate through the Broads' system, entering via the mouth of the River Yare at Great Yarmouth. The economic analysis has identified three residential properties which remain at risk of tidal flooding to a depth of between 0.2m and 0.6m in 2117 (0.5% AEP 1in200yr event). Property Level Resilience measures may be appropriate to further reduce the risk of flooding to these properties in future years. There are other residential properties in the flood risk area which are located in elevated positions with the main dwelling area located above commercial properties. These properties are not eligible for PLR via GiA funding and do not count towards the outcome measure score. Commercial properties are also located within the Mutford lock area and further consideration of potential measures to improve their resilience to flooding should be given. The costs associated with any commercial property level resilience measures for the Mutford lock area have not been included in this appraisal as they would not attract funding from FCERM GiA or NALEP funding. Any future works to prevent a tidal surge entering the Broads' system at Great Yarmouth would help to alleviate this issue once the Lowestoft barrier is in place.</p> <p>In addition to the key issues identified for Option 3 those associated with the barrier include: Impact on navigation, closure timings, construction impacts, interaction with Bascule Bridge structure and resilience of structure to remain operational. Tidal surges can still propagate to Lowestoft (at reduced levels) via Oulton Broad through the Broads' system but revised OBC stage hydraulic modelling indicates the banks of Lake Lothing are not overtopped when considering a 1in200 year (0.5% AEP) tidal event in 2117.</p> <p>The length of demountable barriers, number of services crossings and number of outfalls to be treated would be significantly less than those for Options 3.</p>

Short listed Option	Option description and technical assessment
9 Improve - 40m Bascule Bridge barrier & walls	<p>This is a new option introduced for the 2022 OBC which has a tidal barrier at the same location as Option 5 near the Bascule Bridge but with a 12m wider barrier to reduce the risk of ship impacts (and associated costs and environmental effects of repairs) compared to Option 5, increasing the resilience and therefore reliability of the gates and further reducing restrictions place on the future development of the Lake Lothing entrance channel. As with Option 5, new tidal flood walls and flood gates would be constructed around the perimeter of the outer harbour, tying in to existing coastal defences to the north and south, and tying into the new barrier just downstream of the Bascule Bridge. This option would involve demolition of a section of the southern and northern piers that run along the mouth of the entrance channel to Lake Lothing and reconstruction of the pier 12m further north to accommodate the wider barrier.</p> <p>Due to a different construction approach, the 40m barrier allows the opportunity for unconstrained construction where works are no limited to relatively short seasonal possessions of the entrance channel. This could reduce the construction programme from 6 years to 3 years resulting in a significant construction cost saving.</p>

Environmental assessment

At SOC stage a detailed a SEA Environmental Report (annex to PEIR Appendix H1) was produced, assessing the potential environmental impacts, in combination effects and identifying enhancement opportunities for all shortlisted options. Strategic WFD and HRA assessments were also completed (Appendix H2 and H4 respectively). A Preliminary Environmental Information Report (Appendix H1) and revised WFD and HRA assessments have also been produced for the preferred option. Table 3.5 summarises the key environmental effects and opportunities for the revised shortlisted tidal options and has been refreshed for the preferred option (Option 5), highlighting any changes as a result of the more detailed assessment. **Please note: property numbers given in Table 3.5 are based on the assessment made at SOC stage and differ from OBC stage.**

Please note: the environmental appendices were produced based on assessment of a 28m barrier for shortlisted Option 5 to support the 2018 OBC and this section has not been updated to include the larger 40 m barrier size for Option 9. Given the location of the barrier is the same, it is determined that the effects would not be materially different to those stated in the appendices, although it is likely that the increased size of the barrier could affect the magnitude of some of the effects by, for example, making the barrier more visible and resulting in more dredged material requiring disposal. Conversely, the likely lower frequency of ship impacts for the larger barrier for Option 9 will result in a lower frequency of environmental effects of associated repairs (e.g. noise and disturbance of marine fauna).

Table 3.5 Key environmental effects and opportunities (tidal)

Option 1: Do nothing & Option 2: Do minimum – maintain	
Key positive effects	None identified
Key negative effects	<p>Under a do-minimum option, 128 (648 by 2115 including climate change) (SOC stage) residential properties will be at risk of flooding in 0.5% chance of flood occurring (i.e. a 1in200 year), of which 127 (544 by 2115 including climate change) (SOC stage) properties are located in the 20% Most Deprived Wards.</p> <p>Effects will be exacerbated for more vulnerable members of the population that will be less physically able to respond to a flood event or financially recover.</p> <p>All landfill sites will be at risk from a 0.5% chance of occurring (i.e. a 1in200 year) in 2115 (with climate change).</p> <p>The low level of protection the options will provide will result in increase in the risk of contaminates entering the waterbodies adversely affecting water quality and</p>

	potentially deteriorating hydromorphology, ecological quality/quantity as well as substrate quantity/quality which could lead to homogeneity in habitat structure. Flood water percolation into the underlying ground waterbody could also increase risk of exposure to contaminants. For Option 1, the effect is likely to be exacerbated by the potential introduction of significant quantities of additional saline water into the Broads, through Oulton Broad as the Mutford lock will remain open under this option. This will severely affect the habitats and water quality (locally) but not for the wider Bure and Waveney and Yare and Lothing water bodies.
Mitigation or enhancement opportunity	None identified
Option 3: Improve – flood walls only	
Key positive effects	<p>Minimises risk of flooding to most properties north and south of Lake Lothing, but will not reduce the risk for properties west of Lake Lothing.</p> <p>Option is likely to protect features within Lake Lothing Area Action Plan boundary.</p> <p>Likely to reduce flood risk to locally designated areas, which may result in positive benefits such as limited disturbance to the habitat of terrestrial flora and fauna of these sites, including reed beds, willow and intertidal mudflats.</p> <p>Flood risk at known landfill sites is likely to be reduced.</p> <p>Flood risk to conservation areas and the listed buildings likely to be reduced.</p>
Key negative effects	<p>Presence of defence walls is likely to affect physical and visual access to the river/coast from various locations along the proposed wall.</p> <p>Flood risk in Lake Lothing AAP proposed areas is likely to be reduced, however, during construction and future operation there is likely to be significant impact on port operations, therefore potentially affecting employment and commercial activities.</p> <p>Significant construction material resources will be consumed and construction is likely to generate waste.</p> <p>Option increases risk of contaminants entering the waterbodies adversely effecting water quality. Proposal could affect macroalgae through algae removal operations to facilitate construction and loss of invertebrates under the footprint of the new defences. Should piling construction be used for the defence structures, risk of saline intrusion into the underlying ground waterbody exists.</p>
Mitigation or enhancement opportunity	<p>Potential use of glass topped walls where required, adaptive approach where possible to limit the height and impact of flood walls initially where possible.</p> <p>Continue engagement with local businesses to assess and minimise the impact on business operations of proposed alignments and flood gate locations.</p>
Option 5: Improve – Bascule Bridge barrier and walls	
Key positive effects	<p>Only three residential properties (SOC stage) are likely to be at risk by comparison to 128 residential properties (SOC stage) that are at risk in a 0.5% chance of flood occurring (i.e.a 1in200 year).</p> <p>Option will reduce risk to the whole of the Lake Lothing AAP area, improving investor confidence therefore attracting inward investment.</p> <p>Option will help continue port activities during its operation phase. This will avoid the loss of revenue, working days and disruption resulting from flooding with positive benefits to the local economy.</p> <p>Flood risk to transport infrastructure will be reduced, such as the Lowestoft Station, the railway line and A12 / A47 road.</p> <p>Option reduces flood risk to locally designated sites for 1 in 200 probability of a flood event occurring in any one year up to year 2115 with climate change scenario which may result in positive benefits such as limited disturbance to the habitat of terrestrial flora and fauna of these sites.</p>
Key negative effects	<p>Short term construction impacts may affect port activities and must be mitigated with appropriate programme interventions.</p> <p>There are potential impacts (i.e. disturbance) to marine mammals resulting from construction activity.</p> <p>Construction activity could result in disruption to recreational users of the harbour and Lake Lothing, while in-harbour works are undertaken.</p>

	There are potential adverse noise and vibration effects that could result from piling and other construction activities, which could affect local residents in the surrounding areas.
Mitigation or enhancement opportunity	Further stage Environment Impact Assessment should identify appropriate mitigation measures to address the potential impact. Continue engagement with local businesses to assess and minimise the impact on business operations of proposed alignments and flood gate locations.

PEIR (2018)

A single PEIR (Appendix H1) has been prepared to consider all components (tidal, pluvial and fluvial flood measures) of the LFRMP the following text is summarised from its executive summary.

The PEIR identified that the LFRMP will provide significant benefits to Lowestoft by reducing flood risk to people, property and the environment and unlocking new opportunities for economic investment and regeneration. The development of the project has provided opportunities for the people of Lowestoft to engage with their town and environment, involving schools and local communities in developing aspects of the projects. It also presents specific opportunities to enhance views and landscape character along the banks of the harbour and around the port area.

The receptors and features that are likely to be affected by the construction or operation of the LFRMP have been identified. The key issues, risk and opportunities (i.e. whether potentially significant or uncertain) are identified in Table 1 of the PEIR (Appendix H1). These are considered in terms of the LFRMP as a whole and each component part. A precautionary approach has been taken to ensure a 'worst case' situation was considered and all reasonably foreseeable actions are identified, pending further discussions/agreement with the MMO, Defra and other statutory bodies/stakeholders. Other identified issues not considered to be potentially significant have been 'scoped out' from further assessment.

The PEIR also identified that the potential for cumulative or in-combination effects of the tidal barrier scheme with other plans and projects (e.g. the Lake Lothing Third Crossing), as well as with the other elements of the LFRMP need to be considered further, in particular during the EIA of the tidal barrier scheme.

Given the limited potential for impacts from the proposed property resilience measures, further consideration is not included within this PEIR and no formal environmental assessment is recommended.

The actions recommended to address the identified issues include:

- Consultation with affected statutory bodies, landowners and stakeholders to obtain additional data, discuss potential impacts and mitigation;
- Further surveys, to be agreed with the MMO/statutory bodies: e.g. in-channel habitat and invertebrate surveys, baseline noise surveys; bat roost assessment; sediment analysis;
- Baseline analyses: e.g. fish populations, hydrodynamics and processes, in-channel sediment sample data;
- Modelling, if agreed with the MMO/statutory bodies: e.g. two-dimensional hydrodynamic modelling, sediment plume modelling and groundwater flow modelling;
- Identification and development of appropriate mitigation measures – whether inbuilt within the project proposals or additional. Many of the identified issues can be addressed through good construction practices.
- A statutory EIA for all the scoped in issues relating to the tidal barrier scheme (as shown in Table 1).

Next steps

Subject to funding and technical approvals and pending further discussions/agreement with statutory bodies, the recommended further environmental assessments will be undertaken.

The EIA of the tidal barrier scheme and the [technical assessments needed to provide supporting information for the TWAO and other consents](#) have commenced with draft documents and assessments in development. These draft documents are not at a stage where that can be shared outside of the project team and are therefore not included in the appendices of this document.

The following points outline the key environmental deliverables currently being developed for the tidal barrier:

- [Environmental statement](#)
 - This develops the work that was done for the 2018 PEIR. There is no intention to update the 2018 PEIR.
 - A working draft of the environmental statement has been produced, and is being developed by the project team, it is not intended that this would be made 'public' until a more formal consultation stage (pre-TWAO submission).
- [Habitat Regulations Assessment](#)
 - A working draft of this has been produced. This includes an appropriate assessment for the scheme.
 - The intention is that the working draft would be discussed with Natural England. It would be released for formal consultation in line with the ES above.
- [Water Framework Directive](#)
 - A working draft has been produced, we would be looking to have discussions with stakeholders on this over the coming months, with a view to a more formal consultation in line with the ES above.

The design of various project components will continue to be developed in parallel with the environmental assessment processes. This iterative approach will enable potential adverse impacts to be avoided or reduced and opportunities for environmental improvements to be identified.

HRA Assessments (2018)

HRA assessments have been completed at both SOC and OBC stages. The SOC stage assessment (Appendix H2) considered all strategic options and concluded that all strategy options, either alone or in combination with other plans or projects, would have no likely significant effect on the European Sites and no further assessment is required under The Conservation of Habitats and Species Regulations 2010 (as amended). The HRA report (SOC stage) has been consulted upon with Natural England, who have confirmed that they agree with the above findings.

The OBC stage assessment (Appendix H3) considered the preferred options for each element of the LFRMP (tidal, pluvial and fluvial) and concluded that for most of the sites and their qualifying features there will either be no likelihood of any significant effects occurring or any effects would be trivial with respect to the site Conservation Objectives. This conclusion means that there is no requirement to assess potential in-combination likely significant effects with other plans and projects. However, a likely significant effect of the tidal barrier scheme, alone, has been identified on harbour porpoise, the only feature of the Southern North Sea SCI/cSAC. The information to inform the appropriate assessment has concluded that, with incorporated mitigation measures, it will be possible to avoid a conclusion of adverse effects on the integrity

of the Southern North Sea SCI/cSAC from the LFRMP alone. However, this needs to be corroborated by examination of the detailed noise and vibration levels that the works are likely to generate, once they are available. Likewise, the report has not been able to conclude the absence of in-combination effects at this stage because of the need for this level of information and in the absence of confirmed programmes for any of the in-combination projects (principally the Third River Crossing).

WFD assessments (2018)

WFD assessments have been completed at both SOC and OBC stages. The SOC stage assessment (Appendix H4) considered all strategic options and concluded that the proposed strategy was not predicted to cause deterioration in waterbody status or prevent the waterbody from meeting its objectives and therefore further assessment against the conditions listed in Article 4.7 is not required. Therefore, the Strategy is compliant with WFD, and no further assessment is required. Further stages of the Strategy should however re-evaluate the risk to the waterbodies when further engineering details become available.

The OBC stage WFD assessment (Appendix H5) considered the preferred option and concluded that the works associated with delivering the proposed tidal barrier requires further detailed assessment of the potential impacts on the transitional and coastal WFD waterbodies due to the extent and nature of the works. This will be completed and included as part of the ongoing environmental impact assessment as a Detailed WFD Assessment.

The effect of the tidal flood walls has been assessed and it is considered unlikely that there would be any significant effects due to the proposed walls. The works would be mainly set-back from the edge of the waterfront. Therefore, the tidal flood walls have been assessed as not likely to lead to the deterioration in the status of the Bure & Waveney and Yare & Lothing transitional WFD waterbody or the two downstream coastal WFD waterbodies. They would also not prevent the WFD waterbody from achieving Good status in the future. As a consequence, no further assessment is deemed necessary for this element of the Proposed Project and it is considered compliant with the WFD legislation. Table 3.6 summarises the assessment and identifies the waterbodies considered.

Table 3.6 Edited extract from WFD assessment (2018), Appendix H5 (Table 4.1: Scoping of project components for detailed assessment and Section 5)

Project component	Element	Scoped in or out?	Relevant WFD water body(s)
Tidal	Tidal barrier (construction and operation)	Scoped in – potential effect on transitional WFD waterbody as a consequence of the new concrete foundation structure and gate, including changes to flow and sediment processes during operation of the structure	Bure & Waveney and Yare & Lothing transitional WFD waterbody Suffolk & Norfolk East coastal WFD waterbody Broadland Rivers Chalk & Crag WFD groundwater
	Tidal flood walls (construction and operation)	Initially Scoped in as new flood walls along the edge of the transitional WFD water body. Scoped Out following further consideration as the proposed works are mainly set back from the waterbodies considered and located in existing port/harbour areas.	Bure & Waveney & Yare & Lothing transitional WFD waterbody Broadland Rivers Chalk & Crag WFD groundwater

3.5. Economic appraisal (Tidal)

The economic assessment of the shortlisted tidal defence options has been undertaken in line with the requirements of FCERM-AG. The Lowestoft tidal economic technical memorandum (Appendix E1) details the economic analysis undertaken in relation to the tidal element of this project. The economic analysis was

updated for the 2022 OBC to fully consider and determine the most economically advantageous standards of protection from an FCERM-GIA point of view. In the interests of cost efficiency the hydraulic modelling used to inform the economic analysis has not been updated for the 2022 OBC. Revised climate change and coastal flood boundary data have been published since the hydraulic modelling was completed in 2017. To consider if these updates have a material impact on the appraisal a sensitivity analysis has been undertaken with the findings summarised in Section 3.9.

The technical memorandum giving full details of the economic analysis methodology together with supporting calculation summary sheets are contained within Appendix E1, with a summary presented in the sections below.

It was identified early in the appraisal process that Option 9 was not cost beneficial in terms of the FDGIA economic analysis, it was therefore excluded from the economic analysis to identify the economically preferred option (national economic option).

Option Standard of Protection

Do something Options 3 and 5 were assessed to determine the most economically advantageous SoP. Further detail on this assessment and the associated option costing approach can be found in Appendix E1 and E2 respectively.

Benefits

Table 3.7 summarises the present value damages (PVd) and present value benefits (PVb) that can be attributed to each of the short listed tidal options together with the key qualitative benefits associated with each option. To take into account the potentially reduced in reliability and resilience of the 28m barrier option when compared to the 40m barrier or walls only option a 15 reduction in total benefits has been applied to the PV benefits used to assess the 28m barrier option. Further detail of this approach is included in the Economic technical report (appendix E1).

Table 3.7 – Tidal summary of option damages and benefits

Option	Damage (PVd) £k	Damage avoided £k	Benefits (PVb) £k**	Probability of 100% of benefits being realised	Adjusted Benefits (PVb) £k**	Key additional non-monetised benefits
1 Do nothing	148,720					None
2 Do minimum – maintain	148,720	0	0	1.00	0	None
3a Improve – flood walls only - 1in20 year (5% AEP)	82,936	65,784	67,600	1.00	67,600	Minimises disruption to navigation through Inner Harbour entrance channel during construction.
3b Improve – flood walls only - 1in75 year (1.33% AEP)	66,432	82,288	84,567	1.00	84,567	
3c Improve – flood walls only - 1in200 year (0.5% AEP)	61,271	87,449	89,845	1.00	89,845	
3d Improve – flood walls only - 1in500 year (0.2% AEP)	41,632	107,088	109,549	1.00	109,549	
5a Improve – 28m Bascule Bridge barrier & walls- 1in75 year (1.33% AEP)	34,375	114,345	116,820	0.99	115,652	Enables Bascule Bridge and the A47 trunk road to remain operational during a tidal event. Enables rail links into Lowestoft to remain operational. Reduces impact of tidal flooding on Broads' system.
5b Improve – 28m Bascule Bridge barrier & walls - 1in100 year (1% AEP)*	33,666	115,054	117,536	0.99	116,361	
5c Improve – 28m Bascule Bridge barrier & walls - 1in200 year (0.5% AEP)	30,829	117,891	120,401	0.99	119,197	
5d Improve – 28m Bascule Bridge barrier & walls - 1in500 year (0.2% AEP)	29,061	119,659	122,188	0.99	120,966	

Option	Damage (PVd) £k	Damage avoided £k	Benefits (PVb) £k**	Probability of 100% of benefits being realised	Adjusted Benefits (PVb) £k**	Key additional non-monetised benefits
9 Improve – 40m Bascule Bridge barrier & walls - 1in200 year (0.5% AEP)	30,829	117,891	120,401	1.00	120,401	As Option 5 with the addition of increased resilience and enabling future adaptation pathways for growth and economic development of Lowestoft.

*Interpolated values based on trend analysis.

**Including human health intangibles

The differing levels of PVd and PVb provided by options with the same stated relative SoP is due to the relative length of the flood walls over which tidal water would overtop in events exceeding the design level. In addition, the study area includes properties that do not receive or partially receive a reduction in flood risk from the do something options. These include commercial properties surrounding the outer and inner harbours and residential and commercial properties in the Mutford lock area.

Table 3.8 provides a summary of the key do nothing damage categories and the damages associated with each category, including potential damages associated with tourism were this to be included in the appraisal.

Table 3.8 PV damages – Do nothing damage categories and values.

Damage Category	PV Do Nothing Damages (100yr appraisal period) (£ million)
Residential Building, content and clean up (Direct)	19.7
Vehicle damages	1.9
Temporary and alternative accommodation	2.2
Non-Residential Building, content and clean up (Direct)	75.6
Non-Residential Indirect	2.1
Risk to life	9
Emergency response and recovery	23.2
Mental Health	6.3
Roads	5.7
Rail	0.5
Electrical substation - electricity loss	2.4
Sub Total	148.7
Tourism / Reputational Damage*	194

* Tourism benefits not included in economic analysis

Table excludes intangible health benefits (these are benefits, not damages)

Option costs

Base option cost

Costs for the shortlisted tidal options have been updated following detailed development of the new wider barrier option introduced since the 2018 OBC (Option 9 – 40m Bascule Bridge Barrier and Walls). The tidal flood wall element of Option 9 is complementary to all other 'Do Something' options and construction of these walls has progressed as a package of advanced works utilising funding that was secured and not linked to the financial approval of the 2018 OBC.

To inform detailed consultation with key stakeholders about the Option 9 (40m) tidal barrier in preparation for the development of a TWAO application and to develop greater level of cost certainty a staged approach to the detailed design underway. The 15% detailed design has been used to inform the options costing of this barrier presented in this economic analysis as well as its operation and maintenance requirements.

The SCAPE delivery contractor undertook detailed costing of Option 9 in December 2021, with the assistance of other specialist suppliers. Unit rates from these costing exercises were then used to update the previous costs for Option 3 and 5 which were originally developed for the 2018 OBC

Table 3.9 Costing and risk basis for shortlisted options

Option	Costing basis			Risk register	
	Outline design	Detailed costing	Benchmarked cost elements	Quantative & residual OB	Pro-rata
3 – Improve – flood walls only - 1in200 year (0.5% AEP)	Part	Part	Some	Part	Part
5 – Improve – 28m Bascule Bridge barrier & walls - 1in200 year (0.5% AEP)	Yes	Yes	None	Yes	None
9 – Improve – 40m Bascule Bridge barrier & walls 1in200 year (0.5% AEP) Constrained and unconstrained delivery.	Yes	Yes	None	Yes	None

Detailed option costs were produced for delivering each shortlisted option to a 1in200 year (0.5% AEP) SoP in 2117. To assess the most economically advantageous SoP, a review of the defence alignments required to provide different SoP's was undertaken. This concluded that they remained unchanged from the 1in200 year (0.5% AEP) SoP due to the relatively flat topography and limited scope to tie the defences into high ground. Therefore, only the defence crest level would vary between the SoP's considered. To generate option costs for the alternative SoP's a percentage reduction or uplift was applied to the base option cost. Further detail is included in the option costing technical note (Appendix E2) which outlines the approach in more detail.

Adaptive approach

A managed adaptive approach has been applied to the delivery of the options at locations where it was considered advantageous to do so for both economic and environmental impact reasons. The managed adaptive approach has been applied in the following locations:

- Tidal flood walls along Waveney Road (all shortlisted options)
- Tidal flood walls along Lake Lothing (Option 3)
- The provision of demountable barriers and flood gates (all shortlisted options)

As part of the adaptive approach tidal flood walls would initially be constructed to the required crest level for 50 years' time, at or just before this point, they would be raised to provide the required SoP for the next 50 years. The foundations and groundwater cut-off of the wall would be suitable for the complete 100-year asset life.

For the demountable barriers and flood gates, these typically have a 50-year asset life and would be provided to the level required to provide the SoP for the life of the asset. As for the adaptive tidal flood wall sections, the foundations and groundwater cut-off will be constructed for a 100-year asset life. This approach will generate efficiency in the initial capital cost as well as the operation and maintenance costs of the assets. The only negative being where they are situated in a non-adaptive wall section, they will limit the overall SoP provided along that section. Further detail on the approach to costing the adaptive approach is included in the Tidal Options Costing Note (Appendix E2)

O&M costs

Following detailed development of the preferred options, there is greater certainty on the whole life O&M requirements. The Environment Agency's whole life costing workbook has been used as the basis of calculating the O&M costs for the options, supplemented by input from specialist suppliers with particular attention to the tidal

barrier structure. A schedule of anticipated operational and maintenance activities for the tidal barrier is provided in Appendix F18 which has been used to inform the whole life costing of the tidal barrier. Benchmarking has been undertaken to compare the anticipated O&M requirements and costs against similar barrier structures in addition to taking into account the specific requirements of the barrier structure proposed for Lowestoft.

Present values

Costs have all been discounted over the 100 year appraisal period (using the Treasury variable discount rate) to generate a Present Value Cost (PVC) for each option. The present value and cash costs for all options considered in the detailed economic analysis are given in Table 3.10a, a more detailed breakdown of key options PV whole life costs is given in Table 3.10b.

Table 3.10a - Summary of tidal options whole life PV & cash costs (£k)

Option	PV Cost including risk (50 th ile & residual OB) (£k)	Cash Cost including risk (50 th ile & residual OB) but excluding inflation (£k)
Option 1 - Do nothing	0	0
Option 2 - Do minimum – maintain	472	1,703
Option 3a - Improve – flood walls only 1in20 year (5% AEP) SoP	151,092	179,529
Option 3b - Improve – flood walls only 1in75 year (1.33% AEP) SoP	151,752	180,213
Option 3c - Improve – flood walls only 1in200 year (0.5% AEP) SoP	155,710	184,319
Option 3d - Improve – flood walls only 1in500 year (0.2% AEP) SoP	162,308	191,162
Option 5a - Improve – 28m Bascule Bridge barrier & walls 1in75 year (1.33% AEP) SoP	94,897	141,948
Option 5b - Improve – 28m Bascule Bridge barrier & walls 1in100 year (1% AEP) SoP*	95,118	Not calculated
Option 5c - Improve – 28m Bascule Bridge barrier & walls 1in200 year (0.5% AEP) SoP	96,005	143,149
Option 5d - Improve – 28m Bascule Bridge barrier & walls 1in500 year (0.2% AEP) SoP	98,773	146,151
Option 9LCU - Improve – 40m Bascule Bridge barrier & walls 1in200 year (0.2% AEP) SoP Un-constrained delivery	135,461	190,901
Option 9LCC - Improve – 40m Bascule Bridge barrier & walls 1in200 year (0.2% AEP) SoP Seasonally constrained delivery	141,621	200,699

*Interpolated values based on trend analysis.

Table 3.10b – Detailed summary of key tidal options whole life (PV) costs (£k)

PV Costs including risk (95 th ile and residual OB) (£k)	Option 1 - Do nothing	Option 2 - Do minimum – maintain	Option 5c - Improve – Bascule Bridge barrier & walls 1in200 year (0.5% AEP) SoP*	Option 9LCU - Improve – 40m Bascule Bridge barrier & walls 1in200 year (0.2% AEP) SoP Un-constrained delivery	Option 9LCC - Improve – 40m Bascule Bridge barrier & walls 1in200 year (0.2% AEP) SoP Seasonally Constrained delivery	Option 3c - Improve – flood walls only 1in200 year (0.5% AEP) SoP*
Cost Item						
Existing staff costs	0	0				
Consultants' fees	0	0				
Contractors' fees	0	0	13,109	13,109	13,109	29,530
Site investigation and survey	0	0				
Site supervision	0	0				
Construction	0	0	42,270	67,216	73,714	102,426
Adjusted optimism bias barrier	0	0	1,815	3,258	3,755	
Adjusted optimism bias walls	0	0	1,898	1,882	1,882	14,057
Risk contingency (50 th ile)	0	0	21,253	32,698	32,698	
Legal and stakeholder fees	0	0	* Included above	* Included above	* Included above	* Included above
Subtotal	0	0	80,345	118,163	125,158	146,013
Future costs (construction and maintenance)	0	363	12,046	13,307	12,665	7,460
Optimism bias	0	109	3,614	3,992	3,800	2,238
Project total (present-value) costs	0	472	96,005	135,462	141,623	155,711

Option ranking and economic appraisal conclusion

Table 3.11a presents the findings of the economic analysis of tidal options when partnership funding contributions are excluded from the calculation, as mentioned above Option 9 is excluded from this table as it did not achieve a BCR of greater than 1 and therefore could only be considered as a Local Choice option as presented in Table 3.11b. The analysis confirms that the option with the highest average BCR is Option 5 – 28m tidal barrier and flood walls BCR of 1.2. None of the Option 3 permutations achieve a BCR of greater than 1 and are therefore rejected from further consideration.

Applying the appraisal decision-making criteria, the options with the highest benefit-cost ratio are the Bascule Bridge barrier & walls options where Options 5a, 5b, 5c and 5d all have a BCR of greater than 1 (1.2). The option with the highest NSPV is “Option 5c Bascule Bridge barrier & walls – 1 in 200 year (0.5% AEP)”. The next option that provides greater benefits (option 5d) does not achieve the required iBCR of greater than 5. Indicating that “**Bascule Bridge barrier & walls – 1 in 200 year (0.5% AEP)**” is the nationally economically preferred option.

It is therefore recommended that Option 5c Bascule Bridge barrier and walls providing a SoP of 1in200 year (0.5% AEP) is taken forward as the most economically advantageous and the National preferred economic option on which any FCERM GiA

entitlement will be based. There are no other overriding factors that affect economic option selection.

However, it is the intention of ESC that the Local Choice Option 9 40m tidal barrier and tidal flood walls will be taken forward for delivery subject to sufficient additional partnership funding being secured.

Further detail can be found on the Tidal Economic Appraisal Note (Appendix E1) and the tidal appraisal summary sheet (Appendix F14).

Table 3.11a – Tidal Option ranking and appraisal summary (excluding contributions)

Option	Present Value costs (£k)	Present Value damages** (£k)	Present Value benefits (£k)*	Average benefit: cost ratio (BCR)	Net Social Present Value NSPV (£k)	Incremental benefit: cost ratio (IBCR)	Option for incremental calculation
1 Do nothing	0	148,720	N/A	N/A	N/A	N/A	N/A
2 Do minimum – maintain	472	148,720	N/A	N/A	N/A	N/A	N/A
3a Improve – flood walls only - 1in20 year (5% AEP)	151,092	82,936	67,600	0.4	-83,492	BCR ≤1	N/A
3b Improve – flood walls only - 1in75 year (1.33% AEP)	151,752	66,432	84,567	0.6	-67,185	BCR ≤1	N/A
3c Improve – flood walls only - 1in200 year (0.5% AEP)	155,710	61,271	89,845	0.6	-65,865	BCR ≤1	N/A
3d Improve – flood walls only - 1in500 year (0.2% AEP)	162,308	41,632	109,549	0.7	-52,759	BCR ≤1	N/A
5a Improve – Bascule Bridge barrier & walls - 1in75 year (1.33% AEP)	94,897	34,375	115,652	1.2	20,755	N/A	N/A
5b Improve – Bascule Bridge barrier & walls - 1in100 year (1% AEP)	95,118	33,666	116,361	1.2	21,243	N/A	N/A
5c Improve – Bascule Bridge barrier & walls - 1in200 year (0.5% AEP)	96,005	30,829	119,197	1.2	23,192	Highest NSPV	N/A
5d Improve – Bascule Bridge barrier & walls - 1in500 year (0.2% AEP)	98,773	29,061	120,966	1.2	22,193	0.6	Option 5c

*Including human health intangibles

** Tourism and amenity benefits and reputational damages are excluded from all options

Economically preferred option highlighted in green

Table 3.11b – Local Choice Tidal Option ranking and appraisal summary (excluding contributions)

Option	Present Value costs (£k)	Present Value damages** (£k)	Present Value benefits (£k)*	Average benefit: cost ratio (BCR)	Incremental benefit: cost ratio (IBCR)	
5c*	Improve – 28m Bascule Bridge barrier & walls - 1in200 year (0.5% AEP)	96,005	30,829	119,197	1.2	N/A
9LCU	Option 9LCU - Improve – 40m Bascule Bridge barrier & walls 1in200 year (0.2% AEP) SoP Un-constrained delivery	135,461	30,829	120,401	0.9	0
9LCC	Option 9LCC - Improve – 40m Bascule Bridge barrier & walls 1in200 year (0.2% AEP) SoP Seasonally constrained delivery	141,621	30,829	120,401	0.9	0

* Option 5c included for comparison

** **Tourism and amenity benefits and reputational damages are excluded from all options**

3.6. Non-financial benefits appraisal (Tidal)

The shortlisted options were appraised based on economic, technical, environmental and social factors and considering the feedback from key stakeholders and public consultation. To assist in the appraisal of options and assess the impacts on a number of key objectives including non-financial benefits, an Appraisal Summary Tables (AST) was produced during the Outline Business Case, these are included in Appendix F14.

3.7. Impacts on the regional economy (Tidal)

The Port of Lowestoft has played a key role in the nation's energy security for over 45 years and its location places it at the centre of the world's largest offshore renewable energy market. As a result, it will be serving up to £16billion of wind energy projects (over half of the total UK investment) that will be delivered before 2030 and will continue to support the operation and maintenance for over 30 years. However, the critical transport and utilities infrastructure is at significant risk of tidal flooding, as was proven during the 2013 storm surge which resulted in weeks of disruption.

Wider economic benefits

The Lowestoft Economic Footprint and Impact Report [was revised in 2022](#) (Appendix F3) to consider the wider impacts of flooding on the local Lowestoft economy and the economic growth benefits that tidal flood protection would provide.

The study found that the current economic footprint of project benefit area is estimated to provide **6,400 direct jobs** and generates £342m of annual GVA. When indirect and induced benefits are included, this increases to **8,300 jobs and £443m GVA** per year. Although the indirect and induced effects are not necessarily located in tidal flood plain area, they depend on it – such as businesses supplying the renewable energy sector operations. [The study found that the future economic footprint of the area could support 12,000 direct jobs which could generate £641m of annual GVA, increasing to 15,600 Jobs and £833m GVA per year when indirect and induced benefits are considered.](#)

The study concluded that that under the current flood risk management conditions (Do minimum) with no formal tidal defences **30%** of jobs and **30%** of GVA within the current economic footprint of Lowestoft are impacted in a 0.5%AEP (1in200yr) tidal flood event. Once climate change is considered the level of impact increased **62%** and **62%** respectively. The provision of tidal defences to the 0.5% AEP standard

would reduce this impact to **6% for the current economic footprint and 22% for the future economic footprint when climate change is taken into account.**

In addition, the decline of previous industrial operations has left a legacy of large areas of derelict waterfront land and severe social challenges. Partly due to the costs of site-level flood mitigation to reduce the risk of flooding to a 1 in 200 level necessary to make commercial development viable, flood risk is significant barrier to business growth and job creation. Therefore, by addressing flood risk, the LFRMP will significantly reduce the likelihood of severe direct and indirect economic impact and unlock future growth and investment. As a result, studies show that the LFRMP will support the **generation of 5,600 additional direct jobs locally and 1,700 indirect and induced jobs nationally. It will also support the generation of an additional £299m GVA in the area per year.**

Future development of the local economy was also considered, and the report concluded that the construction of tidal flood defences 'Will lessen the likelihood of economic devastation as well as removing potential barriers to growth and investment by current and future businesses in the area.'

Whilst this assessment is not considered in the national economic analysis undertaken for this FCERM business case it is a critical driver for other sources of funding and is a key piece of supporting evidence for the NALEP funding business case (Appendix N2) illustrating the wider benefits of providing flood risk reduction to Lowestoft.

3.8. Preferred economic option (Tidal)

The appraisal of tidal options has confirmed that Option 5c – Bascule Bridge barrier and walls with a 1in200 year (0.5% AEP) SoP is the most economically advantageous and the **national economic preferred option** for the management of tidal flood risk in Lowestoft.

Table 3.12 summarises the outcome measures associated with the implementation of Option 5c with a 1in200 year (0.5% AEP) SoP and considering the 95%ile QRA risk plus adjusted optimism bias. Full details are included in the tidal partnership funding calculator included in Appendix A1.

Table 3.12 – Nationally Economically Preferred tidal option Outcome Measures (costs with 95%ile risk and adjusted OB)

Contributions to applicable outcome measures	Value
Outcome 1 – Ratio of whole-life benefits to costs	
Present value benefits (£k)	119,197
Present value costs (£k)	112,881
Benefit: cost ratio (Partnership Funding Calculator BCR)	1.1
Outcome 2 – Households and NRP at reduced risk	
rOM2A - Number of households better protected against flood risk (today)	226
rOM2A.b - Number of households moved from the 'very significant', 'significant' or 'intermediate' flood risk bands to lower flood risk bands	126
rOM2A.c - Number of households moved out of the 'very significant', 'significant' or 'intermediate' flood risk bands to lower risk bands in the 20% most deprived areas	125
rOM2A.PLP - Number of households moved from the 'very significant', 'significant' or 'intermediate' flood risk bands to lower flood risk bands through PLP measures	-
rOM2B - Additional households better protected against flood risk in 2040 (adaptation)	42
rOM2B.b - Additional households moved from the 'very significant', 'significant' or 'intermediate' flood risk bands to lower flood risk bands in 2040 (adaptation)	-
rOM2B.c - Number of households moved out of the 'very significant', 'significant' or 'intermediate' flood risk bands to lower risk bands in 2040 in the 20% most deprived areas (adaptation)	-
rOM2.NRP - Number of non-residential properties better protected against flood risk	152

Contributions to applicable outcome measures	Value
rOM2A.NRP - Number of non-residential properties better protected from flood risk (today)	137
rOM2B.NRP - Number of non-residential properties better protected from flood risk in 2040	15
Partnership funding & FCERM-GiA	
Raw Score	10%
Partnership contribution required to achieve 100% (capital Investment) (£k)	87,804
FCERM-GiA available (assuming partnership contribution achieved) (£k)	9,418

3.9. Sensitivity analysis (Tidal)

The tidal economic analysis assessed a number of sensitivity tests as part of the economic analysis further detail is included in the Section 6.1 of the Tidal Economic Appraisal Note (Appendix E1). The main observation was that costs would have to increase (or benefits reduce) by a factor of 6% to become uneconomic with a BCR below 1. This would be an increase in cost (or reduction in benefits) of £6.3 million.

PF calculator sensitivity

The partnership funding calculator includes a number of sensitivity tests detailed in Table 3.13.

Table 3.13 – Tidal preferred option outcome measures sensitivity tests

PF calculator sensitivity test	Raw score
Main scenario	10%
Sensitivity 1 - Change in PV Whole Life Cost (25% increase)	N/A*
Sensitivity 2 - Change in OM2 - 50% of households in Very Significant (Before) risk may already be in Significant Risk band	10%
Sensitivity 3 - Change in OM3 - 50% of households in Medium Term loss (Before) may already be in Long Term loss	N/A
Sensitivity 4 - Increase Duration of Benefits by 25%	10%
Sensitivity 5 - Reduce Duration of Benefits by 25%	10%
Sensitivity 6 - Strategic considerations not demonstrated	4%
Sensitivity 7 - Change in environmental habitat optimistic	N/A

* Reduces BCR to 0.9 so does not qualify for PF GiA

These sensitivity tests indicate that the project is most susceptible to an increase in PV whole life costs where a 25% increase in cost would result in a reduction of the BCR (PF calculator) to 0.9 and therefore does not qualify for PF GiA. The risk of this scenario occurring has been mitigated thorough through option delivery costing, taking a conservative assessment of whole life costs and making robust risk allowances.

Threshold level sensitivity

The sensitivity of the economic analysis to changes in threshold levels of +/- 0.1m considered. The impact this change was indicated to be changes in total benefits of +15% and -19%. A reduction in benefits of 19% would reduce the PF BCR to 0.9 and an increase of 15% would increase the PF BCR to 1.2.

Climate change and CFB change Sensitivity

Climate change guidance and the coastal flood boundary data set have both been updated since the projects hydraulic modelling was initial completed in 2017. In the interests of efficiency, it was agreed that a sensitivity analysis would be undertaken to consider the relative impacts of these changes on the project's economic analysis. Detailed discussion of this sensitivity test can be found in Section 6.1.1 of the Tidal

Economic Appraisal Note (Appendix E1). This sensitivity test concluded that whilst it was not possible to quantify the precise effect of these changes on the benefits calculation on balance it is likely there is a small overestimation of the damages due through the continued use of the 2017 modelling. Given the fact the economic analysis has omitted a number of benefit categories in the assessment in the interests of proportionality it is considered that the current assessment is considered to be lower-bound. In particular should a small percentage of the excluded recreational benefits be included in the analysis this could balance a slight reduction due to change in model boundary conditions. It is also considered that the change of modelled boundary conditions would have no significant impact on the selection of the nationally economically preferred option.

Sensitivity to tidal surges

As mentioned in the Strategic Case (Section 2.1) Lowestoft's Low tidal range makes the town increasingly vulnerable to the effects of tidal surges. Recent studies (inc. Assessment of tidal range changes in the North Sea from 1958 to 2014. *Journal of Geophysical Research: Oceans*¹³) have indicated that observed changes in the North Sea amphidromic point locations due to greater mean depth combined with impacts of surges and climate change impacts could impact Lowestoft more than most other locations. This could result in increased extreme water levels as the effects of climate change become more pronounced. Further detailed assessment would need to be completed to fully understand these potential impacts. As noted above the sensitivity to sensitivity for thresholds levels indicated a decrease of -0.1m (or increase in water level of +0.1m) would generate an additional £17.9m of benefits. Whilst this would not make the local choice options cost beneficial it strengthens the position of the nationally preferred economic option.

3.10. Local Choice

As mentioned above, ESC has selected a local choice option to deliver a 40m wide tidal barrier and flood walls to provide an increased level of resilience to the tidal barrier and lessen future constraints on future changes to the Lake Lothing entrance channel. In line with Local Choices framework under the PF policy, the additional costs for delivering the Local choice option over the national economically preferred option need to be funded entirely through contributions.

The project will deliver National Government outcomes for at least six Government Departments and contribute significantly to the growth of the economy.

The scheme aims to underpin the wider development of Lowestoft port as a central hub for marine and offshore industry notably supporting an accelerated delivery programme for Associated BP LEEF project and as a marine transport hub for the Sizewell C nuclear power station (national infrastructure project).

The selection of a 40m wide tidal barrier for delivery over the 28m barrier option delivers a number of additional benefits that cannot be fully represented in the FCREM economic appraisal:

- Increases the resilience and reliability of the tidal barrier when considering ship impacts.
- Creates adaption pathways to future proof the Port by placing less of a restriction on any potential future widening of the Lake Lothing entrance channel, enabling future growth opportunities for the Port and Lowestoft.

¹³ Jänicke, L., Ebener, A., Dangendorf, S., Arns, A., Schindelegger, M., Niehüser, S., Haigh, I. D., Woodworth, P. and Jensen, J., 2021. Assessment of tidal range changes in the North Sea from 1958 to 2014. *Journal of Geophysical Research: Oceans*, 126(1), p.e2020JC016456.

Delivery of the 40m barrier also provides an opportunity for an accelerated delivery approach which has been referred to as the unconstrained delivery option (Option 9LCU). This brings with it the following additional benefits:

- Reduces the programme for completion of the tidal defences by 2 years, reducing the period that Lowestoft does not benefit from a reduction in tidal flood risk. Reducing the risk to both property and people's health.
- Projected delivery efficiency of £6.5m in PV terms and £9.9m in cash terms
- Accelerated delivery of the tidal defences supports the delivery of the ABP LEEF project.

Whilst the local choice options are shown to have BCR's of less than 1, consideration has been given to potential benefits that have not been included in the economic appraisal. As detailed in the Tidal Economics report (Appendix E1) A potential benefits pool of £194m (PV) associated with the Tourism and reputational damages (principally reputational damage) has been identified but not included due to approximate nature and subjectivity around the assessment. A rough calculation indicates that inclusion of 11% of these potential damages as benefits would be sufficient to provide the unconstrained delivery local choice option (Option 9LCU) with a BCR of greater than 1.

4. The pluvial fluvial FRM economic case

The pluvial fluvial works (Option 6) have been completed since the 2018 OBC was assured with works to reduce the impact of pluvial flooding (surface water) completed in December 2021 and works to reduce the risk of fluvial (river) flooding were completed in July 2021. The fluvial works were delivered as planned and inline with the information outlined in the sections below. Due to a lower than expected uptake of PLR (pluvial) measures by residents and property owners PLR measures were installed in 120 properties. Example photographs of the completed pluvial and fluvial works are included in Appendices C6.

The text below remains the same as in the 2018 OBC and **has not been updated** with financial values and the economic assessment unchanged from the original submission.

4.1. Introduction (Pluvial Fluvial)

The development and economic appraisal of the pluvial fluvial element of the project is fully documented in the Pluvial Fluvial Options¹⁴ and Economic Analysis¹⁵ reports (Appendix F1 and E4 respectively), the following sections present the key information from this reporting which builds on work undertaken at SOC stage in the Lowestoft Drainage Strategy - Pluvial / Fluvial Options Report¹⁶ (Appendix F19). As stated in Section 3.2, the pluvial fluvial and tidal economic cases have been separated to improve clarity of the relative benefits and funding sources.

¹⁴ Pluvial fluvial options report, JBA, 2018

¹⁵ Pluvial fluvial economic appraisal Report, JBA, 2018

¹⁶ Lowestoft Flood Risk Management Strategy, Lowestoft - Fluvial / Pluvial Options Report, Atkins, Dec 2016

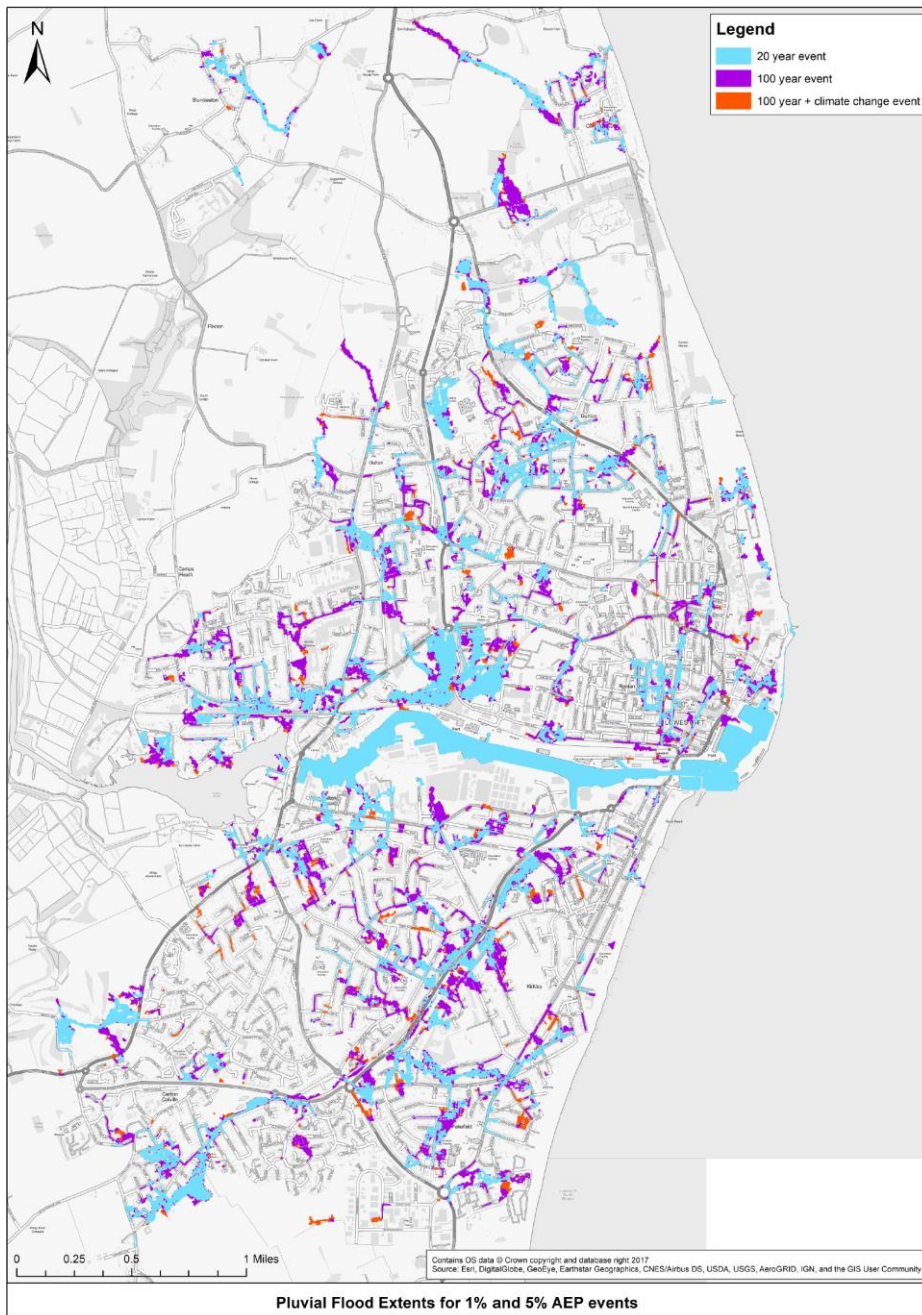


Figure 4.0 pluvial flood extents in study area

4.2. Critical success factors (Pluvial Fluvial)

The factors in Table 4.1a have been used to inform the assessment of the pluvial/fluvial flood defence options considered in this OBC these have been significantly refreshed since SOC stage.

Table 4.1a Critical Success factors – Pluvial/Fluvial

No	Critical Success Factor	Measurement Criteria	Importance (1-5)
1	Strategic fit and business needs	<ul style="list-style-type: none"> Adapting to climate change. Delivery of strategic management plan Publicly supported. 	1
2	Value for money	<ul style="list-style-type: none"> Protect and enhance the local economy by avoiding flood damage to residential and commercial properties, economic assets, and infrastructure. Positive Net Present Value. Increase the life-span of adjacent properties and assets. 	2

3	Potential achievability	<ul style="list-style-type: none"> Local authority capacity to produce and manage the project. Key project stakeholders are supportive of proposals, giving positive feedback. Community are aware and understand project drivers and timescales. 	3
4	Supply side capacity	<ul style="list-style-type: none"> Supply side capability to deliver affordable solution within the timeframe. 	4
5	Potential affordability	<ul style="list-style-type: none"> Achievable within government funding. Further efficiency savings identified as the preferred option is further developed. 	5

The options report also identifies a second set of specific objectives for the management of pluvial fluvial flood risk included in Table 4.1b.

Table 4.1b Pluvial/Fluvial specific objectives

No	Fluvial/Pluvial Outline Business Case Objectives
1	Reduce the risk of household flooding.
2	Support amenity and regeneration in Lowestoft.
3	Maintain and enhance natural, historic, visual and built environments.
4	Promote sustainable management of existing watercourses and drainage networks.
5	Ensure an affordable and deliverable whole life option through a partnership approach and contributions.
6	Ability to secure funding.

4.3. Long list options (Pluvial Fluvial)

A number of options were considered for the management of pluvial fluvial flood risk in Lowestoft. Options 1 to 15 focused primarily on fluvial flooding in the area around The Street in Carlton Colville, Tom Crisp Way and Aldwyck Way and Velda Close. Options 16 to 19 focused primarily on reducing flooding from pluvial sources in the Lowestoft area, with particular attention to areas identified to be at risk. These are summarised in Table 4.2. Further information/detail can be found in the Options Report (Appendix F1).

Table 4.2 – Pluvial/Fluvial Long list of options

Option	Description	Flood Mechanism	Short list or rejection
Do Nothing	No maintenance of existing systems	Fluvial and Pluvial	Shortlist (baseline for economics)
Do minimum	Continue to maintain existing drainage systems	Fluvial and Pluvial	Shortlist (baseline)
LL_01	Create new storage and restrict flows	Fluvial	Shortlist Option 1
LL_02	Additional storage in existing green spaces	Fluvial	Shortlist Option 1
LL_03	Re-routing of the watercourse	Fluvial	Shortlist Option 1 and 2
LL_04	Reducing flows from upstream watercourses	Fluvial	Shortlist Option 1
LL_05	Throttle flows to use capacity in existing drainage system	Fluvial	Rejected
LL_06	Creation of embankments	Fluvial	Shortlist Option 2
LL_07	Installing a two-stage channel in Kirkley Stream	Fluvial	Shortlist Option 1 and 2
LL_08	Earlier operation of surface water pumps	Fluvial	Shortlist Option 2
LL_09	Increasing capacity of existing storage areas	Fluvial	Shortlist Option 1
LL_10	Removal of silt and re-grading of the watercourse	Fluvial	Rejected
LL_11	Install non- return valves on the network.	Fluvial	Shortlist Option 4
LL_12	Not used	Not used	-
LL_13	Installing local mitigation measures	Fluvial	Shortlist Option 5
LL_14	Optimising throttles in the river	Fluvial	Shortlist Option 2

Option	Description	Flood Mechanism	Short list or rejection
LL_15	Strategic non-return valves and underground storage	Fluvial	Shortlist Option 4 (NRV's only)
LL_16	Offline storage in the public sewer system	Pluvial	Rejected
LL_17	Increased conveyance in the public sewer system	Pluvial	Rejected
LL_18 & LL_19	Implementation of SuDS (20% & 40 reduction in impermeable are in each TARZ).	Pluvial	Shortlist Option 3

A detailed description of why options were shortlisted or rejected can be found in sections 4.3 and 4.4 of the pluvial fluvial options report (Appendix F1).

At SOC stage the benefit of utilising a tidal barrier for water level management to reduce the period of tide locking for the Kirkley Stream and other outfalls was considered. It was rejected due to significant impacts on navigation and the tidal regime within Lake Lothing, this option was not re-considered at OBC stage.

4.4. Shortlisted options (Pluvial Fluvial)

Overview

The five shortlisted improvement options for providing pluvial fluvial flood defence to Lowestoft taken forward following consultation and agreement with the project's key stakeholders are listed in Table 4.3 with a summary description of each option. Further detail describing each option can be found within the Lowestoft Fluvial/Pluvial Options report which is included in Appendix F1.

Table 4.3 – Pluvial/Fluvial short list of options

Short listed Option	Option Description
Do minimum – maintain	Continued maintenance of the existing drainage network as is currently undertaken.
1 Storage (Fluvial)	Increase the storage capacity along the Kirkley Stream. Long list options 1, 2, 3, 4, 7 and 9 were progressed and included in the shortlisted option 1, which focuses on storage of storm water. Long list options 1, 3, 4 and 9 produced beneficial results to lower flood risk and long list option 2, although it did not show any specific benefit in flood risk reduction was included to investigate linkage with wider strategic storage option.
2 Conveyance (Fluvial)	Increasing conveyance of water along the Kirkley Stream. Conveyance (Fluvial): long list options 3, 6, 7, 8 and 14 were progressed and included in short list option 2 which focuses on increasing fluvial conveyance. Long list options 6 and 7 showed limited benefit and long list option 14 did not bring benefits but these options were considered as part of a wider strategy.
3 SUDS (Pluvial)	Sustainable Urban Drainage Systems SuDS (Pluvial): long list options 18 and 19 were progressed to shortlist options 3a and 3b, focusing on the implementation of SuDS to reduce impermeable areas by 20% and 40% respectively. Both long list options showed significant flood risk reduction and were therefore investigated further as part of a shortlisted option.
4 Non return Valves (Fluvial)	Installing non-return valves (to reduce the risk of water from Kirkley Stream backing up into the drainage network). long list option 15 showed no benefit, however, the use of non-return valves was decided to be investigated further as a widespread use.
5 Property Level Resilience (PLR)	Local mitigation measures such as property level resilience measures long list option 13 involves local mitigation measure and would, by nature, benefit each property where these would be installed.




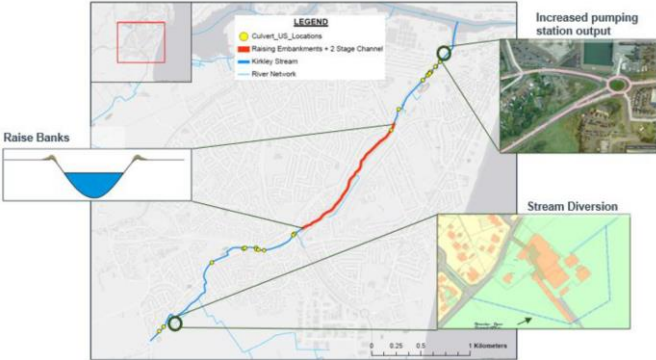
Technical assessment

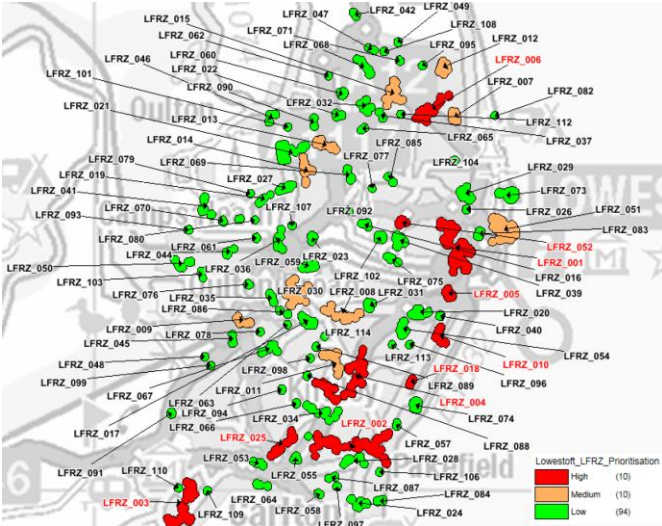
Table 4.4 contains a summary of the technical description of options for the reduction of pluvial fluvial flood risk. This table is summarised from Section 5 (Options Appraisal

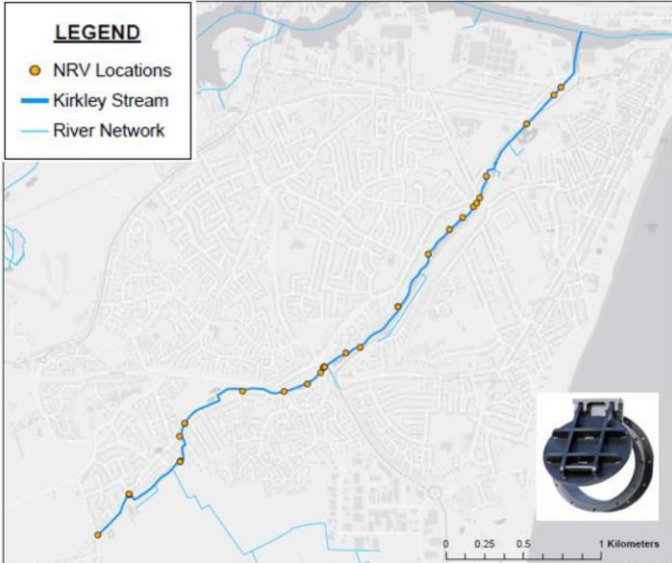
and Comparison) of the Pluvial Fluvial Options Report Appendix F1). Further non-technical details of the shortlisted options can be found within the Lowestoft FRMP public consultation document (Appendix G2).




Table 4.4 – Technical description of Pluvial/Fluvial short list of options

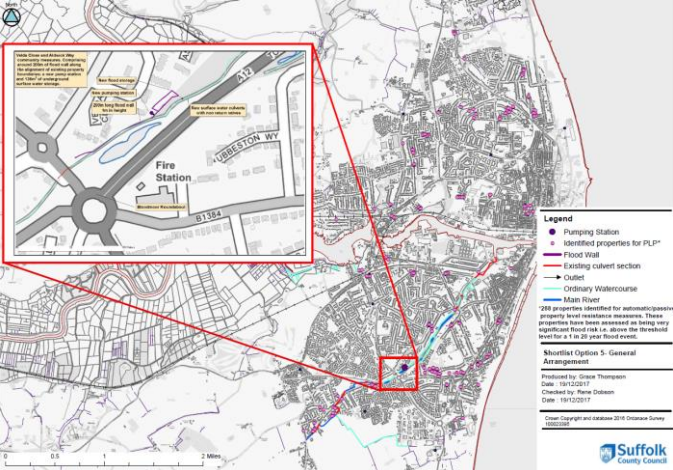
Shortlisted Option	Option Technical Description and Technical Assessment	Taken forward / rejected
Do minimum – maintain	Continued maintenance of the existing pluvial fluvial drainage systems.	<i>Option taken forward as baseline</i>
1 Storage (fluvial)	<p>The option seeks to increase of storage along the Kirkley Stream through the construction of following:</p> <ul style="list-style-type: none"> • Construct 3,400m³ of storage in Meadow Park as offline flood storage.  <ul style="list-style-type: none"> • Construct 15,100m³ of storage upstream of Carlton Colville  <ul style="list-style-type: none"> • Implement a two stage channel from Bloodmoor Roundabout to the New Road bridge.  <ul style="list-style-type: none"> • Re-establish the maximum design capacity in the existing storage area off Tom Crisp Way. 	<i>Option rejected.</i>

Shortlisted Option	Option Technical Description and Technical Assessment	Taken forward / rejected
	 <p>Although technically feasible, the land needed to incorporate sufficient flood storage is not available at this time. The two-stage channel option is also technically feasible, but the environmental impact would be detrimental and is therefore rejected.</p>	
2 Improve conveyance (fluvial)	<p>The option involves the following components to increase conveyance along the Kirkley Stream:</p> <ul style="list-style-type: none"> Divert the Kirkley Stream around Belle Vue Farm. The new culvert (2000mm x 2000mm) connects into the existing tributary to the south of the existing route. Diverted flow reconnects downstream into the Kirkley Stream.  <ul style="list-style-type: none"> Raise river banks on the Kirkley Stream from the Bloodmoor Roundabout to New Road bridge totalling 2.98km.  <ul style="list-style-type: none"> Upsize 27 culverts along Kirkley Stream by 25%. Increase Kirkley Stream terminal pumping station output capacity from 1.2m³/s to 5.35m³/s 	Option rejected.

Shortlisted Option	Option Technical Description and Technical Assessment	Taken forward / rejected
	<p>The diversion of the Kirkley Stream around Belle Vue Farm is technically feasible as an open channel but increases flows routed to Low Farm Drive and therefore flood risk. This option could only be completed in conjunction with the flood storage considered and rejected in Option 1. The sub-options to create new flood embankments and increase the capacity of 27 culverts is not technically feasible as there is insufficient space to construct the structures. However, the hydraulic modelling of increased capacity of the Kirkley Stream pump station did not show any damages averted and was therefore rejected.</p>	
<p>3a & 3b SUDS (Pluvial)</p>	<p>Options 3a and 3b seek to reduce the amount of impermeable area which generates runoff from entering the existing sewer system by 20% and 40% respectively through the implementation of SuDS. As part of the OBC options appraisal, further investigation into the opportunities available for SuDS was undertaken.</p> <p>The technical assessment of replacing impermeable surfaces with permeable surfaces, was completed focusing on the following points:</p> <ul style="list-style-type: none"> • Identification of Target Area Reduction Zones highlighted in the Drainage Strategy prepared for the SOC. • Estimation of impermeable areas within them using the Lowestoft Mastermap in ArcGIS. • Differentiation of impermeable areas within roads and buildings and identification of potential areas for the implementation of SuDS such as roads with existing green verges, large commercial buildings, parking spaces or green spaces where surface water could be routed for formal and informal temporary storage. • Estimation and review of the proportion of impermeable area reduced by the implementation of the highlighted SuDS opportunities in each TARZ.  <p>Option 3 (SuDS retrofit) options are not technically feasible options as only around 10% to 15% impermeable area could be retrofitted into permeable areas among the flood risk zones and Option 4 did not show any damages averted</p>	<p><i>Options rejected.</i></p>
<p>4 Non-return Valves (fluvial)</p>	<p>Option 4 included the incorporation of non-return valves on all surface drainage outfalls along the Kirkley Stream to prevent river locking of the drainage network or back flow into the drainage network and causing flooding. 29 NRVs were therefore added to the OBC model and reviewed.</p>	<p><i>Options rejected.</i></p>

Shortlisted Option	Option Technical Description and Technical Assessment	Taken forward / rejected
	 <p>The hydraulic modelling indicates that there is no direct benefit of implementing non-return valves on all surface drainage outfalls. This option was therefore rejected.</p>	
5 Property Level Resilience (PLR)	<p>Option 5 looks at the introduction of Property Level Resilience on a large scale to protect properties that fall within the very significant flood risk banding. The technical assessment of this option included a desk study complemented by a site visit inspection to validate potential local scheme feasibility and investigate areas where information was missing. It was proposed that in areas where Property Level Resilience was proposed for multiple properties there would be potential to install community schemes that could mitigate against local surface water flood risk and provide wider benefits.</p>	<p><i>Option taken forward as Option 6 when combined with 5b.</i></p>

Shortlisted Option	Option Technical Description and Technical Assessment	Taken forward / rejected
	 <p>PLR property Locations</p> <p>This option is potentially technically feasible subject to confirmation by detailed property surveys. The measures need to be effective against short duration high intensity rainfall events, which are difficult to predict and have very little advanced warning. Therefore, the PLR needs to be an automatic/passive system that operates without the need for assembly.</p>	
<p>5b Community scheme at Velda Close and Aldwyck Way</p>	<p>Fourteen sites with potential for community schemes were identified as part of a desk study for Option 5b and their practicability and suitability assessed during a site survey. The on-site investigations revealed that none were obviously suitable with the exception of properties at Velda Close and Aldwyck Way.</p>  <p><i>Artist's impression of fluvial wall from Aldwyck way carpark</i></p>  <p><i>Artist's impression of fluvial wall from footbridge adjacent to Bloodmoor Road towards Velda Close properties.</i></p>	<p><i>Option taken forward Option 6 when combined with 5.</i></p>

Shortlisted Option	Option Technical Description and Technical Assessment	Taken forward / rejected
	<p>A number of options and configurations were considered for Velda Close and Aldwyck Way. The technical assessment indicates that the preferred scheme is direct defence along the Kirkley Stream, approximately 200m long by around 1m high (top of existing bank level), with a pump station with a capacity of around 300 l/s.</p>  <p>The map displays the proposed flood wall and pump station along Kirkley Stream. Key features include: <ul style="list-style-type: none"> Pumping Station: Located near the intersection of Velda Close and Aldwyck Way. Flood Wall: A red line indicating the proposed defence along the stream. Existing culvert section: Shown as a dashed line. Outlet: Indicated by an arrow pointing towards the stream. Ordinary Watercourse: Shown as a blue line. Main River: Shown as a thick blue line. A legend in the bottom right corner provides details on the symbols used. It also notes that 288 properties are identified for automatic-passive property level resilience measures. The map is titled 'Shortlisted Option 5 - General Arrangement' and includes a scale bar and the Suffolk County Council logo.</p>	

Full details of the technical assessment of the shortlisted options is presented in Section 5 of the Pluvial Fluvial Options report (Appendix F1). Annex B of the options report presents the Options Appraisal Summary Table which highlights the key technical differences between the shortlisted options.

Environmental assessment

At SOC stage a detailed a SEA Environmental Report (annex to Appendix H1) was produced, assessing the potential environmental impacts, in combination effects and identifying enhancement opportunities for all shortlisted options. Strategic WFD and HRA assessments were also completed (Appendix H3 and H5 respectively). Further option development at OBC identified an additional shortlisted option (Option 6 – PLR and Velda Close wall). A Preliminary Environmental Information Report (Appendix H1) and revised WFD and HRA assessments have also been produced for the preferred option. Table 4.5 summarises the key environmental effects and opportunities for the revised shortlisted pluvial fluvial options and has been refreshed for the preferred option, highlighting any changes as a result of the more detailed assessment, please note that with the exception of Option 6, reference to property numbers is based on SOC stage and differ from OBC stage. This is not considered to be of concern as these options were removed from the shortlist for other technical reasons as detailed in the Options Report (Appendix F1).

Table 4.5 – Key environmental effects and opportunities (pluvial fluvial)

Shortlist option 1: Storage (fluvial) (SOC option – 1 Upstream storage)	
Key positive effects	<p>Option is likely to reduce flood risk to three commercial (SOC stage) and one residential (SOC stage) properties for a 1in75 year return period (and one commercial and two residential properties, for a 1in75 year RP+ climate change). As the benefit is only partial, a minor positive effect has been predicted.</p> <p>Storage may provide opportunities for habitat improvement/enhancement, positively affecting biological elements for example by providing an offline refuge for fish or improving opportunities for aquatic invertebrates. These improvements depend on the design specification but adverse effects to waterbodies are not anticipated.</p>
Key negative effects	<p>Where upstream storage is proposed at Carlton Colville, dependent on current land use (if for farming) and the proposed design, the option may affect farming practice for a small population, details of which are not known at this stage therefore uncertain effect</p>

	(as part of split assessment) predicted against economic development objective. (uncertain effect). Southern part of the area is within the Hundred Tributary Valley Farmland Landscape Character Area; effect of the storage facility on this area will be dependent on the design. (uncertain effect).
Mitigation or enhancement opportunity	Potential for habitat creation as part of storage areas.
Shortlist option 2: Improving conveyance (Fluvial)	
Key positive effects	None identified
Key negative effects	Although the option will reduce flood risk to nine residential properties (SOC stage) and six 'other' type properties, it is likely to introduce risk of flooding to eight residential (SOC stage) properties for a 1in75 year RP; similarly, in a 1in75 year RP+ climate change, the option might increase the risk of flooding to 13 residential properties, but reduce the risk to some 22 residential properties, minor positive impact in the long term, but negative and positive effect in the short to medium term. Short term negative effect on biodiversity to vegetation clearance and disturbance to habitats may occur.
Mitigation or enhancement opportunity	Consideration could be given to the river restoration techniques, where compatible with the option aim of improving conveyance.
Shortlist option 3a: Sustainable Drainage Systems (Pluvial - 20% permeable surface)	
Key positive effects	Option 3a (20% reduction) is likely to reduce the risk of flooding to 57 residential (SOC stage) and three commercial (SOC stage) properties for a 1in75 year RP and for 54 residential and nine commercial properties for a 1in75 year RP + climate change, therefore minor positive effect predicted for the population and human health and economic development objectives. Proposed option is likely to help reduce risk of flooding to key infrastructure such as the A12 and A117, Wellington Esplanade (B1532), A146/B1531, A146/Bridge Road and on the access road to Oulton Broad South Rail Station and part of the A12, linking to the Outer Harbour area and to the Lowestoft Station.
Key negative effects	LFRZs 001, 004, 007, 008, 009 and 052 are known to contain historic landfill sites. Dependent on the location and works involved to construct and maintain SUDS, the proposed option might have a neutral or a negative effect on the land contamination objective (assuming without appropriate mitigation).
Mitigation or enhancement opportunity	Habitat creation as part of SUDS system may be possible depending on the systems used.
Shortlist option 3b: Sustainable Drainage Systems (Pluvial - 40% permeable surface)	
Key positive effects	Option 3b (40% reduction) is likely to reduce the risk of flooding to 150 residential (SOC stage) and 27 commercial properties (SOC stage) for a 1in75 year RP and for 56 residential and nine commercial properties for a 1in75 year RP + climate change. This implies significant positive effect in the short to the medium term, but in the long term (with climate change) both options appear to provide similar benefits in terms of property protection, therefore minor positive predicted for Option 3b in the long term under the population and human health and economic development objectives. Proposed option is likely to help reduce risk of flooding to key infrastructure such as the A12 and A117, Wellington Esplanade (B1532), A146/B1531, A146/Bridge Road and on the access road to Oulton Broad South Rail Station and part of the A12, linking to the Outer Harbour area and to the Lowestoft Station. Due to scale and coverage of SUDS, this option is likely to support species and habitats at local nature reserves/ county wildlife sites, Habitats of Principal Importance of wood pasture and parkland in the Carlton Manor area and the priority habitat area of deciduous woodland.
Key negative effects	LFRZs 001, 004, 007, 008, 009 and 052 are known to contain historic landfill sites. Dependent on the location and works involved to construct and maintain SUDS, the proposed option might have a neutral or a negative effect on the land contamination objective (assuming without appropriate mitigation).
Mitigation or enhancement opportunity	Habitat creation as part of SUDS system may be possible depending on the systems used.

Shortlist option 4: Non-return Valves Fluvial (SOC option 4 Non-return Valve installation)	
Key positive effects	Option 4 is likely to reduce impact on one commercial/ tourism related property for a 1in75 year RP scenario, minor positive effect on economic development.
Key negative effects	Although the option will reduce flood risk to two residential properties, it is likely to introduce risk of flooding to one residential property at in a 1in75year RP, but the risk in a 1in75 year RP+ climate change increases to three residential properties with no risk reduction to any property; therefore, not supportive of the population and human health objective for the short-term and the long-term.
Mitigation or enhancement opportunity	None identified
Shortlist option 5a: Local mitigation – Property Level Resilience	
Key positive effects	Assuming the Property Level Resilience (passive) features function correctly, the proposed option is likely to reduce the risk of flooding to 274 residential properties (SOC stage, 281 at OBC stage), and ten commercial properties (SOC stage) representing a significant reduction therefore assigned major positive effect. If historic buildings benefit from PLR, the option will be supportive of the Cultural Heritage objective.
Key negative effects	None assessed
Mitigation or enhancement opportunity	None assessed
New combined Option 6: Property Level Resilience & Community scheme at Velda Close and Aldwyck Way	
Description	This option was not considered at SOC stage and was introduced at OBC stage as a combination of shortlisted Options 5 and 5a. Shortlist option 5a was developed following revised hydraulic modelling undertaken at OBC stage. Further detail of the environmental assessment of this option is contained within the PEIR (Appendix H1) and is summarised below.

PEIR & HRA

A single Preliminary Environmental Information Report (Appendix H1) and HRA (Appendix H3) have been prepared to consider all components of the LFRMP, i.e. tidal, fluvial and pluvial. The key findings of this relevant to all LFRMP components are summarised in Section 3.4 of this OBC.

WFD Assessments

WFD assessments have been completed at both SOC and OBC stages. The SOC stage assessment (Appendix H5) considered all strategic options and concluded that the proposed strategy was not predicted to cause deterioration in waterbody status or prevent the waterbody from meeting its objectives and therefore further assessment against the conditions listed in Article 4.7 is not required. Therefore, the Strategy is compliant with WFD, and no further assessment is required. Further stages of the Strategy should however re-evaluate the risk to the waterbodies when further engineering details become available.

The OBC stage WFD assessment (Appendix H5) considered the preferred option and concluded that the works associated with delivering the fluvial pluvial preferred option would not lead to any significant effects on the WFD waterbodies and have therefore been scoped out of further assessment. Table 4.6 summarises waterbodies in the assessment and identifies the waterbodies considered.

Table 4.6 Extract from WFD assessment, Appendix H5 (Table Error! No text of specified style in document..2: Scoping of project components for detailed assessment)

Project component	Element	Scoped in or out?	Relevant WFD water body(s)
Fluvial	Flood walls along Kirkley Stream from Bloodmoor roundabout culvert for 200m downstream (construction and operation)	Scoped out – the flood walls would be set back from the channel bank. There would be some removal of riparian vegetation, however, re-planting is proposed along the slope face. If during construction the channel bank were to be altered, it would be reinstated as per the baseline conditions	Waveney (Ellingham Mill - Burgh St. Peter) fluvial WFD water body Broadland Rivers Chalk and Crag WFD groundwater
	New pumping station - below ground (construction and operation)	Scoped out – set back from the banks of Kirkley Stream. There would be a new discharge point to the watercourse, but this is highly unlikely to lead to any significant effects to the channel or at a WFD waterbody scale. Therefore, no further assessment has been deemed as required for this scheme element	Waveney (Ellingham Mill - Burgh St. Peter) fluvial WFD waterbody Broadland Rivers Chalk & Crag WFD groundwater
	New flood storage area - below ground (construction and operation)	Scoped out – the water tank is proposed to be located at a level of 0.1m AoD beneath a car park. The water tank would be sealed and therefore it would be highly unlikely to have any significant effect at a WFD waterbody scale on groundwater	Broadland Rivers Chalk and Crag WFD groundwater
Pluvial	Direct defences at 281 properties across Lowestoft. The detail is to be confirmed but could include: flood doors, water proofing, water resisting air bricks, non-return gullies and valves and internal sump pumps (construction and operation)	Scoped out – would be unlikely to lead to any direct or indirect effects to surface watercourses or groundwater as a consequence of localised improvements around individual properties	Not applicable

4.5. Economic appraisal (Pluvial/Fluvial)

The economic appraisal undertaken for the pluvial fluvial options appraisal is contained within the Economic Appraisal Report (Appendix E3).

Options assessed

Further option assessment was undertaken, considering in detail each shortlisted option's suitability against the critical success factor and the technical practicalities of delivery to determine if each shortlisted option should be taken forward for outline design and economic appraisal. Further detail is presented in Section 1.5 of the Option Appraisal Report (Appendix E4), and Table 4.4 above.

Table 4.6 summarises the key option parameters that were taken forward for outline design and economic analysis.

Table 4.6 – Pluvial Fluvial final option description

Shortlisted Option	Option detail for appraisal
No Nothing	-
Do Minimum	-
5 Property Level Resilience	Property Level Resilience to 281 residential properties at risk from a 1in20 year flood. PLR options are assumed to apply to properties in the Very Significant flood risk band; assumed to be the 1in20 year flood for the purposes of this assessment. This restriction is based on partnership

Shortlisted Option	Option detail for appraisal
	funding guidance that does not allow grant in aid for properties in the Significant or Moderate flood risk bands.
6 PLR & Community scheme at Velda Close and Aldwyck Way	PLR for 281 residential properties plus a formal flood defence to protect properties at risk in Aldwyck Way and Velda Close

Benefits

The assessment of damages and benefits was undertaken in line with the requirements of FCERM-AG and further detail can be found in Section 5 of the Options Appraisal Report (Appendix E4).

The PV damages and benefits associated with each of the shortlisted options taken forward for economic appraisal are presented in Tables 4.7a and 4.7b, considering a 20 year and 100 year appraisal period respectively. The 20 year appraisal period was considered as it aligns with the duration of benefits for Option 5 (PLR) and to allow for the replacement of the PLR measures at the end of the appraisal period.

Table 4.7a – Pluvial Fluvial option (PV) damages and benefits 20 year appraisal period

Option	Damage (PVd) (£k)	Damage avoided (£k)	Benefits (PVb)
- Do nothing	31,787	-	-
- Do minimum – maintain	29,251	2,536	2,536
5 Property Level Resilience	17,463	14,324	14,324
6 Property Level Resilience and Community scheme at Velda Close and Aldwyck Way	17,410	14,377	14,377

Table 4.7b – Pluvial/Fluvial option (PV) damages and benefits 100 year appraisal period

Option	Damage (PVd) (£k)	Damage avoided (£k)	Benefits (PVb)
- Do nothing	52,460	-	-
- Do minimum – maintain	47,726	4,733	4,733
5 Property Level Resilience	23,516	28,944	28,944
6 Property Level Resilience and Community scheme at Velda Close and Aldwyck Way	22,393	30,067	30,067

Costs

The assessment of pluvial fluvial options costs is detailed fully in Section 3 of the Economic Appraisal report (Appendix E4), the following sections are summarised from this report. Costs were developed in consultation with project partners and through early contractor involvement.

Baseline

Do minimum baseline costs maintenance costs have been considered in the appraisal as follows:

- Inspection and channel clearance costs of £2,500/km/year. As the reach length is 700m long, this suggests a value of £1,725/annum.
- Periodic channel dredging based on recorded costs of £50,000 for a one-off clearance. This has been assumed to occur every 5 years under the Do Minimum option.

Scheme Costs

The total estimated cost of supplying and fitting the PLR measures is £2,392,715 including the following:

Enabling costs

- £5,000 for public engagement and surveyor procurement
- £126,450 for property surveys (at £450/property)
- £5,000 for procurement and management of contractor

PLR purchase and installation costs

- £2,392,810 for supply and fitting of PLR measures

Additional items for supervision, designer's supervision, GE book and risk derived by Balfour Beatty have also been included. Inflation costs have been omitted from the economic appraisal.

The estimated cost for the Velda Close defence is £500,600. In addition, an enabling cost for design and appraisal has been assumed of £110,000. Additional items for supervision, designer's supervision, GE book and risk have also been included.

Present Values

The costs have all been discounted over a period of 100 years (using the Treasury variable discount rate) to generate a Present Value Cost for each option, including initial capital investment and whole life maintenance costs. Where the 100 year appraisal period is considered, asset replacement (PLR) is included every 20 years. The present value whole life costs are given in Tables 4.8a and 4.8b for the 20 year and 100 year appraisal periods respectively. These include risk allowance in line with current Environment Agency risk management guidance which is further discussed in Section 3.2 of the Economic Appraisal Report (Appendix E4).

Table 4.8a – Summary of pluvial fluvial options whole life present value (PV) costs (£k) 20 year appraisal period (Table 3-2, JBA pluvial fluvial options report (Appendix F1))

Cost element	Cash Costs (£k)	PV Costs (£k)	PV Costs with Optimism Bias (£k)
Do Minimum O&M	£408	£289	£289
Do Minimum total			£291
PLR Enabling	£136	£136	£150
PLR Capital	£3,378	£3,263	£3,596
PLR O&M	£84	£59	£65
PLR Total			£3,811
Combined Enabling	£246	£246	£278
Combined Capital	£4,084	£3,946	£4,455
Combined O&M	£371	£262	£295
Combined Total			£5,029

Table 4.8b – Summary of pluvial fluvial options whole life present value (PV) costs (£k) 100 year appraisal period (Table 3-3, JBA pluvial fluvial options report (Appendix F1))

Cost element	Cash Costs (£k)	PV Costs (£k)	PV Costs with Optimism Bias (£k)
Do Minimum O&M	£2,035	£588	£764
Do Minimum total			£764
PLR Enabling	£136	£136	£150
PLR Capital (reoccurs every 20 years)	£13,085	£5,576	£6,145
PLR O&M	£294	£128	£141
PLR Total			£6,437
Combined Enabling	£246	£246	£278

Cost element	Cash Costs (£k)	PV Costs (£k)	PV Costs with Optimism Bias (£k)
Combined Capital	£13,902	£6,259	£7,067
Combined O&M	£2,015	£572	£646
Total Combined scheme			£7,991

Option ranking and economic appraisal conclusion

Tables 4.9a to 4.10b summarise information presented in Sections 5.7 and 5.8 of the Pluvial/Fluvial Options Report (Appendix F1). These tables present option rankings in terms of the 20 and 100 year appraisal periods considered in addition to the impact of contributions secured against Option 6. This economic analysis assumes 100% uptake of PLR measures, sensitivity testing has been undertaken to consider a reduced take up of the measures, this is discussed in detail in section 7.3 of the Economic Appraisal Report (Appendix E4). The 100 year duration of benefits is presented here to confirm the long term economic justification for the approach, the 20 year duration of benefits has been used to inform the calculation of partnership funding contributions.

Table 4.9a – Pluvial Fluvial short list Summary of economic analysis 20-year appraisal period excluding contributions

Option	Present Value costs (£k)	Present Value damages (£k)	Present Value benefits (£k)	Average benefit: cost ratio (BCR)	Incremental benefit cost ratio (IBCR)
- Do nothing	0	31,787	-	-	-
- Do minimum – maintain	376	29,251	2,536	6.7	-
5 Property Level Resilience	3,811	17,463	14,324	3.8	3.4
6 Property Level Resilience and Community scheme at Velda Close and Aldwyck Way	4,821	17,410	14,377	3.0	0.1

Table 4.9b – Pluvial/Fluvial short list Summary of economic analysis 20-year appraisal period including contributions

Option	Present Value costs (£k)	Present Value damages (£k)	Present Value benefits (£k)	Average benefit: cost ratio (BCR)	Incremental benefit cost ratio (IBCR)
- Do nothing	0	31,787	-	-	-
- Do minimum – maintain	376	29,251	2,536	6.7	-
5 Property Level Resilience	3,811	17,463	14,324	3.8	3.4
6 Property Level Resilience and Community scheme at Velda Close and Aldwyck Way	4,601	17,410	14,377	3.1	0.1

Table 4.10a – Pluvial Fluvial short list Summary of economic analysis 100-year appraisal period excluding contributions

Option	Present Value costs (£k)	Present Value damages (£k)	Present Value benefits (£k)	Average benefit: cost ratio (BCR)	Incremental benefit cost ratio (IBCR)
- Do nothing	0	52,460	-	-	-
- Do minimum – maintain	764	47,726	4,733	6.2	-
5 Property Level Resilience	6,437	23,516	28,944	4.5	4.3
6 Property Level Resilience and Community scheme at Velda Close and Aldwyck Way	7,991	22,393	30,067	3.8	0.7

Table 4.10b – Pluvial Fluvial short list Summary of economic analysis 100-year appraisal period including contributions

Option	Present Value costs (£k)	Present Value damages (£k)	Present Value benefits (£k)	Average benefit: cost ratio (BCR)	Incremental benefit cost ratio (IBCR)
- Do nothing	0	52,460	-	-	-
- Do minimum – maintain	764	47,726	4,733	6.2	-
5 Property Level Resilience	6,437	23,516	28,944	4.5	4.3
6 Property Level Resilience and Community scheme at Velda Close and Aldwyck Way	7,771	22,393	30,067	3.9	0.8

Whilst the do minimum option has the highest benefit cost ratio it was dismissed as it does not fulfil the objectives of the scheme to mitigate flood risk in a sustainable way. The economic assessment suggests that based on the Benefit-Cost Ratio, Incremental Benefit Cost Ratio and the decision rules defined by the FCERM-AG that the economically preferred option is the PLR option alone (Option 5) as the IBCR for Option 6 is less than 1, suggesting that Option 5 should be taken forward. As the wider Velda Close defence aims to provide a 100 year defence standard, in order for this option to be preferred, and following the FCERM-AG decision rule, the IBCR ratio would need to be greater than 3. Sensitivity testing shows that if the PLR take-up is less than 90% then the IBCR for Option 6 decreases to >3. Given that PLR take-up is very unlikely to be above 90% it is recommended that Option 5 is identified as the economically preferred option.

However, when stage 5 of the decision-making process is applied, considering the factors summarised in Section 4.6, the provision of PLR and the Velda Close and Aldwyck Way community scheme (Option 6) becomes the preferred option with additional costs over Option 5 being met through additional contributions in line with the Local Choices framework.

There are uncertainties in the hydraulic modelling of the area resulting in difficulties matching the historic nature of flooding in the Velda Close area. The modelling may be underestimating the flood levels in this location and the associated flood damages and option benefits, the economic assessment of this option is considered to be conservative. The development of this option considered this uncertainty and included an allowance for uncertainty with regards to water level.

4.6. Non-financial benefits appraisal (Pluvial Fluvial)

The shortlisted options were appraised based on economic, technical, environmental and social factors and considering the feedback from key stakeholders and public consultation. To assist in the appraisal of options and assess the impacts on a number of key objectives including non-financial benefits, an Appraisal Summary Tables was produced during the Outline Business Case, these are included in Appendix F14. The key non-financial benefits that confirmed Option 6 as the preferred option under ‘Local Choices’ are:

- The option achieves the clear stated aim of the project to mitigate against flooding to the community at Velda Close via a means other than PLR (this has been attempted in the past without significant success).
- The option will also offer private contributions to the scheme from the housing association which would not be forthcoming for a PLR only option.
- The scheme provides a long-term mitigation against flood risk to this community that may not be realised using a PLR option alone.

4.7. Preferred option (Pluvial Fluvial)

The appraisal has identified Option 6 – PLR with a community scheme at Velda Close and Aldwyck Way as the preferred option for a scheme to improve the management of pluvial fluvial flood risk in Lowestoft over a 20-year duration of benefits. Table 4.10 summarises the outcome measures that are associated with the implementation of Option 6. Full details are included in the pluvial fluvial partnership funding calculator included in Appendix A2.

Table 4.10 – Pluvial/Fluvial summary of outcome measures for Option 6 - 20 year appraisal period

Contributions to applicable outcome measures	
Outcome 1 – Ratio of whole-life benefits to costs	
Present value benefits (£k)	14,337
Present value costs (whole life) (£k)	5,028
Benefit: cost ratio	2.86
Outcome 2 – Households at reduced risk	
2a – Households moved to a lower risk category (number – nr)	271
2b – Households moved from very significant or significant risk to moderate or low risk (nr)	271
2c – Proportion of households in 2b that are in the 20% most deprived areas (nr)	108
Partnership funding & FCERM-GiA	
Raw Score	44%
Adjusted Score (assuming no contributions secured)	44%
FDGIA available cells ((11) – (2))	£2,113

As the preferred option has a lower IBCR than that needed by the FCERM-AG decision rule, **the additional costs need to be funded entirely through contributions**. This is reflected in the local choices framework under the PF policy.

In-line with the partnership funding rules, the amount of FCERM-GiA that can be claimed is based on the most economically preferred option and a partnership funding calculator has been prepared for Option 5 (PLR) which is the economically preferred option, a summary of the option outcomes and conformation of the FCERM-GiA available is presented in Table 4.10b.

Table 4.10b – Pluvial/Fluvial summary of outcome measures for Option 5 - 20 year appraisal period

Contributions to applicable outcome measures	
Outcome 1 – Ratio of whole-life benefits to costs	
Present value benefits (£k)	14,324
Present value costs (whole life) (£k)	3,811
Benefit: cost ratio	3.76
Outcome 2 – Households at reduced risk	
2a – Households moved to a lower risk category (number – nr)	264
2b – Households moved from very significant or significant risk to moderate or low risk (nr)	264
2c – Proportion of households in 2b that are in the 20% most deprived areas (nr)	101
Partnership funding & FCERM-GiA	
Raw Score	57%
Adjusted Score (assuming no contributions secured)	57%
FDGIA available (£k) cells ((11) – (2))	2,140

4.8. Sensitivity analysis (Pluvial Fluvial)

As part of the technical development of the refined shortlist of options sensitivity analysis was undertaken as detailed in Section 5.8.2 of the options report this analysis focused on the sensitivity of the Kirkley Stream to blockage at bridges and culverts. This issue was considered in detail as it has been reported (Appendix F6 -

Kirkley Stream Flood Report - October 2015) that blockages along the Kirkley Stream have exacerbated historic flooding as well as for model calibration purposes.

The economic analysis considered the following sensitivity tests: to consider a number of factors where there is uncertainty surrounding the delivery of the options and are discussed in detail in Section 7 of the Economic Appraisal Note (Appendix E4):

- Inclusion of contributions to PLR by homeowners to the value of £500/property.
- A reduction in PLR effectiveness due to longer term damage.
- A reduction in the take-up of PLR.

The first two tests indicated some sensitivity of the PF score to the tests but not enough to alter the preferred option choice. The third test considered a reduction of 25% and 50% of PLR properties, this indicated that whilst a reduction in PLR take up would reduce the amount of FCERM-GiA available, this would be broadly proportionate to the cost of delivering the remaining PLR properties. As the fluvial flood wall is being delivered through partnership funding under the 'Local Choices' framework the delivery of this element is not affected by the reduction in GiA.

In addition, the partnership funding calculator includes a number of standard sensitivity tests on the following parameters as detailed in Tables 4.11a. and 4.11b for the 20 year and 100 year appraisal periods respectively.

Table 4.11a – Pluvial Fluvial preferred option OM sensitivity tests – 20 year appraisal period

PF calculator sensitivity test	Raw score	Contributions required for 100% Score (£)
Main scenario	44%	2,653,340
Sensitivity 1 - Change in PV Whole Life Cost (25% increase)	16%	5,007,800
Sensitivity 2 - Change in OM2 - 50% of households in Very Significant (Before) risk may already be in Significant Risk band	35%	3,113,300
Sensitivity 3 - Change in OM3 - 50% of households in Medium Term loss (Before) may already be in Long Term loss	44%	2,653,340
Sensitivity 4 - Increase Duration of Benefits by 25%	39%	2,890,500
Sensitivity 5 - Reduce Duration of Benefits by 25%	39%	2,893,698

Table 4.11b – Pluvial Fluvial preferred option OM sensitivity tests – 100 year appraisal period

PF calculator sensitivity test	Raw score	Contributions required for 100% Score (£)
Main scenario	56%	2,079,560
Sensitivity 1 - Change in PV Whole Life Cost (25% increase)	20%	4,722,589
Sensitivity 2 - Change in OM2 - 50% of households in Very Significant (Before) risk may already be in Significant Risk band	44%	2,643,821
Sensitivity 3 - Change in OM3 - 50% of households in Medium Term loss (Before) may already be in Long Term loss	56%	2,079,560
Sensitivity 4 - Increase Duration of Benefits by 25%	-	-
Sensitivity 5 - Reduce Duration of Benefits by 25%	54%	2,176,305

These sensitivity tests demonstrate that under both appraisal periods considered the PF score of the preferred option is sensitive to a number of the tests, in particular an increase in the whole life costs and change in number of OM2s.

5. The commercial case

5.1. Introduction and procurement strategy

The agreed approach to the procurement of services in relation to the LFRMP and delivery of the preferred options identified in this OBC is the SCAPE Procure Framework (SCAPE). SCAPE is a cost effective and OJEU compliant procurement route. As lead partner, ESC have entered into contract with Balfour Beatty as the SCAPE contractor. The SCAPE route was also endorsed by SCC who are the key partner for delivery of the pluvial fluvial aspects of the Lowestoft FRMP.

A review of all procurement routes open to the project partners was undertaken and SCAPE was selected on the basis of potential cost/programme savings combined with a commitment by the framework contractor to use local businesses and resources in the delivery of the project.

ESC have procured a number of technical services utilising the Scape Perfect Circle framework. These services include technical advisor, ECC project management, site supervision and cost management support.

Further details of the projects procurement approach is included in the LFRMP Procurement Strategy document, Appendix K1.

5.2. Key contractual terms and risk allocation

The key commercial and legal agreements that are being progressed to enable the delivery of the preferred options are summarised below:

- Landowner agreements and tripartite agreements with tenants where appropriate
- TWAO application and associated agreements
- Planning permission and associated agreements
- SCAPE risk share arrangements;
- Risk share agreements with partnership funders
- Operation and maintenance considerations

Detailed consultation with key stakeholders has established a framework for developing the legal agreements required. The approach to delivering these legal agreements is detailed in the Legal agreements briefing note (Appendix O1). Advance meetings have taken place to develop heads of terms for the legal agreements.

5.3. Procurement route and timescales

As mentioned in Section 5.1, SCAPE has been selected as the procurement route for delivering the necessary construction to deliver this project. The SCAPE agreement has regular staged check points incorporated into it to review contractual performance and ensure that best value is achieved. SCAPE does not require ESC to undertake any further procurement exercise in relation to the technical delivery of the preferred options outlined in this OBC. Subcontracts procured within the SCAPE agreement are required to go through a competitive tender process which is further detailed in Appendix K1 and defines the approach taken by the SCAPE delivery contractor for securing legally compliant, best value for money services for delivery of the project.

The project may procure further commercial support services through other available frameworks, further detail is provided within Appendix K1.

5.4. Efficiencies and commercial issues

Project efficiency is driven through the requirements of SCAPE, partner organisations and other funding sources. The project will seek to generate efficiencies at each stage to ensure best value is achieved for the public purse, Table 4.1 presents a summary of the project efficiency targets.

Table 4.1 – Summary of project efficiency requirements

Organisation / Funder	Efficiency measure / target	Reporting requirement
ESC, ESC and Scape framework	General commitment to drive efficient delivery of the project to achieve best value for the public purse.	Through general project financial reporting and benchmarking against similar projects.
EA / FCERM-GIA	15% of project expenditure to be from partnership funding	EA Partnership Funding Calculator
EA / FCERM-GIA	10% of project expenditure (of contributed amount)	EA CERT form
RFCC / Local Levy	10% of project expenditure (of contributed amount) – Assumed in line with FCERM - GiA	EA CERT form

A strategic efficiency register has been compiled using the EA's Capital Efficiency Reporting Tool (CERT) and is included as Appendix L6 (2018 OBC version) with a summary of key efficiencies identified included in Table 4.2.

Table 4.2 – Summary of FCERM (or FCERM funded) Efficiency

Efficiency Category	Efficiency Target/Idea	Forecast Value of Saving £k	Explanatory notes/ Breakdown of calculations
Innovation & Value Engineering	Shared use of Highways England's Bascule Bridge control building for the tidal barrier controls.	200	Estimate based on cost of constructing new control building.
	Alternative alignment of tidal flood wall to avoid diversion of intermediate pressure gas pipeline	150	Difference between estimated costs of tidal wall realignment and cost of diverting gas pipeline.
Contracting Approach	Delivery of preferred option using an appraise, design and build project delivery approach.	350	Estimate based on forecast cost savings against a traditional appraise, design and construct approach.
Streamlined Processes	Utilisation of Scape Procure framework to streamline project procurement and delivery.	40	£20k in 16/17, £10k in 17/18 and £10k in 18/19 based on programme reduction of approximately 6 months of Project management time.
Operational Productivity	Storage of demountable barrier components on stakeholders' land adjacent to deployment location rather than at central depot or leased land.	103	Estimate based on costs for commercial storage.

In addition, a value engineering register is now being used to record value engineering efficiencies with the current version included in Appendix L8. This identifies potential value engineering efficiencies of up to £730k. for the delivery of the tidal wall's element of the project.

A key efficiency the project is pursuing is the unconstrained delivery approach associated with the local choice tidal barrier option (Option 9LCU) whereby the reduced construction period has the potential to result in a saving of circa £10m in cash terms, in addition to the potential carbon savings associated with reduced construction period.

6. The financial case

6.1. Staged delivery

Given the need to secure additional partnership funding as a result of increases in delivery costs between SOC and OBC stages, the LFRMP is being delivered in a staged approach. The first stage has delivered the pluvial fluvial elements of the project in 2021 and is forecast to deliver the tidal flood wall works (as advanced works) by 2023. The second stage will deliver the tidal barrier element of the project. The Stage One works are fully funded and the Stage Two works are partially funded with an additional funding need of £113,089,000. The LFRMP Funding Programme (Appendix N1) outlines the approach for securing this additional funding. It is acknowledged that a risk remains that sufficient funding to enable the tidal barrier element of the works to proceed will not be secured and that the risk of not securing the required budget remains with ESC. Should this be a case, alternative options to the 'local choice' 40m barrier may need to be put forward, such as the 'nationally economically viable' option.

6.2. Financial summary

Tables 6.1a and 6.1d summarise the whole life costs of the preferred [national economic](#) options for the management of tidal and pluvial fluvial flood risk respectively. [Tables 6.1b and 6.1c summarises the whole life costs for the seasonally constrained and constrained delivery of the local choices tidal option respectively.](#) As detailed in Sections 3.5 and 3.10, detailed option costs have been developed based on a number of sources including risk allowance developed in accordance with Environment Agency risk management guidance.

Table 6.1a – Project cost summary (tidal – national economic Option 5c)

Costs(£k)	Cost for economic appraisal (PV)	Whole-life cash cost	Total project cost (approval)
Costs to OBC:	N/A -sunk costs		
Existing staff costs		65	65
Site investigation and survey		188	188
Consultants' fees		1,774	1,774
Contractors' fees		0	0
Subtotal		2,027	2,027
OBC to construction:			
Existing staff costs*			
Site investigation and survey*			
Consultants' fees*	3,277	3,277	3,277
Contractors' fees*			
Legal and stakeholder fees*			
Subtotal	3,277	3,277	3,277
Construction:			
Construction costs	42,270	46,926	46,926
Staff costs*	3,178	3,178	3,178
Consultants' fees*	3,178	3,178	3,178
Site supervision*	3,476	3,476	3,476
Inflation allowance (2.5% pa)			4,460
Subtotal	52,102	56,758	61,217
Risk contingency:			
Adjusted optimism bias barrier*	1,815	1,815	1,815
Adjusted optimism bias walls*	1,898	1,898	1,898
Risk - Monte Carlo 95%*			36,590
Risk - Monte Carlo 50%*	21,253	21,253	
Extra Inflation Risk (0% pa post commencement of construction)			0
Future costs:			
O&M & Other	12,046	54,535	
Optimism Bias (30% on future costs)	3,614	16,361	
Project total costs	96,005	157,923	106,824

*PV taken as cash cost (worst case)

Table 6.1b– Project cost summary (tidal – local choices option – 40m barrier seasonally constrained – 9LCC)

Costs(£k)	Cost for economic appraisal (PV)	Whole-life cash cost	Total project cost (approval)
Costs to OBC:	N/A -sunk costs		
Existing staff costs		65	65
Site investigation and survey		188	188
Consultants' fees		1,774	1,774
Contractors' fees		0	0
Subtotal		2,027	2,027
OBC to construction:			
Existing staff costs*			
Site investigation and survey*			
Consultants' fees*	3,277	3,277	3,277
Contractors' fees*			
Legal and stakeholder fees*			
Subtotal	3,277	3,277	3,277
Construction:			
Construction costs	73,714	85,506	85,506
Staff costs*	3,178	3,178	3,178
Consultants' fees*	3,178	3,178	3,178
Site supervision*	3,476	3,476	3,476
Inflation allowance (2.5% pa)			10,887
Subtotal	83,546	95,337	106,224
Risk contingency:			
Adjusted optimism bias barrier*	3,755	3,755	3,755
Adjusted optimism bias walls*	1,882	1,882	1,882
Risk - Monte Carlo 95%*			53,828
Risk - Monte Carlo 50%*	32,698	32,698	
Extra Inflation Risk (0% pa post commencement of construction)			0
Future costs:			
O&M & Other	12,665	59,951	
Optimism Bias (30% on future costs)	3,800	17,985	
Project total costs	141,623	216,914	170,994

*PV taken as cash cost (worst case)

Table 6.1c– Project cost summary (tidal – local choices option – 40m barrier seasonally unconstrained – 9LCU)

Costs(£k)	Cost for economic appraisal (PV)	Whole-life cash cost	Total project cost (approval)
Costs to OBC:	N/A -sunk costs		
Existing staff costs		65	65
Site investigation and survey		188	188
Consultants' fees		1,774	1,774
Contractors' fees		0	0
Subtotal		2,027	2,027
OBC to construction:			
Existing staff costs*			
Site investigation and survey*			
Consultants' fees*	3,277	3,277	3,277
Contractors' fees*			
Legal and stakeholder fees*			
Subtotal	3,277	3,277	3,277
Construction:			
Construction costs	67,216	75,570	75,570
Staff costs*	3,178	3,178	3,178
Consultants' fees*	3,178	3,178	3,178
Site supervision*	3,476	3,476	3,476
Inflation allowance (2.5% pa)			7,511
Subtotal	77,048	85,401	92,913
Risk contingency:			
Adjusted optimism bias barrier*	3,258	3,258	3,258
Adjusted optimism bias walls*	1,882	1,882	1,882
Risk - Monte Carlo 95%*			53,828
Risk - Monte Carlo 50%*	32,698	32,698	
Extra Inflation Risk (0% pa post commencement of construction)			0
Future costs:			
O&M & Other	13,307	60,394	
Optimism Bias (30% on future costs)	3,992	18,118	
Project total costs	135,462	207,056	157,185

*PV taken as cash cost (worst case)

Table 6.1d – Project cost summary (pluvial fluvial - 2018 values)

Costs (£k)	Cost for economic appraisal (PV)	Whole-life cash cost	Total project cost (approval)
Costs to OBC:	N/a -sunk costs		Exc previous app
Existing staff costs		£6	£6
Consultants' fees		£18	£18
Contractors' fees		£0	£0
Subtotal		£24	£24
OBC to construction:			
Existing staff costs	£5	£8	£8
Consultants' fees	£246	£246	£246
Contractors' fees	£4	£4	£4
Subtotal	£255	£258	£258
Construction:			
Construction costs	£3,438	£3,568	£3,568
Inflation allowance			£151
Existing staff costs	£15	£16	£16
Consultants' fees	£270	£280	£280
Site supervision	£223	£232	£232
Subtotal	£3,946	£4,095	£4,246
Risk contingency:			
Risk MEV & Optimism Bias	£541	£559	£559
Future costs:	£0	£0	
Maintenance & future costs	£262	£371	
Optimism Bias (on future costs)	£33	£47	
Project total costs	£5,037	£5,354	£5,087

6.3. Funding sources

The LFRMP Funding Programme (Appendix N1) sets out the planned approach to ensure sufficient funding is available for delivering the project objectives. Multiple funding sources have been explored in the production of this comprehensive plan with multiple sources already secured. The programme clearly sets out the secured funding for the first stage of works and provides further detail on the approach taken to secure the additional funding required to deliver the second stage of works.

ESC will be responsible for the operation and maintenance of the tidal elements of the LFRMP and will make provision for undertaking these future activities with a defined funding allocation, in addition to seeking beneficiary contributions. ESC has committed to underwriting these O&M costs, this will be confirmed in a letter from ESC's Section 151 Officer (Appendix N3).

Table 6.2 summarises the key funding sources that will be used to progress the initial capital work elements of the projects and indicates the status of this funding (secured or allocated).

Table 6.2 Summary of project funding sources (Source: Funding timetable, Section 4.5, V16 – LFRMP funding strategy)

Annualised funding needs (£k)	Pre 21-22 (sunk)	22-23	23-24	24-25	25-26	26-27	27-28	28-29	29-30	Total
Stage 1 – Tidal Walls										
New Anglia Local Enterprise Partnership (LEP)	10,000	-	-	-	-	-	-	-	-	10,000
East Suffolk Council	-	-	-	-	-	-	-	-	-	-
Green Recovery Fund	-	7,795	-	-	-	-	-	-	-	7,795
OGD Funding	-	-	1,400	-	-	-	-	-	-	1,400
COVID impacts funding	-	1,198	-	-	-	-	-	-	-	1,198
Stage 1 Tidal Walls - Identified funding	10,000	8,993	1,400	-	-	-	-	-	-	20,393
Partnership Funding Required	-	-	-	-	-	-	-	-	-	-
Stage 1 Tidal Walls- Total funding	10,000	8,993	1,400	-	-	-	-	-	-	20,393
Stage 1 – Pluvial Fluvial										
FCERM-GIA	1,492	-	-	-	-	-	-	-	-	1,492
Suffolk County Council (SCC)	3,000	-	-	-	-	-	-	-	-	3,000
Local Levy via RFCC	1,751	-	-	-	-	-	-	-	-	1,751
COVID impacts funding	385	-	-	-	-	-	-	-	-	385
Stage 1 Pluvial fluvial - Identified funding	6,628	-	-	-	-	-	-	-	-	6,628
Partnership Funding Required	-	-	-	-	-	-	-	-	-	-
Stage 1 Pluvial Fluvial - Total funding	6,628	-	-	-	-	-	-	-	-	6,628
Stage 2 – Tidal Barrier										
FCERM-GIA	-	-	-	-	-	4,186	-	-	-	4,186
Local Levy via RFCC	-	-	1,589	-	-	-	-	-	-	1,589
East Suffolk Council	-	-	250	250	250	250	-	-	-	1,000
Suffolk County Council (SCC)	-	-	-	-	-	-	-	-	-	-
Department for Education	-	-	-	-	-	-	200	-	-	200
Green Recovery Fund	-	2,500	656	2,266	28,494	1,775	-	-	-	35,691
Stage 2 Tidal Barrier - Identified funding	-	2,500	2,495	2,516	28,744	6,211	200	-	-	42,666
Partnership Funding Required	-	-	-	-	-	22,974	29,437	30,101	30,577	113,089
Stage 2 Tidal Barrier - Total funding	-	2,500	2,495	2,516	28,744	29,185	29,637	30,101	30,577	155,755

On the 2nd February 2016, £10m partnership funding contribution from the NALEP was secured for the management of tidal flood risk to promote growth in Lowestoft.

In addition in [July 2020](#), [£43.5m](#) of additional funding was secured from the HMG Green Recovery Fund towards the management of tidal flood risk in Lowestoft.

The funding programme provides further detail on the approach taken to secure the remaining funding required, identifying a number of additional funding sources that are being actively explored.

The funding requirements set out in Table 6.2 are correct at the time of initial submission of the [OBC \(October 2022 or October 2017 for pluvial fluvial works\)](#). Please note that the extract from the funding strategy above includes an allowance for construction costs associated with the Hamilton Road flood wall which is excluded from economic assessment included within this OBC. The construction costs for this flood wall were funded through the New Anglia LEP to provide flood risk reduction to the PowerPark enterprise zone with benefits attributed economic growth in the LEP business case (Appendix N2). Whilst the construction of the Hamilton Road flood wall falls within the scope of the LFRMP it has been removed from the FCERM economic assessment due to a disproportionate impact of the benefit cost ratio of all options. The limited FCERM benefits associated with this flood wall are separate and distinct from the FCERM benefits associated with the remainder of the tidal walls and barrier, it was therefore considered appropriate to remove this from the economic assessment.

6.4. Impact on revenue and balance sheet

The funding programme has considered in detail the whole life funding requirements of implementing the tidal and pluvial fluvial preferred options and demonstrates the approach to ensuring sufficient funding is available for both the initial capital and operational and maintenance phases of the project.

The tidal defence element of the project will create an FCERM asset in the ownership of ESC, who as asset owner and a Coast Protection Authority will be responsible for the whole life operation and maintenance of the tidal scheme.

The PLR measures installed as part of the pluvial fluvial preferred option will become assets of the property owners who will be responsible for their maintenance. This arrangement will be formalised in a legal agreement with the PLR beneficiary, the agreement will not restrict the property owner to apply for a grant (if available) in the future and will only be in force for the life span of the product (20 years). Therefore, the installation of PLR measures will not result in any additional cost to the promoting organisations beyond the initial capital expenditure. The Velda Close fluvial wall works and associated pumping station will be an FCERM asset owned by SCC as lead local flood Authority. Operation and maintenance costs associated with the wall will be funded by SCC through asset maintenance budgets. The pumping station may

be adopted by Anglian Water in which case they will be responsible for its operation and maintenance and the associated costs, otherwise operation and maintenance will remain the responsibility of SCC.

6.5. Overall affordability

Table 6.3a presents the tidal elements whole life cash costs for both stages of the tidal elements of the LFRMP (Post OBC). It should be noted that a small element of the future O&M costs associated with completion of the tidal walls, forecast for late 2023 is not currently shown in the table.

6.3a FCRM - Annualised spend profile – Tidal (£k Cash)

Annualised spend profile (£k cash)	Sunk	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7 +	Yr 8 +	Total
	Pre 21-22	22 - 23	23 - 24	24 - 25	25 - 26	26 - 27	27 - 28	28 - 29	29-30	30-31	
Stage 1 - Tidal Walls											
Authority staff costs - Stage 1	2,027	1,374									3,401
External fees - Stage 1											0
Construction costs - Stage 1 Tidal Walls		10,413									10,413
Risk contingency (95%ile) - Stage 1		458									458
Optimism Bias - Stage 1		1,882									1,882
Inflation - Stage 1		0									0
Stage 1 Subtotal	2,027	14,127	0	0	0	0	0	0	0	0	16,154
Stage 2 - Tidal Barrier											
Authority staff costs - Stage 2	1,639		397	397	397	397	397	397	397		4,419
External fees - Stage 2 (including TWA0)			1,217	1,217	977	977	977	977	977		7,316
Construction costs - Stage 2 Tidal Barrier					15,018	15,018	15,018	15,018	15,018		75,092
Risk contingency (95%ile) - Stage 2		847	847	847	10,166	10,166	10,166	10,166	10,166		53,371
Optimism Bias - Stage 2					751	751	751	751	751		3,755
Inflation - Stage 2		0	20	40	1,260	1,702	2,154	2,618	3,093		10,887
Stage 2 subtotal	0	2,486	2,481	2,501	28,570	29,011	29,463	29,927	30,402	0	154,840
Stage 1&2 sub total	2,027	16,613	2,481	2,501	28,570	29,011	29,463	29,927	30,402	0	170,995
O & M and Future Costs											
O&M and other future costs										59,951	59,951
Optimism Bias - future works										17,985	17,985
Future costs sub total	0	0	0	0	0	0	0	0	0	77,937	77,937
Total costs	2,027	16,613	2,481	2,501	28,570	29,011	29,463	29,927	30,402	77,937	248,932

Table 6.3b presents whole life cash costs for the pluvial fluvial elements of the LFRMP (as per 2018 OBC).

6.3b FCRM - Annualised spend profile – Pluvial Fluvial (£k Cash – 2018 values)

Annualised spend profile (£k cash)	Sunk	Yr 0	Yr 1	Yr 2+	Total
	Pre 18-19	18 - 19	19 - 20	2020 +	
Authority staff costs	6	9	9		24
External fees - Stage 1	18	372	372		761
Construction costs - Stage 1		714	2,854		3,568
Risk contingency (MEV + Optimism bias) - Stage 1		112	447		559
Inflation - Stage 1			151		151
Project Total Stage 1 sub total	24	1,206	3,833	0	5,063
O&M and other future costs				371	371
Optimism Bias - future works				47	47
Total costs	24	1,206	3,833	418	5,481

Considering the staged approach to delivery of the initial capital works, Table 6.4 presents the capital expenditure profile (Cash costs) required to deliver the LFRMP tidal Local choice option (40m barrier – seasonally constrained). The costs below include the 95%ile QRA value, additional optimism bias allowance and a 2.5% PA inflation allowance on construction costs, as defined in Section 3.

Table 6.4– Project initial capital spend profile (Cash – tidal only)

Cash Cost (£k) (inc risk+inflation)	Sunk	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Total
	Pre 21-22	22 - 23	23 - 24	24 - 25	25 - 26	26 - 27	27 - 28	28 -29	29 - 30	
Stage 1 - Tidal walls	2,027	11,787								13,814
Stage 1 - Risk	0	2,340								2,340
Stage 1 - Inflation	0	0								0
Stage 2 - tidal barrier	0	1,639	1,614	1,614	16,392	16,392	16,392	16,392	16,392	86,827
Stage 2 - Risk	0	847	847	847	10,917	10,917	10,917	10,917	10,917	57,126
Stage 2 - Inflation	0	0	20	40	1,260	1,702	2,154	2,618	3,093	10,887
Total	2,027	16,613	2,481	2,501	28,570	29,011	29,463	29,927	30,402	170,995

The Funding Programme (Appendix N1) focuses on providing sufficient funding for the initial capital costs but also sets out the approach for securing funding for the operation and maintenance of the tidal flood defence measures.

Comparison of the forecast initial capital spend for the tidal works (Table 6.4) against the currently identified funding sources (Table 6.2) indicates a total funding gap of approximately £113,089,000 to enable delivery of Stage Two of the project. The preferred Local Choice option has been developed to a higher level of detail than is usual for the OBC stage, with detailed design completed for the tidal flood walls and progressing for the 40m tidal barrier combined with a high level of consultation with key stakeholders directly impacted by the proposals to ensure greater certainty of delivery cost and risks, with the greatest certainty for Stage One of the project.

Robust risk management approaches have been applied compliant with Defra risk management guidance to ensure sufficient budget is available to deliver the project.

Appendix N1 section 4.3 of the Funding Programme provides an overview of the main sources of committed and secured funding that will be used to deliver the Stage One works. Section 6.4 of the programme outline the approach taken to secure additional contributions to enable the delivery of the Stage Two works (Tidal Barrier). The additional sources of funding being explored are as follows:

- Secure additional contributions from current core funders
- Secure private beneficiary contributions: land owners; built asset owners
- commercial tenants
- Secure developer contributions (direct / indirect)
- Monetise contributions in-kind
- Multi-departmental asks for Central Government funding.

A number of these approaches have been successful and others have been discounted as they either require significant capital borrowing that is beyond the scope of a District Authority or will not raise the required level of funding (even in aggregate) at the at the pace it is required.

As the vast majority of the benefit relates to the economic value and jobs the project will unlock to benefit the region and nation, the remaining funding sources are the focus:

- Multi-departmental asks for Central Government funding.
- Secure additional contributions from current core funders

Even at the level of costs required to deliver the 40m 'local choice' tidal barrier, the return on this investment to the nation and will help secure Lowestoft Port as a key hub for offshore renewable energy projects for decades.

7. The management case

7.1. Project management

The development of this OBC is being led by ESC as a Maritime Authority with responsibilities under the Coast Protection Act 1949 and their permissive powers under Section 14A of the Land Drainage Act (1991) as amended by the Flood & Water Management Act (2010). Support on the fluvial and pluvial elements of the project will be provided by SCC as Lead Local Flood Authority under the Flood and Water Management Act 2010. A dedicated project team was established to take the lead in delivery of the Lowestoft FRMP and is developing and using project control processes following the PRINCE2 project management methodology and in accordance with ESC project and financial control processes.

Project structure and governance

ESC are supported by a number of partners and specialist suppliers in the delivery of this project. The project is supported by four key groups:

- Project Board
- Strategic Steering Group
- Project Delivery Group
- Key Stakeholder Group

The Project Board is responsible for making formal decisions and includes Cabinet Members from both SCC and ESC, plus representatives from AW, ABP, NALEP and the EA. The Project Board is supported by the Strategic Steering Group and the Project Delivery Board.

A Key Stakeholder Group provides local knowledge and input to guide and shape the project and how we engage with the wider community and businesses. This group's membership has been drawn from volunteers at the February 2016 business engagement event and subsequent public consultation. This approach has been adopted as good practice as demonstrated in the communications and engagement process for the G2LS.

A project organogram has been prepared to illustrate the structure of the project team and the key project governance routes and is included in Appendix D7.

Project roles and responsibilities

Key roles and responsibilities of individuals and organisations involved in the delivery of the Lowestoft FRMP are presented in Table 7.1.

Table 7.1 Key Project roles and responsibilities

Role	Name	Responsibility, Organisation
Project Sponsor & Project Board Chair	Cllr David Ritchie	ESC Cabinet Member for Planning and Coastal Management and SCC Councillor.
Project Executive	Karen Thomas	Head of Coastal Management, Coastal Partnership East on behalf of East Suffolk Council
Project Manager	Tamzen Pope	Coastal Engineering and Operations Manager, Coastal Partnership East on behalf of East Suffolk Council
Assistant Project Manager – Pluvial Fluvial	Nicola China	LLFA FCRM Advisor – Suffolk, Environment Agency, on behalf of Suffolk County Council
Principal Designer	Troy Doherty	Defined role under CDM 2015 regulations, Balfour Beatty
EA representative	Will Todd	Partnership and Strategic Overview team FCRM Advisor – Suffolk, Environment Agency
Suffolk County Council representative	Matt Hullis	Head of Environment Strategy, Suffolk County Council

Role	Name	Responsibility, Organisation
Lead Contractor	Balfour Beatty	SCAPE framework contractor leading the development of the Lowestoft FRMP
Lead Consultant	Jacobs – Tidal	Lead sub consultant developing the tidal flood risk management options and producing the Lowestoft FRMP
Consultant	JBA – Fluvial/ Pluvial	Sub-consultant considering pluvial fluvial flood risk.
Ground Investigation Contractor	Tetrattech	Undertaking initial ground investigation along the alignment of the likely preferred tidal option (Option 5).

Project plan

Detailed project programmes have been prepared to accompany this OBC and are included in Appendix J1 to J3 which have informed the economic appraisal of the barrier options considered. Appendix J4 is the projects master programme that takes into account an accelerated TWAO process with a seasonally constrained delivery approach. Table 7.2a summarises the delivery key milestones (including those completed) from the Master Delivery programme (appendix J4) for delivery of the local choice 40m barrier option with an unconstrained delivery approach.

Table 7.2a – Key project Milestones for the Tidal works (seasonally constrained) (Actuals in Bold)

Activity	Date (DD/MM/YY)	Comment
SOC recommended for approved	04/05/17	By LPRG and submitted to ESC & SCC cabinets for information
Approval to proceed to OBC & TWAO	06/06/17	By ESC Cabinet
Tidal walls planning application submitted	10/07/19	By ESC to ESC Planning department
2018 OBC recommended for technical approval (tidal)	11/01/19	By LPRG followed by ESC cabinets
Tidal walls planning application granted	06/05/20	By ESC Planning department
TWAO - Issue draft Order to DEFRA	09/05/23	By ESC to DEFRA
TWAO - Order made	07/06/24	Assumes written representations only
Tidal works		
Tidal walls work to start on site	08/04/21	Tidal wall construction commences in advance of tidal barrier, subject to planning permission
Tidal walls work substantially completed by	11/07/23	Excluding barrier tie in works
Tidal barrier work to start on site	01/07/24	Subject to TWAO
Tidal barrier work completed	31/03/27	Assumes 40m barrier –unconstrained construction approach

Table 7.2b summarises the key delivery milestones (including those completed) from the Master Delivery programme (Appendix J4) for delivery of the local choice 40m barrier option amended to take into account the delivery efficiency associated with a constrained delivery approach.

Table 7.2b – Key project Milestones for the Tidal works (unconstrained) (Actuals in Bold)

Activity	Date (DD/MM/YY)	Comment
SOC recommended for approved	04/05/17	By LPRG and submitted to ESC & SCC cabinets for information
Approval to proceed to OBC & TWAO	06/06/17	By ESC Cabinet
Tidal walls planning application submitted	10/07/19	By ESC to ESC Planning department
2018 OBC recommended for technical approval (tidal)	11/01/19	By LPRG followed by ESC cabinets
Tidal walls planning application granted	06/05/20	By ESC Planning department
TWAO - Issue draft Order to DEFRA	09/05/23	By ESC to DEFRA
TWAO - Order made	07/06/24	Assumes written representations only

Activity	Date (DD/MM/YY)	Comment
Tidal works		
Tidal walls work to start on site	08/04/21	Tidal wall construction commences in advance of tidal barrier, subject to planning permission
Tidal walls work substantially completed by	11/07/23	Excluding barrier tie in works
Tidal barrier work to start on site	01/07/24	Subject to TWAO
Tidal barrier work completed	01/11/29	Assumes 40m barrier – seasonally constrained construction approach

7.2. Communications and stakeholder engagement

The approach to communications and engagement across all project communications and engagement has been, and will continue to be, a two-way symmetrical approach (systems theory), allowing for the development of ideas and the co-creation of progress. This approach has been adopted to support the project development through each phase and to raise awareness of, and to help support, the early identification and resolution of objections and concerns.

From the outset, the project team identified that a successful communication approach and accompanying strategy were of paramount importance in delivering the objectives of the LFRMP. A comprehensive structure of communication and stakeholder engagement has been adopted and continually developed. A detailed summary of the stakeholder engagement undertaken to date is included as part of the Lowestoft Tidal Communications Plan (Appendix G1). To ensure the smooth delivery of this project, ensuring that both external and internal communications are undertaken in an efficient and effective manner, extensive consultation and engagement has, and will continue to be, undertaken.

Communications and engagement planning, and delivery has and will continue to broadly follow the Environment Agency's 'Working with Others' guidelines centred around the 'Engage, Deliberate and Decide' approach but with additional evaluation points. All engagement is planned, conducted, and delivered in accordance with the Chartered Institute of Public Relations (CIPR) Code of Conduct, specifically adhering to the guidance around ethical communication. As required by East Suffolk Council, an Equality Impact Assessment has been completed.

It is noteworthy that during the pandemic consultation and engagement was of course challenging. However, digital and virtual reality engagement played a critical role in engaging people. Virtual reality rooms, using gaming technology has proved successful and we will continue to enhance and develop these tools for use throughout the project. Value-based digital surveys have proved exceptionally useful tools in other areas of work and again we will continue to develop and use those tools during project engagement as is appropriate.

- Consultation and engagement have been achieved through a number of mechanisms, including but not limited to:
- Public drop-in sessions,
- Stakeholder workshops,
- Involvement in and attendance at key local events
- Public and statutory consultations on options and environmental assessments,
- Use of the LFRMP project's web site¹⁷,
- Use of social and traditional media

¹⁷ <http://www.lowestoftfrmp.org.uk/>

- Extensive engagement with schools, and FE colleges
- Engagement with local business groups (including the Lowestoft Chamber of Commerce),
- The Strategic Stakeholder Group and Key Stakeholder Group,
- Focused meetings with individuals and organisations as required.
- Public consultation documents (Appendix G2)
- Virtual reality visitor centre
- Virtual reality careers centre
- Awareness raising through social value activities such as local volunteering

For all methods of consultation, mechanisms are in place to capture and analyse consultation responses and incorporate this feedback into the development of the options. Further detail is included in Appendix G1.

The key stakeholders consulted through the development of the Lowestoft FRMP are summarised in Table 7.3. A more extensive analysis and stakeholder list is included in the communications and engagement plan (Appendix G1).

Table 7.3 - Key Project stakeholders (excluding project partner organisations)

Stakeholder	Interest (tidal/pluvial/fluvial)	Represented on / Consulted through
Royal Yacht Association, Royal Norfolk and Suffolk Yacht Club and leisure users	tidal	Public and focused consultation
Broads Authority	tidal	Statutory consultation
Businesses and their customers	tidal/pluvial/fluvial	Focused consultation
Highways England	tidal/pluvial/fluvial	Statutory consultation
Associated British Ports	tidal	Focused consultation – represented on project Board and steering group
UK Power Networks	tidal/pluvial/fluvial	Focused consultation
Landowners (potentially affected by the tidal works inc walls)	tidal/pluvial/fluvial	Focused and Public consultation Some represented on project steering group
Historic England	tidal/pluvial/fluvial	Statutory consultation
Environmental bodies	tidal/pluvial/fluvial	Statutory consultation
Network Rail	tidal	Statutory consultation
The Crown Estate	tidal	Statutory consultation
General public	tidal/pluvial/fluvial	Public consultation

The in-house engagement specialists overseeing and supporting the project's communication and engagement, including that of the contractor Balfour Beatty, are all either working towards or hold a CIPR qualification. The project's strategic communications lead is a Chartered PR Practitioner.

7.3. Change management

Any organisational change required as a result of the delivery of the preferred options will be managed in accordance with the project governance procedures. Where organisational change is required with partner organisations and or other interested parties, legal agreements will be put in place to formalise this change and clearly establish responsibilities.

These organisational changes and agreements will be the main focus of the operation and maintenance of the assets created by the project together with any third party operation and access agreements. Further detail of the O&M requirements for the tidal barrier and the approach to implementing legal agreements is included in Appendix O1 and F18 respectively.

7.4. Benefits realisation

Monitoring and reporting on benefits realisation will be undertaken by ESC in collaboration with the EA and utilise the EA's established FCERM protocols. Tables 7.4a and 7.4b summarise the forecast realisation of Tidal OM's for the Option 9 Local choice options, considering constrained and unconstrained delivery approaches. Please note that this is based on the master delivery programme which assumes an accelerated TWA0 process (Appendix J4). The benefits realisation presented below is more optimistic than that included in the economic analysis which is based on the detailed project programmes (Appendix J1 to J3).

Table 7.4a Forecast OM2 realisation plan – Tidal Option 9LCC (constrained delivery)

Ref	Outcome Measure (OM)	Yr 1 2023	Yr 2 2024	Yr 3 2025	Yr 4 2026	Yr 5 2027	Yr 6 2028	Yr 7 2029	Total
rOM2A	Number of households better protected against flood risk (today)							226	226
rOM2A .b	Number of households moved from the 'very significant', 'significant' or 'intermediate' flood risk bands to lower flood risk bands							126	126
rOM2A .c	Number of households moved out of the 'very significant', 'significant' or 'intermediate' flood risk bands to lower risk bands in the 20% most deprived areas							125	125
rOM2A .PLP	Number of households moved from the 'very significant', 'significant' or 'intermediate flood risk bands to lower flood risk bands through PLP measures							-	-
rOM2B	Additional households better protected against flood risk in 2040 (adaptation)							42	42
rOM2B .b	Additional households moved from the 'very significant', 'significant' or 'intermediate' flood risk bands to lower flood risk bands in 2040 (adaptation)							-	-
rOM2B .c	Number of households moved out of the 'very significant', 'significant' or 'intermediate' flood risk bands to lower risk bands in 2040 in the 20% most deprived areas (adaptation)							-	-
rOM2. NRP	Number of non-residential properties better protected against flood risk							152	152
rOM2A .NRP	Number of non-residential properties better protected from flood risk (today)							137	137
rOM2B .NRP	Number of non-residential properties better protected from flood risk in 2040							15	15

Table 7.4b Forecast OM2 realisation plan – Tidal Option 9LCC (un constrained delivery)

Ref	Outcome Measure (OM)	Yr 1 2023	Yr 2 2024	Yr 3 2025	Yr 4 2026	Yr 5 2027	Yr 6 2028	Yr 7 2029	Total
rOM2A	Number of households better protected against flood risk (today)					226			226
rOM2A .b	Number of households moved from the 'very significant', 'significant' or 'intermediate' flood risk bands to lower flood risk bands					126			126
rOM2A .c	Number of households moved out of the 'very significant', 'significant' or 'intermediate' flood risk bands to lower risk bands in the 20% most deprived areas					125			125
rOM2A .PLP	Number of households moved from the 'very significant', 'significant' or 'intermediate flood risk bands to lower flood risk bands through PLP measures					-		-	-
rOM2B	Additional households better protected against flood risk in 2040 (adaptation)					42			42
rOM2B .b	Additional households moved from the 'very significant', 'significant' or 'intermediate' flood risk bands to lower flood risk bands in 2040 (adaptation)					-		-	-
rOM2B .c	Number of households moved out of the 'very significant', 'significant' or 'intermediate' flood risk bands to lower risk bands in 2040 in the 20% most deprived areas (adaptation)					-		-	-
rOM2. NRP	Number of non-residential properties better protected against flood risk					152			152
rOM2A .NRP	Number of non-residential properties better protected from flood risk (today)					137			137
rOM2B .NRP	Number of non-residential properties better protected from flood risk in 2040					15			15

Tables 7.4a and 7.4 b illustrate the impact of an unconstrained delivery approach has on the forecast realisation of benefits with a reduction of almost 2 years in the time to deliver the tidal benefits.

The realisation of Pluvial Fluvial OMs is based on the properties protected by the Velda Close flood wall and a PLR take-up rate of 100%. Further detail can be found in the Pluvial Fluvial Options Report (Appendix F1).

Table 7.5 Forecast OM2 realisation plan – Pluvial fluvial (2018 values)

Outcome Measure (OM)	Yr 1 2017	Yr 2 2018	Yr 3 2019	Yr 4 2020	Yr 5+ 2021	Total
OM2a Households moved to a lower risk category (number- nr)			264	7		271
OM2b Households moved from very significant or significant risk to moderate or low (nr)			264	7		271
OM2c Proportion of households in 2b that are in the 20% most deprived areas (nr)			101	7		108

*Old OM2 references as these were Forecast to be delivered in the previous CSR period.

Whilst every effort has been made to identify areas of environmental enhancement that can be economically delivered within the LFRMP, it has not been possible to identify areas where sufficient quantities of habitat or river restoration could be undertaken to enable an Outcome Measure claim to be made. These OMs together with OM3 for coastal erosion have therefore been omitted from the benefits realisation plan tables.

7.5. Risk management

Project level risk

Up to the point of agreeing the Target Cost for individual work packages, the risk of overspend remains with ESC although the SCAPE framework KPI places emphasis on the Contractor to help manage this as part of the overall scheme budget and pass the KPI. Once the Target Cost is agreed the Compensation Event and the pain/gain contractual mechanisms define who the risk of overspend rests with.

Risk management of the project will follow the procedure established through the SCAPE framework combined with ESC's own internal risk management processes, further detail of the risk management structure is included in Appendix L7.

The SCAPE framework mandates the ECC NEC3 for delivery agreements and so provides a basis for the division of risk to each of the project parties. Additional risks have been recorded on the project risk register. The risk owner is the party best placed to manage the risk from a commercial, programme or delivery basis. This would be agreed by the project team once a risk had been identified. The quantitative risk registers for the 40m Tidal barrier and tidal walls represent the comprehensive project risk assessment for delivering the tidal Works (Appendix L). Key project risks summarised in Table 7.6.

Table 7.6 Key project risks

	Key Risks	Risk VH/H/M /L/VL	Owner	Mitigation	Risk Post mitigation VH/H/M/L/ VL
1	TWAO application / Legal agreements – Objections to the TWAO / contents of required legal agreements may delay the tidal barrier.	H	ESC	Extensive consultation with impacted parties is being and will continue to be undertaken prior to submission of the applications and during the development of legal agreements.	M
2	Unforeseen ground conditions – Extensive GI has been completed to inform the design and construction of the tidal flood walls with initial GI undertaken for the tidal barrier.	H	ESC	Further GI at barrier location will be undertaken to confirm design assumptions, risk allowance is included for a level of risk relating to ground conditions.	M
3	Funding – high level of additional partnership funding required to progress Stage 2 of project (tidal barrier).	VH	ESC	Funding programme in place – plan in place to source additional funding and provide regular formal updates to funders and stakeholders. Staged approach to delivery, risk of not completing second stage of tidal project	H
4	Inability to agree land access with key stakeholders	M	ESC	Include requirements as part of early consultation / development of legal agreements. Progress heads of terms and continue with TWAO development.	L
5	Delays in discharging TWAO consent conditions	L	ESC	Ensure conditions are included in programme and scope of works. Early liaison with stakeholders to reduce the risk of unknown conditions.	VL
6	Inflation – current levels of inflation result in increased delivery costs.	VH	ESC	Monitor inflationary pressures – work with supply chain to deliver efficiency. Include an allowance for a reasonable level of inflation as risk. Consider recommendations of Environment Agency guidance on managing cost uncertainty.	H

Option delivery risk management

Risk workshops were initially undertaken in March 2017 and February 2018 to develop and refine the option specific quantitative risk registers for the preferred Tidal Barrier, Tidal Walls and Pluvial Fluvial options. For the tidal options, continued development of these risk registers has taken place with the latest risk workshops completed in February and March 2023. The most recent versions of the quantitative risk registers are included as Appendix L2, L3 and L4. These risk registers were used to inform the development of risk allowances included within the option costs. In line with current Environment Agency risk management guidance and assessment of residual option risks was also undertaken and an element of Optimism Bias identified and included in the option costs.

The quantitative risk registers will be reviewed and refined by the project team at regular intervals through the duration of the project. This will ensure that risk budgets reflect the projects current stage with consideration given to risks that have been realised or have passed so that the project governance and funders are kept informed. Further detail of this approach is detailed in Appendix L7.

7.6. Contract management

Contractual commitments will be made in accordance with ESC's procurement processes and those of the SCAPE framework contractor. Day to day contractual management will be undertaken by ESC's Project Manager supported by the project management and project governance structures detailed in Section 6.1. In addition to

enable the management of the Scape contract as it moves into its delivery phase, ESC will formally appoint the following roles:

- ECC Project Manager
- Technical reviewer
- ECC site supervisor
- Project Cost Manager

ESC will continually monitor the level of commercial support needed to deliver the projects and where necessary bring in additional support as required.

7.7. Assurance

Project assurance is acknowledged as being critical to the successful and efficient delivery of the project. The Project Board is accountable for overall assurance of the project and report directly to ESC's elected members and SCC's elected members.

Day to day assurance is undertaken by the project team in line with the quality assurance processes of their respective organisations together with the overarching requirements of the project delivery plan.

Multiple funding streams will be required to deliver the preferred options, each of which have specific assurance requirements associated with the release of funding. The Lowestoft FRMP Funding Programme¹⁸, included in Appendix N1 contains details of assurance processes that will be followed for each funding stream.

Assurance of this OBC will be undertaken through the EA's LPRG following review and recommendation of the Project Board to proceed with document submission. Following a recommendation by LPRG to approve the OBC, the document will be submitted to the ESC and SCC Cabinets for information.

Once the complete funding package for the second stage of delivery (Tidal Barrier – Local choice option) is secured the OBC will be resubmitted to LPRG for financial assurance. Following a recommendation for approval of the second stage works, it will be resubmitted to the ESC cabinet for information and for approval to further progress activities associated with the tidal barrier element of the preferred tidal option.

7.8. Post project evaluation

A post project evaluation will be undertaken in line with ESC's project management procedures. In addition, any additional requirements from the projects funders requirements for post project evaluation will be incorporated into the evaluation, a summary of these requirements is presented in Table 7.7.

¹⁸ Lowestoft FRMS Funding Programme, ESC, 2017

Table 7.7 Post project evaluation requirements

	Source	Measure	Target
1	ESC	Tidal elements of the FRMP	
		Budget – complete the works within the Approval value	OBC stage cost estimates
		Programme – complete works within the programme at FBC stage	OBC stage completion milestone
2	FCRM-GiA	Tidal OM2's delivered	OBC stage PF calculator
		Pluvial Fluvial OM2's delivered	OBC stage PF calculator
3	Local Levy	As FCRM-GiA	
4	SCAPE framework	Socio economic Benefits (demonstrated using SVP or LM £ socio economic calculator)	To be defined in the final scape delivery contract.
		Commercial value for money (report produced referring back to initial costings)	
		Post Project Review and Learning Workshop with Client. (Carried out with <i>whole</i> team).	
		KPI post construction MAP survey carried out with the client	
		KPI supply chain Surveys completed	
5	NALEP	No specific requirements	N/A
6	Green Recovery Fund	No specific requirements	N/A

In addition to these funding specific requirements, the Lowestoft Infrastructure prospectus established an overriding measure of success for the LFRMP which is as follows:

“The threat from fluvial and tidal flooding in Lowestoft will have been significantly reduced”

The Local plan for Lowestoft also specifically mentions the provision of Strategic flood risk management measures as a key enabler for the future growth of Lowestoft.

The exact criteria for this measure of success is to be quantified against success in achieving the objectives of this strategy. *With the completion of the pluvial fluvial elements of the project, this objective has been partially met.*

7.9. Contingency plans

At present Lowestoft has no formal tidal or pluvial fluvial flood defences. Existing contingency arrangements will remain in place and include:

- Tidal flood warning service
- Suffolk Flood Plan
- Evacuation plans
- Emergency Services' response plans
- Local authority response plans

Some local businesses have their own contingency arrangements, in particular ABP which has a published flood contingency plan¹⁹ detailing how the port will respond to a tidal flood event.

¹⁹ ABP Lowestoft Flood contingency Plan, ABP, 2014 available from: http://www.abports.co.uk/Marine/Short_Sea_Ports/Lowestoft/Lowestoft_Flood_Contingency_Plan

The Lowestoft FRMP Funding Programme (Appendix N1) considers contingencies in relation to funding shortfalls and cost increases as far as possible at this stage of the project. As a living document, the funding programme will further develop as increased certainty is gained with respect to tidal barrier option costs.

Lowestoft temporary tidal defences

As an interim measure 1.4km of temporary tidal flood defences have been procured to reduce the risk of flooding to key sections of Lowestoft. The temporary defence system has been in place since December 2016 and it is intended to be available for use for a period of up to five years until the permanent tidal defences are completed. After this time the asset will be released to the Environment Agency. It was successfully deployed in January 2017 in response to a forecast surge event, further detail is given in Section 2.5.

As part of the two-stage delivery approach for the tidal element of the LFRMP the temporary defences will be utilised to reduce the risk of flooding during the period between completion of the tidal walls and tidal barrier elements of the tidal preferred option.

Although undesirable, consideration could be given to extending the use of this system should there be a delay in completion of either stage of the permanent tidal defences. However, this would not be in line with the objectives of this project.

Appendix A: Partnership funding calculators

- A1 Tidal preferred option partnership funding calculator (National Economic option)
- A2-1 Pluvial fluvial preferred option partnership funding calculator – 20 year Appraisal Period (2018 OBC version)
- A2-3 Pluvial fluvial preferred option partnership funding calculator – 100 year Appraisal Period (2018 OBC version)

Appendix B: List of reports produced

NB: It should be noted that during the time frame of this this OBC development. Waveny District Council (WDC) has become East Suffolk Council (ESC). Any referenced to WDC should be taken as referring to ESC.

Report Title	Description	Risk Focus	Date
Tidal Modelling reports	Initial Lowestoft tidal hydraulic modelling report, supplemented by additional studies focusing on the outer harbour.	Tidal	2014 & 2016
Economics Report	Summary of economic analysis undertaken	Tidal	2016
Option summary note	Note produced to support consultation of the SEA Environment Report prior to the finalisation of the SOC	Tidal	2017
Local economic impact report	Report considering the impact of tidal flooding on Lowestoft's economy - GVA	Tidal	2016
Lowestoft Tidal Barrier Feasibility Study	Study considering the feasibility of using a tidal barrier as part of a tidal defence system to protect Lowestoft.	Tidal	2015
Pluvial/Fluvial options report	Report summarising the appraisal of pluvial fluvial flood risk management options.	Pluvial/fluvial	2016/2017
Pluvial/Fluvial Economic analysis summary note	Summary note to support the pluvial fluvial GIS economic analysis outputs.	Pluvial/fluvial	2016
Integrated Catchment Modelling Report	Report on the integrated catchment modelling undertaken as part of the assessment of pluvial fluvial flood risk	Pluvial/fluvial	2016/2017
Lowestoft Integrated Modelling Report	Report summarising the pluvial fluvial modelling work and sensitivity work undertaken.	Pluvial/fluvial	2016/2017
Lowestoft FRMP procurement Cabinet briefing note	East Suffolk Councils Cabinet briefing document detailing the recommended approach for procuring work relating to the Lowestoft FRMP. NB: Confidential document	All	2015/2016
Lowestoft FRMP Funding Programme	Summary of funding sources for the Lowestoft FRMP, detailing funding status and plan for obtaining further funding as required.	All	2016
Strategic Approach document	Document produced to clearly establish interaction of Lowestoft FRMP with other local plans and strategies. Establishing any overlap between FCERM risk and the approach of fairly apportioning benefits.	All	2017
WFD Assessment	Water Framework Directive Assessment for tidal and pluvial/fluvial options	All	2016
HRA	Habitats Regulations Assessment for tidal and pluvial/fluvial options	All	2016
SEA Environment Reports	Strategic Environmental Assessment Report – summarises the assessment of environmental impacts of options considered.	All	2016 & 2017
Public consultation document	Document produced for public consultation of tidal and pluvial fluvial options	All	2016 – 2022 (living document)
Communication plan	Lowestoft FRMP – Project communications plan	All	2016 – 2022 (living document)

Appendix C: Photographs

- C1 Tidal – Option 5 alignment walkthrough
- C2 Historic Flooding Photographs
- C3 Aerial Photographs
- C4 Artists impression – Tidal Option 5 (28m tidal barrier width)
- C5 Tidal - Option 5 flood walls works in progress
- C6 Completed pluvial fluvial works

Appendix D: Figures

- D1 Constraints plan
- D2 Tidal Shortlisted Option Plans
- D3 Tidal Option 5 – Detailed design GA's and sections
- D4 Pluvial Fluvial Shortlisted Option Sketches
- D5 Tidal Flood Extents
- D6 Pluvial Fluvial Flood Extents
- D7 Project Organogram
- D8 Key Plan
- D9 40m tidal barrier 15% GA's and sections – to follow in future OBC submission

Appendix E: Economic Appraisal

- E1 Tidal Economic Appraisal Note
 - DEFRA Summary sheet
 - PV damages summary sheet – Main tidal area
 - Option costing summary spreadsheets
- E2 Tidal options costing note and spreadsheets
- E3 Tidal options technical descriptions note
- E4 Pluvial Fluvial economic appraisal note

Appendix F: Technical Reports

- F1 Pluvial Fluvial Options Note
- F2 Lowestoft tidal Barrier feasibility study
- F3 Lowestoft Local Economic Impact report
- F4 Lowestoft Infrastructure Prospectus
- F5 Tidal modelling reports
- F6 Kirkley stream flooding reports
- F7 Dec 13 surge reports
- F8 Enterprise zone
- F9 Broads Climate change high level review
- F10 SMP's
- F11 Anglian FRMP 2015
- F12 Suffolk FRMS 2016
- F13 Lowestoft Local Plan
- F14 Tidal Appraisal Summary Sheet
- F15 Pluvial Fluvial Appraisal Summary Sheet
- F16 Lowestoft SFRA
- F17 Lowestoft Tidal flood walls FRA
- F18 Tidal Barrier O&M requirements
- F19 Lowestoft Drainage Strategy - Pluvial / Fluvial Options Report (SOC stage)
- F20 [Tidal Barrier – Technical review note](#)
- F21 [Option 3 - Flood Walls Only - Technical and Cost Review for OBC \(2018\)](#)
- F22 [CFB and UKCIP change comparison technical note](#)
- F23 [Navigation Simulation Report](#)
- F24 [East Suffolk CFMP](#)

Appendix G: Consultation

- G1 Communications and Engagement Plan
- G2 Lowestoft FRMP Public Consultation Documents
- G3 Action Plan and Communications Log List (Action Plan - Lowestoft 12_08_22)

Appendix H: Environmental Reports

- H1 PEIR and appendices
- H2 HRA Screening report and response (OBC)
- H3 HRA Screening report and response (SOC)
- H4 WFD assessment (SOC)
- H5 WFD assessment (OBC)

Appendix I: Natural England Letter of Support

I1 Natural England letter of support

Appendix J: Project Programme

- J1 Lowestoft FRMP 28m Tidal barrier Programme
- J2 Lowestoft FRMP 40m Tidal barrier (seasonally constrained delivery) Programme
- J3 Lowestoft FRMP 40m Tidal barrier (un-constrained delivery) Programme
- J4 Lowestoft FRMP 40m Tidal barrier Master delivery (seasonally constrained) Programme

Appendix K: Procurement Strategy

K1 LFRMP Procurement Strategy

Appendix L: Risk & Efficiency Registers

- L1 Project risk register – superseded by L2 and L3
- L2 Tidal Walls Option 5 quantitative register
- L3a 28m Tidal Barrier Option 5 quantitative register
- L3b 40m Tidal Barrier Option 5 quantitative register
- L4 Pluvial fluvial preferred option quantitative register – Removed as works delivered
- L5 Tidal Optimism Bias Assessment
- L6 Project efficiency register 2018 version
- L7 LFRMP approach to risk and cost management
- L8 Tidal walls value engineering register – Live version

Appendix M: Strategic Approach

M1 Strategic Approach document

Appendix N: Funding Programme & NALEP Business Case

- N1 CONFIDENTIAL DRAFT - Lowestoft FRMP - Funding Programme
- N2 CONFIDENTIAL DRAFT - Lowestoft FRMP - NALEP Business Case
- N3 Tidal O&M Commitment Letter – To follow in final revision of OBC

Appendix O: Licences, Consents and Legal agreements

- O1 Legal Agreements Briefing Note
- O2 TWAO Briefing note

Appendix P: Carbon Optioneering Tool

P Tidal barrier carbon assessment technical note and carbon assessment tools