Adaptive Scillies - Natural Dune Restoration & Flood Resilience

Council of the Isles of Scilly
FCERM Outline Business Case

St. Mary's with Tresco & St. Martin's in the background, illustrating the low-lying vulnerabilities of the islands (photo courtesy of Visit Isles of Scilly)

Version No: 5

***Date*: 20/04/2020**

BUSINESS CASE APPROVAL SHEET

1 Review & Technical Approval

Project title	Isles of Scilly Natural Dune Restoration & Flood Resilience Project		
Authority project reference		EA reference*	SWS005C/000A/074A
Lead authority	Council of the Isles of Scilly	Date of submission	
Consultant	JBA, Arcadis	Document stage (SOC/OBC/FBC)	OBC
Previous document		Previous doc ref	IOS/IP/2016-1

Job title	**Name**	**Signature**	**Date**
'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 recommend we apply to the Environment Agency for capital grant and local levy in the sum of £1,376, 750*			
Authority Project Executive	Craig Dryden		16/02/2020
'I have reviewed this document and confirm that it meets the current business case guidelines for local authority and Internal Drainage Board applications.'			
Business case reviewer			
'I confirm that the project is ready for assurance and that I have consulted with the Director of Business Finance'			
Area Flood & Coastal Risk Manager			

NPAS Assurance ✓ Projects £100k - £10m (Tick the appropriate box)	Large project review group ☐ Projects >£10m (LPRG)

Recommended for approval			Date
NPAS or LPRG Chair			
Project total as approved £	£3,056k	Version number	
Project total made up of :	Capital Grant (£k)	£1,356k	
	Levy (£k)		
	Other Contributions (£k)	£1,700k	

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)		Version number (if different)	
Date approved by Defra (or N/A)			
Comments			

For FSoD Coordinator use only:

Table of Contents

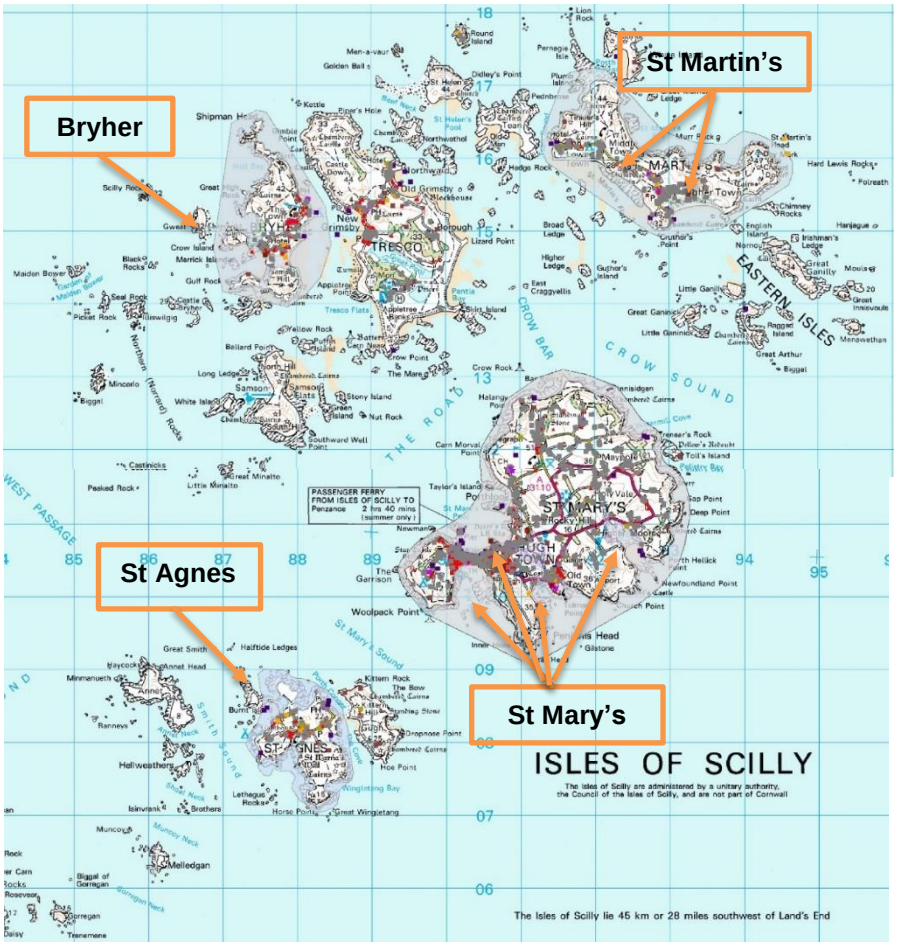
1. Executive Summary

1.1. Introduction

The Isles of Scilly, its communities, wildlife, the visitor economy, freshwater habitats and scarce water supplies are all threatened by increasing flood, coastal & uncertain future climate risks. This granite archipelago lies 40km South West of Land's End and it's low-lying coastal topography makes these islands and their 2200 residents particularly vulnerable to the impacts of extreme North Atlantic storms.

Investment is sought to sensitively restore the natural strength & adaptive flexibility of the extensive systems of coastal dunes across four inhabited islands. Enhancing these Natural Capital assets offers the opportunity to improve the standard and consequent value of flood protection (ecosystem) services they provide. This needs complementing with localised 'gap-plug' measures to address inundation risks, especially in Hugh Town, the island's main settlement. Investment is also required to enhance and sustain the resilience capabilities of communities on the smaller inhabited 'off-islands'. This will enable timely, complementary responses that assure the NFM measures and incrementally further reduce flood risk & damages from frequent extreme storm events.

This single business case is based upon four separate (but fundamentally inter-related) fully cost apportioned economic appraisals - one for each island. Both individually, but also in combination as a single deliverable project, this OBC seeks to; demonstrate the selection of the most contextually viable and appropriate combination of measures; and; justify investment of FCERM GiA across each and all of four islands on the basis of evidenced risk, eligible benefits and value for money. It proposes, and is fundamentally dependent upon, realising an allocated & currently available (but time-limited) £1.7m sum of ERDF capital investment (as FCRM Partnership Funding) to address flood, coastal and climate vulnerabilities and the significant risk impacts on the environment, businesses and the local economy. It is only through the alignment of both sources of investment (into a coherent, single, cross-island project) that makes FCRM measures financially viable and deliverable for any of the islands. It is only a combined scheme and an investment partnership approach which can deliver the prospective range of flood risk, coastal resilience and climate adaptive outcomes and outputs, in a manner that is compatible with such a fragile, heavily designated environment. A combined business case is essential to the meeting of ERDF compliance criteria and to delivering a socially and economically cohesive approach which reflects and satisfies stakeholder shared objectives.



1.2 The Strategic Case

1.2.1 Context

There are five inhabited islands with 1,388 dwellings (2011 census). The total land area is 16.37 km2, St. Mary's being the largest island with a population of 1723 and a land mass of 6.29 km2. The remaining population live on Bryher, St. Agnes, St. Martins & Tresco. 30% of the land area, including much of the residential and commercial development, and the majority of critical infrastructure is concentrated in coastal areas at or below 5m elevation. The centre of the main settlement and District hub, Hugh Town, is located on a narrow sandy isthmus.

Tourism dominates the local economy, 85% direct dependency on the estimated 235,000 visitors p.a. The main local economic constraints being; water scarcity & insecurity, isolation, transport difficulties & the acute shortage of housing & commercial space.

The Duchy of Cornwall owns much of the islands, the main exception being the built-up area of Hugh Town. Tresco is leased long-term and in its entirety to the Tresco Estate (it is not included in this business case). Uninhabited islands, untenanted land and most of the dunes, moors and meadows are leased to and managed by the Isles of Scilly Wildlife Trust.

The Council of the Isles of Scilly (CIoS) is by far the smallest local authority (unitary) in the UK, yet it has some of the widest responsibilities. The small size and distribution of the population, isolation, logistical issues and, the environmental & economic seasonal constraints have all been incorporated into the development & evaluation of potential measures and into the development, proposed procurement and delivery of those measures.

While communities may be limited in size (especially on the off-islands) the adaptive capabilities of islanders has been a significant influence on the evolution and shortlisting of prospective measures. Proposals seek to recognise, value, incorporate, enhance and sustain the resilience of these remote self-reliant communities by investing in their 'resilience stocks'. The proposed scheme will continue to benefit from input and participation in enhanced stewardship of coastal environments, integrating more effective local management of coastal assets as an effective way to address the uncertain future impacts of flood, coastal and climate risks.

The case for investment is made through identification of sources of flood risk and of probabilities, of specific problems and issues in each context and of iterative development with stakeholders of potential solutions at an individual and inter-connected frontage level, combined into defined options at an individual island scale.

1.2.2 Alignment with Strategies and Plans

Proposed measures strongly align with and deliver –

- The **Shoreline Management Plan**, in particular the 2016 mid-term SMP2 Review frontage policy objectives, recognition of connectivity and linkage between Policy Unit across the islands & it recognition of flood vulnerability of lowland moors, meadows and related freshwater & groundwater supply areas on St Marys and on the off-islands (since evidenced by the JBA modelling). This provided a strategic and granular framework for analysis of (linked) frontages and has enabled and shaped from the outset the consideration and development of strongly aligned proposed measures for and across each island. The SMP2 objectives, the use of a relatively short benefit appraisal period (which aligns with SMP epochs and inter-dependent coastal management decision-making) ensure fullest possible compatibility of proposed measures to address flood risk, with coastal processes and considerable future management uncertainties, in this uniquely challenging context, regarding climate change impacts and near-future regression rates.
- **Isles of Scilly FCERM** needs identified on the FCERM1 MTP National Capital Programme and deliver outcomes utilising the £1,4m (nominally) allocated.
- **The Council's statutory duty under the Flood and Water Management Act** 2010, delivery of the IoS Local Flood Risk Management Strategy & protection of local critical infrastructure identified as at risk.
- The **draft Local Plan for 2015-2030** by focusing on protecting identified main settlements & the only prime employment/industrial site on St Mary's, extent of environmental & heritage sensitivities, the need to avoid inappropriate/high risk coastal development despite extremely limited land supply (the Flood Zone 2 1:200 NPPF flood map outline remains the 5m contour due to lack of prior flood risk modelling and mapping) an opportunity to refine flood zone mapping so as to more accurately reflect distribution of risks and better differentiation between appropriate and inappropriate development opportunities in terms of flood risk.

Isles of Scilly Flood Risk Modelling Report (draft) JBA December 2018 has been a key input to the progression and definition of this project. It provides baseline mapped evidence of the pathways, extent & depths of (overtop) flood risk & property receptors counts, across a range of event probabilities across all the inhabited islands. This enables the potential benefits of measures to reduce flood risk to be quantified, compared & appraised. Comparison with recent flood event gauge measurements, extents and depths (on St Agnes & Bryher) has enabled best possible recalibration to take account of the additional flood risk and consequential damages arising from (commonly occurring) breaches in dunes. This additional risk has limited impact on St Mary's and St Martin's where overtop TUflow modelled extents and depths reflect recent events but is of greater significance on St Agnes & Bryher with their greater dependence on damaged and vulnerable dunes which are exposed to greater wave action.

St Mary's Dune Management Study (CPW 3182, 3179 & 3184) Arcadis with the benefit of a £95k FCERM2 grant) has informed shortlist options, provided outline design specification and quantified costing of proposed measures on the Porthloo, Porthmellon, Porth Hellick and Old Town frontages (St Mary's)

Breakdown quantified costings of the range of measures across these frontages, suitably cross referenced and checked, have provided a basis (alongside surveying) for the development of natural dune restoration outline specifications and cost estimates across the other islands, where hard civil engineering measures, with much higher unit costs and risk, are not required.

1.2.3 Environmental Sensitivities and Opportunities

Landscape quality, sensitivity & designations - the whole of the Isles of Scilly are an Area of Outstanding Natural Beauty, a Conservation Area and a Heritage Coast. A number of terrestrial (freshwater) SSSIs are potential direct beneficiaries. The extensive dune systems and their seaward and landward context are integral to the quality, distinctiveness and functioning of the environment. Sensitivity, the need to work with natural processes and better value the dunes as multi-functional natural capital assets and wildlife habitats have been essential considerations from the outset and central to the identification, shaping and short-listing of appropriate measures which maximise opportunities to deliver environmental benefits.

Approaches to specific sites on St Mary's and across the off-islands have been developed through discussions with relevant site owners, local communities, Members of the Council of the Isles of Scilly, the Duchy of Cornwall, the Isles of Scilly Wildlife Trust, the Isles of Scilly Area of Outstanding Natural Beauty Partnership, Natural England and the Environment Agency. There is widespread support and agreement about the need for the project from a wider environmental conservation as well as flood, coastal and climate risk management perspectives.

The value of working with natural processes – an integral outcome of the project will be to protect, improve & sustain 45.4 hectares of coastal and freshwater habitats. This can be achieved by strengthening, improving elevation profiles, raising crest heights, addressing the causes of damage, improving public access and appreciation of the dunes and their coastal defence function. These will all contribute to giving them the space and enhanced structural flexibility to naturally, steadily regress in response to sea level change and associated climactic impacts. The proposed measures are to manage flood risk (not resist coastal erosion). They do not seek to 'hold the line' against dune regression, instead they will enable the dunes, as repaired and restored eco-systems, to adaptively regress (as a 'system') in a manner that maximises environmental and habitat adaptation.

Investment in assisted and enhanced natural restoration, which integrates a larger and more diverse web of living biomass into the dunes, will provide enhanced habitat for invertebrates, birds and support the continued recovery of species such as the Scilly Shrew. It will also give the dunes and their eco-systems the capability to better recover and rejuvenate with less loss of crest height in the aftermath of future extreme storm events and damage.

Restored sustainable dunes offer multiple benefits to beach environments and the inter-tidal zone on their seaward side as well as better protection of large hinterlands of designated sites from flood inundation and saline intrusion. These include the islands freshwater wetland and native woodland which are vital for a range of bird species during migration, feeding and breeding periods.

Timely investment in the proposed blue/green infrastructure approach will minimise the materials needed, the generation of waste and the carbon emissions and costs, especially when compared to those that would arise from a deferred and perhaps reactive hard civil engineered approach. Delaying these relatively modest investments in dune restoration could result in the opportunity to harness their adaptive coastal defence capabilities being lost for good (along with the habitats and essential to life eco-services they provide).

The significant net gain environmental benefits on offer are fully recognised and supported by local and statutory stakeholders.

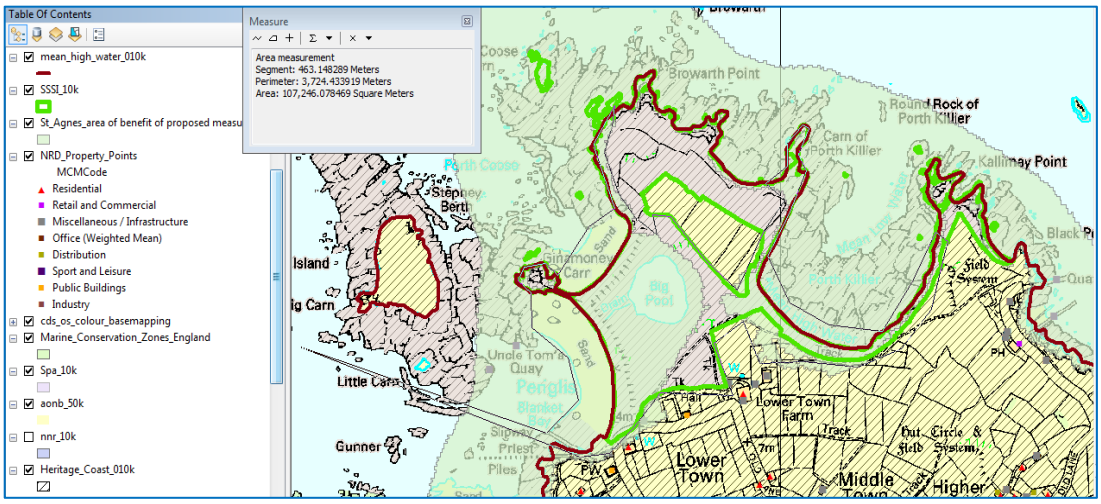
Habitat Regulations Assessment (HRA) screening and Environmental Impact Assessment (EIA) - have been completed for the proposed frontage works on St Mary's, the Screening Statement & the Assessment were completed June 2019. These conclude - *"given the location, nature and scale of the works proposed at each development site and the very limited scale and duration of the construction works required, the assessment has not identified any likely significant effects on the European sites. As such, no further assessment is required."*

The originally proposed works on St Mary's, & iterative process of expanding the prospective scheme to include the off-islands, has included a number of site visits with Natural England, the IoS AONB and the IoS Wildlife Trust.

Explicit inclusion in the project objectives, direct involvement in consideration of and shaping the proposed measures and direct involvement in executive management of the project have ensured that further mitigation is not going to be required.

The Council of the Isles of Scilly has used its reserve funds to commission and progress the HRA & EIA for the works on St Mary's. These are complete, available and will enable the Council of the Isles of Scilly, as the LPA, to consent and enact these works as per the proposed schedule. Off island works will be subject to an additional/extension of the EIA if/when funding is committed.

This will take place in advance of the tender specification, procurement and delivery of these works (2021-22) via separate contracting.



***St Agnes** – in addition to restored biodiversity of dune eco-systems, reduced risk of saline inundation across freshwater habitat is essential to sustaining value of whole SSSI & fauna of much wider surrounding designated land & seascapes. 10Ha*

1.2.4 Climate Change

The JBA modelling includes an assessment of the increasing overtopping risk arising from UKCP09 climate change predictions. However, even when calibrated to also reflect breach risk, it does not include the uncertain but potential increased probability, frequency and severity of breaches and erosion or the resulting damage-consequences as a result of climate change.

UKCP18 scenario projections (& allowances) for costal risk are based on just mean sea level rise. The other potential effects of climate change, via the dynamics of low-pressure systems, the potential for greater tidal surges and increases in wind velocity & wave heights are not included. Sea surface temperature in this context has already risen by 1°C.

These further possible dynamic effects of a warming climate, which are beyond the current scope of predictions, are a concern because of the particular vulnerability of the islands to any increase in the frequency, severity and especially track of (extreme) cyclonic Atlantic low pressure systems.

The Isles of Scilly is the District in England with the greatest proportionate exposure to current & future climate change risks. Assessments of those risks and opportunities to reduce them should factor in uncertain climate change vulnerabilities.

While investment to reduce flood and coastal risks will be central to climate resilience for IoS, it really should be complemented by development of a climate change adaptive plan for IoS, one that identifies; the range of future climate threats; the relevant indicators/triggers; and; the required future resilience & civil contingency measures. This is beyond the scope of this business case, current guidance and FCERM GiA eligibility, but, development of a climate change adaptive (action) plan is an integral element of the expanded ERDF funding bid.

1.2.5 Investment Opportunity and Dependencies

EU Structural Investment Funds, under the Promoting Climate Change Adaptation, Risk Prevention & Management Priority of the 2014-20 ERDF England Operational Programme, in particular the Less Developed Regional allocation for the Cornwall & Isles of Scilly Local Enterprise Partnership area, offers a substantial complementary source of investment needed to deliver this business case.

A clearly defined objective of the development of this project is realising the opportunity to combine FCERM GiA with this available, strongly aligned, but time-limited EU source of funding.

The range of outcomes and outputs which the project offers are eligible from each of these sources of investment and both are required to make the scheme financially viable. Funding from both will enable delivery of a programme of measures which will better protect & sustain households & commercial properties as well as critical and environmental infrastructure, especially the vulnerable freshwater supplies (and habitats) which are essential to sustaining biodiversity, livelihoods and the local economy.

The primary output measure for Priority (Axis) 5 investment under the 2014-20 ERDF programme is the number of commercial properties directly (and indirectly) benefiting from reduced flood and coastal risk, the secondary output measure is areas of designated habitat which are improved and benefit from reduced risk.

The sum of ERDF available to this FCERM project (as a result of proposing and being invited to expand the previously agreed 2015 IoS Dune Management ERDF bid) is £1,700,250. This is the substantive part of a wider

programme of Adaptive Scillies interventions (the other/s being to address water scarcity, the adaptive action plan and related participation and engagement) which it is proposed will benefit from a further £315,000 of ERDF.

Securing the aligned and available ERDF investment depends on parallel progression and approval of the refreshed/expanded ERDF bid alongside this business case.

A range of local and wider partnership working and smaller/in-kind investment opportunities are available, and necessary, especially regarding the natural restoration of dunes. Examples of these opportunities include; working with the Wildlife Trust, AONB Partnership, the Duchy and tenant farmers on the re-routing of sections of coastal footpaths across the islands as well as information, interpretation and participation in restoration. It is also anticipated that a variety of mutually beneficial resourcing arrangements & efficiencies will arise through further engagement with the Duchy of Cornwall, its leaseholders and with water and wastewater service providers.

1.2.6 Agreed Partnership Funding Objectives

Reduce current and future flood & coastal risks to households, businesses, natural capital & infrastructure across the inhabited islands to better protect and help sustain the environment & the local economy.

Do so by identifying measures, securing the required investment and establishing delivery mechanisms which;

- Reduce the modelled flood risk and damages from overtopping of dunes and sea defences
- Deliver increased resilience and reduce risks from erosion and breaches
- Take account of the uncertain impacts of climate change, incorporate opportunities to better understand potential impacts, mitigate them & enable adaptive responses
- Align with and deliver the policy objectives of the Shoreline Management Plan and be reflective of and fully compatible with relevant national and local guidance, policies, plans and strategies.
- Protect fresh water habitats and wider ecosystems, contribute to the conservation of the biodiversity & character of the land & seascape of the islands while enabling adaptive natural change.
- Sustain the islands' scarce freshwater supplies by better protecting wells, vulnerable groundwater source recharge areas and wastewater treatment infrastructure in a manner compatible with future changes to the delivery of water services
- Help to sustain inter-island & mainland transport links, local community & visitor amenities and support recreational and tourism businesses, many of whom have strong dependencies upon the accessibility and quality of coastal environments
- Generate strong support from engaged communities & stakeholders (including visitors), who value and share ownership of sustaining flood, coastal and climate resilience, and who are enabled to develop longer-term adaptive plans.
- Secure and realise an expanded, available but time-limited remaining sum of RDF Flood Risk & Climate Change Adaptation (priority theme) EU Structural Fund Investment.

1.2.7 Current Arrangements and Problems – Each Frontage, Each Island

St Mary's

Porthloo – weak, low-level embankment overtops and 'breaches' at about a 1:7 threatening immediate small number of residential properties, infrastructure and inundation running into Lower Moor at greater than 1:100
Porthmellon – overtopping (and erosion) threatens the main road connecting Hugh Town (the administrative centre) to the rest of St Mary's. Lower level events disrupt access while Higher level events (1:200+) risk inundation of electrical substation, combined fire, ambulance and coastguard response station, waste transfer and wastewater treatment plant and some risk of saline inundation of Lower Moor SSSI.
Old Town – wave overtop accumulations and run-off threaten cluster of 10 residential and 10 non-residential as well as most significant saline inundation threat to Lower Moor & island's primary water supply.
Porth Hellick – damaged sections of dune are overtopped and further damaged by 1:1 events. Higher Moors Pool and larger SSSI wetland area and secondary source of island's freshwater supplies are vulnerable from 1:20 and inundated by 1:75 events. Landscape value is being compromised by inappropriate recreational access.
Hugh Town – eight low slipway/access routes through de-facto defences are flat-water overtopped, compounded by wave overtopping at Mermaid Inn sea wall creates accumulation in core of town that floods properties from the landward side affecting an estimated 40 properties at 1:7.

Porthloo – view along *embankment from north end*

Porthmellon - *assess over the dune causing erosion*

Old Town – *wave overtopping of the Sea Wall 2004*

Porth Hellick *– Aerial view of compromised dune*

Hugh Town *– defacto defences along town beach*

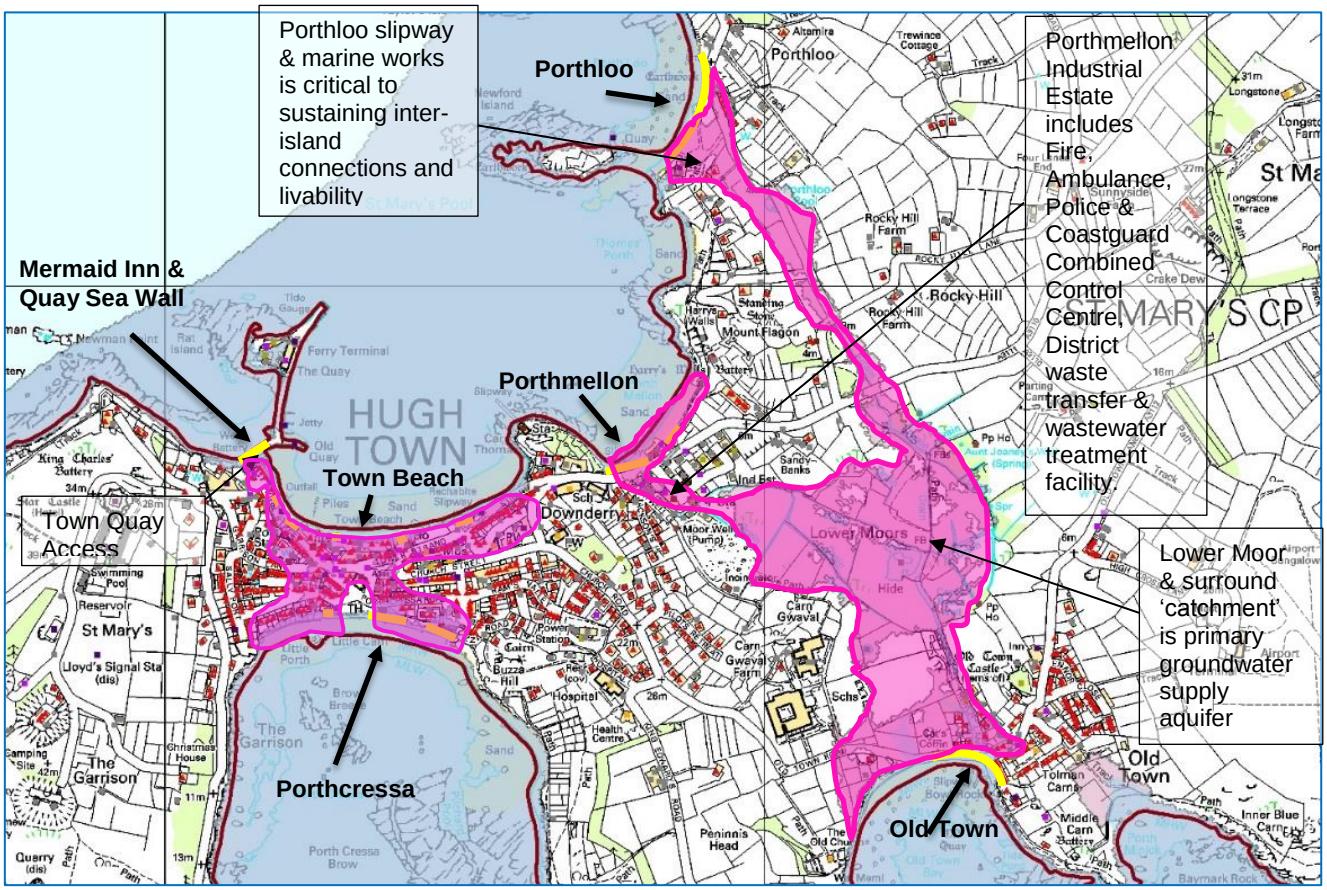
Hugh Town *– wave overtopping February 2014*

Overtopping of Mermaid Sea Wall, 2014 (photo courtesy of the Duchy of Cornwall)

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Non-Residential properties at risk	Mean depth of flooding	Average m²
2		-0.05		-0.05	400
5		0.00	4	0.00	400
10	54	0.00	44	0.00	400
25	72	0.08	64	0.08	400
50	73	0.15	67	0.15	400
100	81	0.22	78	0.22	400
200	85	0.33	80	0.33	400
300	85	0.35	82	0.35	400

St Mary's has an estimated SoP of 1:7 with current measures & arrangements

St Mary's property counts for return periods (assuming 250mm thresholds)



St Mary's

Benefit Area Light purple 1:200 with 2050 climate change allowance.

Frontages & Locations of Potential Measures Yellow

Mean High Water Brown line

St Agnes

Porth Killier – scouring of toe and foundation of central section of 30 year old sea wall. Localised ram erosion & overtopping flood risk at a 5 metre section to SE of sea wall. Overtopping risk of embankment to NW side of Porth Killier. All risk inundation of Meadow, Pool, freshwater habitat, wells and aquifer recharge area of island's main rainwater catchment.

Periglis & Porth Cooth – damaged, compromised and lowered sections of these extensive dunes are overtopped and pose significant breach and inundation risks to the Meadow, a small number of properties, local infrastructure, important freshwater habitat, wells and aquifer recharge area. Core section of Periglis Slipway, which provides a protective breakwater, is suffering from scouring as is quay and beach entrance.

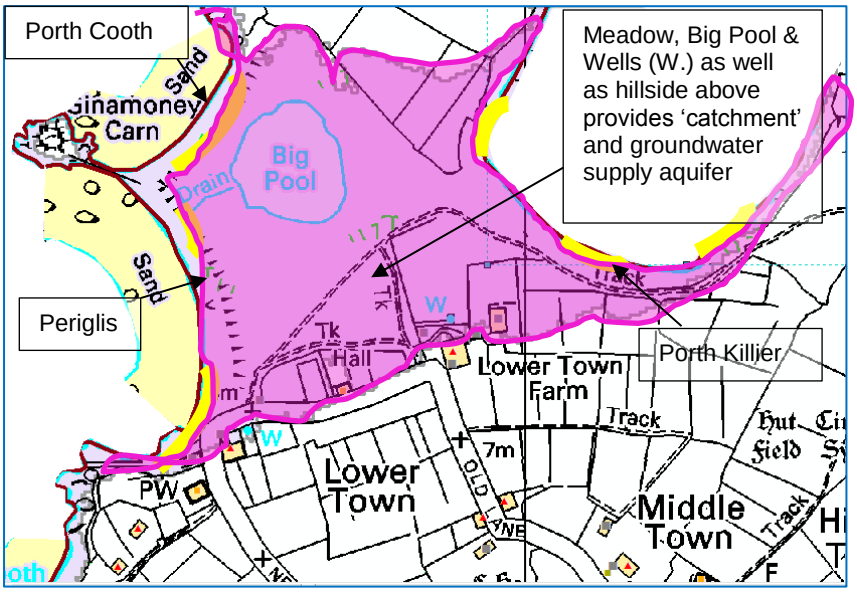
Porth Cooth - *dune viewed from Browarth Point*

Porth Killier

St Agnes has an estimated SoP of 1:20 with current measures & arrangements

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	0		0		
5	0		0		
10	0		0		
25	2	0.33	7	0.33	400
50	2	0.35	7	0.35	400
100	2	0.37	7	0.37	400
200	2	0.40	7	0.40	400
300	2	0.45	8	0.45	400

St Agnes property counts for return periods, calibrated to incorporate breach risk (assuming 250mm thresholds)



St Agnes

Benefit Area Light purple 1:200 modelled with 2050 climate change allowance.

Frontages & Location of Potential Measures Yellow

Mean High Water Brown line

Bryher

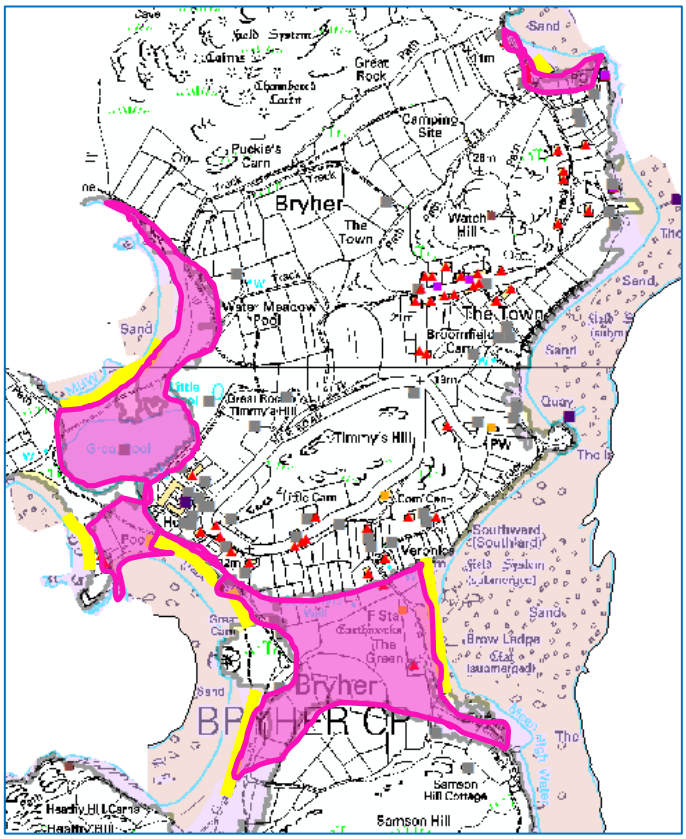
Hell's Bay – at Stinking Porth, Great Popplestone and the north of Great Porth, sections of mixed rock/dune embankments have had rip rap, rock armour and a concrete crest wall added, presumably as an attempt to fix alignments, resist recession and sustain protection. Across these frontages amenity access has eroded some dune sections and where damage and interventions have taken place crest heights are significantly lower than adjacent section where dunes have been relatively free to recess**.** Further south along Great Porth the dune is less constrained but more exposed. In areas vegetation is poorly established and crest heights are low. A 900m^2 area of breach remnant exists to the immediate south of Tommy's Hill. Access through weak points and tracks cutting into the backs of dunes appear to be hampering natural recession.

Green Bay Frontage - the low-level embankment (250mm) which runs around the sheltered east-facing and shallow sandy bay within Tresco Sound is virtually non-existent in numerous places. Flooding of 'The Green' is largely from overtopping & breaches of Hell's Bay frontages but it is also vulnerable from a westerly low pressure

system sea-level height 'surge' into the sound (rather than more generally dissipating around the islands), coinciding with a spring tide.

Kitchen Porth – modelling identifies a cluster of 4 residential and 8 non-residential properties (2 are considered water resilient) at flood risk from overtopping of a similar low level embankment at the northern end of the sheltered Tresco Sound. The access roadway to the high-tide quay runs through it.

Hell's Bay – *prior actions taken to resist recession*



Bryher - Benefit area Light purple**.**

Frontages & Location of Potential Measures Yellow

Great Porth – *flood inundation, February 2014*

Flooding of the lowland behind Great Porth, 2014 (photo courtesy of Gareth Tibbs)

Green Bay - *host an array of water recreation*

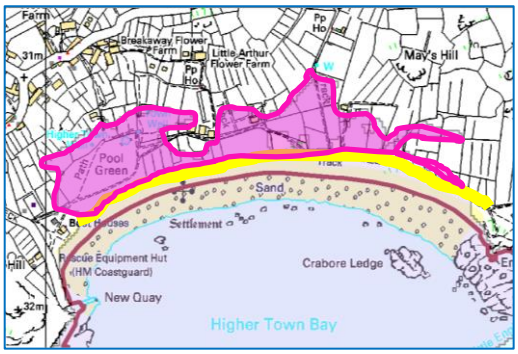
Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	5	-0.05	7	-0.05	400
5	6	0.00	7	0.00	400
10	6	0.05	8	0.05	400
20	6	0.15	9	0.15	400
50	6	0.25	9	0.25	400
100	6	0.35	9	0.35	400
200	7	0.40	9	0.40	400
300	7	0.40	10	0.40	400

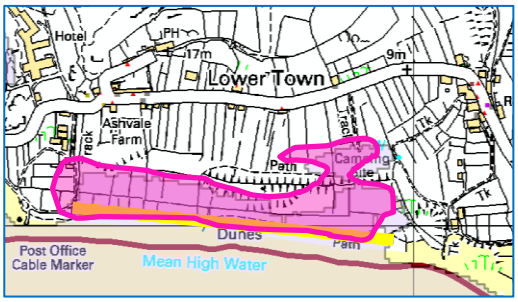
Bryher property counts for return periods, calibrated to incorporate breach risk at Hell's Bay

Bryher has an estimated SoP of 1:1

St Martin's

Campsite & Higher Town – damage to these dunes from February 2014 and other storm events is evident as is unintentional compounding damage from recreational use and beach access. As a result risk is probably greater than the JBA overtop modelling identifies, which itself suggests infrastructure, including more than half of St Martin's freshwater supply wells, are at flood risk.





St Martin's – (image; Clare Kendall)

St Martin's has an estimated SoP of 1:20 with current arrangements (based on overtop flood modelling)

St Martin's property counts for return periods (assuming 250mm thresholds)

St Martin's - Benefit area Light purple.

Location of Potential Measures Yellow

Return Period of the flood (years)	Residential properties at risk (No.)	Non-Residential properties at risk	Mean depth of flooding	Average m²
2		1		400
5		1		400
10		1	-0.02	400
25		2	-0.02	400
50		2	-0.01	400
100		3	0	400
200		5	0.03	400
300		5	0.04	400

1.3 The Economic Case

1.3.1 Identifying, Developing and Shortlisting of Options

An array of potential long-list interventions were considered, many being incorporated into short-listed 'combined measure' options at a frontage and island scale via an engaged and iterative process. These included –

- Managing and moving receptors through changes in land use and relocations
- Educational & behavioural change
- Property level and incident management resilience measures
- Temporary defences
- Working with natural processes
- Adaptive approaches
- Range of physical measures which could potentially reduce probabilities and/or consequences

These were screened with many considered environmentally inappropriate or technically unfeasible in the context.

The identified project objectives by which long and shortlisted options (combinations) have been considered also came largely out of the process of extensive, iterative stakeholder engagement. The evidence and process is described at a frontage scale, across all islands within ***2.8 Current arrangements & assessment of problems & causes of risk.*** The short-listed options for each island being:

- **Do Minimum** – continue managing and maintaining what defences exist and rely on responsive and reactive, often third party incident management and post event repairs with very limited available materials, and continued maintenance of at least aspects of dunes as part of coastal landscape management.
- **Do Something 1** – seek to reduce risk through raising the crest height (by nourishing) and FCERM performance of the dunes, complemented where required, and to the degree feasible and compatible with access arrangements, with passive/fixed measures to plug gaps in de-facto defences.
- **Do Something 2** – Incremental actions in addition to DS1 that further reduce risk through enhancing the FCERM & Natural Capital value & sustainable eco-system performance of the dunes, not just nourishing them but restoring their biomas, anchoring and fixing nourishment materials and re-establishing the structural integrity of each so they function as whole, flexibly regressing eco-systems (enabling them to walk backwards slowly and with their crests held high). Complement where required with robust active measures that plug gaps in de-facto defences in a manner compatible with context and access requirements and which offer a height consistent with delivery of a higher/more suitable SoP for the urban core of Hugh Town*. Complement and assure these enhancements by providing for and better enabling adaptive resilience and the response capacity of local communities. This will assure that any breaches from extreme storms are rapidly repaired (before next tide) in a manner that re-establishes and sustains the integrity of dunes. Do all with a strong focus on protecting and sustaining key environmental and economic infrastructure.
- **Do More** – consider alternatives and additional measures, often 'harder' more 'traditional defence' hold the line approaches regarding dunes, and more formalised (and obtrusive measures) with less focus on environmental and socio-economic benefits.

**In this context, at least in terms of local choice and when negative impacts and practical, legal and time constraints are factored in, active measures (offering at least 750mm of raised defence) are preferable to (350mm realistic limit) passive measures.*

1.3.2 Costs

Optimism Bias - rate applied for each island based upon current cost-certainty

St Mary's	30%	With exception of Hugh Town flood gates we have QS bill of quantities for all proposed PO measures + HRA, EIA, landowner/manager agreements & consents in place for early 2021 contract start.
St Agnes	40%	Extensive engagement & support for dune restoration & resilient stock elements provides relative cost confidence so 30%, while 60% for less detailed rock armour interventions at Porth Killier. Combined this equates to 40%, reflective of planned contract start mid-2021.
Bryher	60%	More limited engagement & post-survey assurance of quantified costs to date. 60% is reflective of this & end 2021 contract start
St Martin's	60%	Although works are relatively simple and don't need bulk materials or heavy plant, similar issue of limited engagement & post-survey assurance

Full Cost Apportionment for Individual Island Economic Appraisal

St Mary's	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (62% of existing salary cost, maintain & 30% OB)	£91k	£38k	£33k	**£162k**
Do Something 1 (62% of FOH & 30% OB)	£745k	£188k	£280	**1,213k**
Do Something 2 (62% of FOHs & 30% OB)	£986k	£188k	£493	**£1,667k**
Do More (62% of FOH & 30% OB)	£2,350	£188k	£903	**£3,441k**

St Agnes	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (19.6% of salary cost, 40% OB)	£53k	£7k	£23k	**£83k**
Do Something 1 (19.6% of FOH & 40% OB)	£306k	£61k	£147k	**£514k**
Do Something 2 (19.6% of FOH & 40% OB)	£358k	£61k	208k	**£627k**
Do More (19.6% of FOH & 40% OB)	£1,330k	£61k	£596k	**£1,987k**

Bryher	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (15% of salary cost, & 60% OB)	£53k	£5k	£36k	**£94k**
Do Something 2 (15% FOH & 60% OB)	£252k	£78k	£179k	**£509k**
Do More(15% FOH & 60% OB)	£620k	£78k	£400k	**£1,098k**

St Martin's	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (3.4% of salary cost, & 60% OB)	£5k	£1k	£3k	**£9k**
Do Something 2 (3.4% FOH & 60% OB)	£61k	£18k	£43k	**£122k**
Do More (3.4% FOH & 60% OB)	£210k	£18k	£132k	**£360k**

1.3.3 Damage Avoidance Benefits

The national economic damage estimates are based on residential and non-residential property counts for each island, by return period modelled event (with existing defences), as defined in the JBA flood risk (overtop) modelling report, recalibrated for St Agnes and Bryher to reflect their significant additional risk from dune breaches. A 250mm threshold adjustment was universally applied & all non-residential property size was capped at 400m2 (only 25% of mainland averages) to reflect local circumstances.

Checked property receptor counts, fed into the 2019 MCM BCA Tool define the (modelling evidenced) baseline do-nothing PV flood damage estimates for each island.

The MCM BCA Tool has also been used to provide consistent assessment of the PV damages to property receptors, again based just on the NRD counts of the estimated reduced extents and depths, as a result of the different levels of investment in the measures of each shortlisted do-something option. Again these are provided at an individual island scale.

Flood Damages

National NRD economic damages	Do nothing baseline damages	Do Minimum	Do Something 1	Do Something 2	Do More
St Mary's	£7,157,322	£4,199,754	£1,230,125	£853,674	£853,674
St Agnes	£1,224,810	£1,042,231	£183,842	£82,120	£82,120
Bryher	£1,570,078	£1,345,112		£284,628	£288,974
St Martin's	£144,811	£126,244		£12,786	£134,422

1.3.2 The Benefit Period

The defined benefit period of 25 years reflects the relatively short and uncertain longevity of asset performance and depreciation in the medium to long-term of; enhancements to dunes; flood gates and barriers; and; enhanced community resilience stock arrangements (although residual benefits, especially from restoration of the dunes are very likely). It also reflects uncertainty about future coastal & climate risks as well as wider medium term economic sustainability and IoS investment dependencies.

A 25 year benefit period has been used and is proposed as most appropriate for the following reasons -

- It offers the most appropriate fit with SMP epochs and reviews and the need for a better understanding of changes in coastal processes and erosion risks.
- Climate change modelling and allowances don't (yet) include considerations beyond mean sea-level rise and this is of particular relevance in this context
- The vulnerability over short timescales of the lowland areas (that these measures seek to protect) to rapid climactic change (during C6th AD archipelago lost 50% of land in approximately 75 years.
- While some long-list measures initially considered had elements with longer lifespans, the shortlisted measures, those viewed as appropriate and feasible in such a sensitive and protected context, only have an estimated lifespan of 25 years.
- Economic sustainability & communities across the islands are heavily dependent in the medium-term upon other infrastructure investment externalities (e.g. the mainland transport links). These are beyond scope but add to the rationale of using a limited benefit period

1.3.3 Areas of Environmental Benefit

For each island this was calculated using GiA shapefile overlays and measurements of the areas of direct habitat enhancement as a result of dune restoration and also to 'hinterland' freshwater habitat which would benefit from reduced flood and saline inundation risk, where these were part of designated sites.

Island	Estimated area
St Mary's	20 ha
St Agnes	10 ha
Bryher	12
St Martin's	3.4

1.3.4 Individual Island Economic Appraisal Summary Tables

St Mary's

Options	EA total PV Costs with 30% OB	Total PV costs with 30% OB	Present Value damages	Present Value benefits	Raw BCR	Raw PF score	Partner Funding	Adjusted PF score & BCR	IBCR on Do Minimum	SoP
Do Nothing	0	0	£7,157k	**0**	**0**	**0**	**0**	**0**		**1:1**
Do Minimum	£162k	£162k	£4,200k	**£2,958k**	**18:1**	**102%**	**0**	**102%**		**1:7**
Do Something 1	£1,213k	1,213k	£1,230k	**£5,927k**	**4.8:1**	**59%**	**0**	**59%**	**2.8**	**1:75**
Do Something 2	£742k	£1,667k	£854k	**£6,304k**	**3.6:1**	**47%**	**£925k**	**100% 6.8:1**	**5.8**	**1:150**
Do More	£3,441k	£3,441k	£854k	**£6,304k**	**2:1**	**24%**	**0**	**24%**	**1**	**1:150**

St Agnes

Option	EA total PV costs with 40% OB	Total PV costs with 40% OB	Present Value damages	Present Value benefits	Raw BCR	Raw PF score	P Funding	Adjusted PF score & BCR	IBCR on Do Minimum	SoP
Do Nothing	0	0	£1,225k	**0**	**0**	**0**	**0**	**0**		**1:7**
Do Minimum	£83k	£83k	£1,043k	**£183k**	**2.2:1**	**15%**	**0**	**15%**		**1:15**
Do Something 1	£514k	£514k	£184k	**£1,041k**	**1:2**	**34%**	**0**	**34%**	**2,2**	**1:75**
Do Something 2	£197k	£627k	£82k	**£1,143k**	**1.8:1**	**34%**	**£430k**	**102% 5.8:1**	**12**	**1:150**
Do More	£1,987k	£1,987k	£82k	**£1,143k**	**0.6:1**	**9%**	**0**	**9%**	**0.8**	**1:150**

Bryher

Option	EA total PV costs with 60% OB	Total PV costs with 60% OB	Present Value damages	Present Value benefits	Raw BCR	Raw PF score	P Funding	Adjusted PF score & BCR	IBCR on Do Minimum	SoP
Do Nothing	0	0	£1,570k	**0**	**0**	**0**	**0**	**0**		**1:1**
Do Minimum	£94k	£94k	£1,345k	**£225k**	**2.4:1**	**13%**	**0**	**13%**		**1:1**
Do Something 2*	£234k	£509k	£285k	**£1,285k**	**2.5:1**	**51%**	**£275k**	**105% 5.5:1**	**7.6**	**1:45**
Do More	£1,098k	£1,098k	£289k	**£1,281k**	**1.2:1**	**29%**	**0**	**29%**	**1**	**1:45**

St Martin's

Option	EA total PV costs with 60% OB	Total PV costs with 60% OB	Present Value damages	Present Value benefits	Raw BCR	Raw PF score	P Funding	Adjusted PF score & BCR	IBCR on Do Minimum	SoP
Do Nothing	0	0	£145k	**0**	**0**	**0**	**0**	**0**		**1:15**
Do Minimum	£9k	£9k	£126k	**£19k**	**2:1**	**11%**	**0**	**11%**		**1:20**
Do Something 2*	£52k	£122k	£13k	**£132k**	**1.1:1**	**46**	**£70,250**	**103% 2.55:1**	**2.7**	**1:75**
Do More	£360k	£360k	£10k	**£134k**	**0.4:1**	**15**	**0**	**15**	**0.3**	**1:100**

1.3.5 Selection Criteria & Choice

Critical Success Factors	Criteria	Priority	Nothing	Existing	DS1	DS2	Do More
Reduces flood risk damages	PV Benefits	5	5 (25)	4 (20)	3 (15)	1 (5)	2 (10)
Adaptive to CC uncertainties	CC sensibility testing	4	5 (20)	4 (16)	3 (12)	1 (4)	2 (8)
Aligns with & delivers SMP	Policy units delivered	3	4 (12)	3 (9)	2 (6)	1 (3)	5 (15)
Eco-system net gains	Benefiting habitat ha	3	5 (15)	4 (12)	2 (6)	1 (3)	3 (9)
Protects water supplies	reduced risk to sources	3	5 (15)	4 (12)	3 (9)	1 (3)	2 (6)
Supports local economy	Infrastructure receptors	2	5 (10)	4 (8)	3 (6)	1 (2)	2 (4)
Community support	Member preferences	3	5 (15)	4 (12)	2 (6)	1 (3)	3 (9)
Secures ERDF funding	Success of ERDF bid	2	5 (10)	4 (8)	2 (4)	1 (2)	3 (6)
Appraisal scores	(lowest being best)		**122**	**97**	**64**	**25**	**65**

Scoring for each factor, prioritised 5-1 (5 being most important) is by ranking each option 1-5 (1 being best) then, for each factor multiply the priority score by the ranking (number in brackets) and then add them up to provide comparative score totals of the options. Clearly DS2 is preferable.

**please note that the Do Something option, as opposed to the Do Minimum and/or Do More (also do something) options on Bryer and St Martins are (nominally) identified as Do Something 2. The reason for this is simply easy of summary when combined into a single OBC*

1.3.6 Summary of proposed measures for each island

St Mary's – nourish, restore and protect damaged dunes, install flood gates and complement with bespoke localised 'set-back' measures to manage (residual) wave overtop volumes. Deliver an estimated 1:150 SoP by raising the low point crest/defence heights by 750mm (+250mm freeboard) on all the identified floodwater pathways.

St Agnes – nourish, restore and naturally strengthen damaged dunes, raising of all identified floodwater pathway low points and crest heights by minimum of 750mm (with 250mm freeboard), complemented by localised tie-in measures to achieve consistent height of defences 750mm above current minimum level. Ensure dunes are strengthened to enable slower and adapted recession & complement and assure this with community resilience (breach management) arrangements to assure estimated 1:150 SoP for benefit period inclusive of breach risk.

Bryher - raising identified floodwater pathway low point crest heights in dunes via nourishment and planting to achieve rise in minimum dune height by 500mm on western side and by 250mm to compromised sections of embankment on sheltered/protected eastern side. Complement by removal and reuse of previous 3rd party 'hold the line' rock armour measures to enable adaptive recession and recovery of dunes. Invest in community resilience arrangements to assure 1.45 SoP for 25 year benefit period, inclusive of breach risk.

St Martin's – restore & protect to enable the recovery of the natural strength of damaged sections of whole dunes, raising low point crest heights by 500mm. Move paths and engage to minimise future erosion damage to deliver and sustain estimated 1:75 SoP.

1.3.7 Summary of Costs & Benefits of proposed measures across the four islands

Island	Current (Do-Minimum) SoP	Full PV Costs apportioned per island	Resulting (Preferred Option) SoP	PV Benefits each island	Apportioned Contributions (£1,700k ERDF)	Raw PF score	Adjusted PF	BCR (with PF)
St Mary's	14%	£1,667k	**0.66%**	£6,304k	**£925,000**	47%	100%	**6.8:1**
St Agnes	6.6%	£627k	**0.66%**	£1,143k	**£430,000**	34%	102%	**5.8:1**
Bryher	100%	£509k	**2.22%**	£1,285k	**£275,000**	51%	105%	**5.1:1**
St Martins	5%	£122k	**1.33%**	132k	**£70,250**	46%	103%	**2.5:1**

1.3.8 Properties at Risk by Return Period. Current (& prospective) SoPs - each Island

St Mary's Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05	42	39	Do Nothing 1:1
5	0.00	52	43	**Current Do Minimum 1:7**
10	0.00	54	44	
25	0.08	72	64	
50	0.15	73	67	Do something 1 1:75
100	0.22	81	78	**Preferred Option** & Do More 1:150
200	0.33	85	80	
200 CC 2050	0.45	110	98	
1000	0.40	99	86	

St Agnes Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05	0	1	
5	0.00	0	2	Do Nothing 1:7
10	0.08	1	2	
25	0.33	2	7	**Current Do Minimum 1:15**
50	0.35	2	7	DoSomething 1:75
100	0.37	2	7	**Preferred Option** & Do More 1:150
200	0.40	2	7	
200 CC 2050	0.50	3	8	
1000	0.45	2	7	

Bryher Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05	5	7	Do Nothing <1:1 **Current Do Minimum 1:1**
5	0.00	6	7	
10	0.05	6	8	
25	0.15	6	9	**Preferred Option** & Do More 1:45
50	0.25	6	9	
100	0.35	6	9	
200	0.40	7	9	
200 CC 2050	0.50	10	11	
1000	0.45	8	10	

St Martin's Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05		1	
5	0.00		1	
10	0.05		1	Do Nothing 1:15 **Do Minimum 1:20**
25	0.15		3	
50	-0.01		3	
100	0		4	**Preferred Option 1:75** Do More 1:100
200	0.03		6	
200 CC 2050	0.05		7	
1000	0.04		7	

1.4 Commercial Case

1.4.1 Procurement Strategy

The Council of the Isles of Scilly is able to provide accountability, executive oversight and assurance of financial and contractual compliance. It will deliver the required planning & legal support and the management of tendering and contracting via its procurement function.

Procurement is central to project and risk management & effective delivery. As such it is embedded in the time-lined project delivery plan and a separate/joint Procurement Plan is provided as an appendix.
This identifies in detail how all procurement relevant to the delivery of this project will be in line with the Public Contracts Regulations 2015 (PCR 2015) and the ESIF-GN-1-001 Procurement Guidance.

The procurements to be undertaken within this project shall be based on the 6 stage methodology set out in "Public Procurement Guidance for Practitioners on the avoidance of the most common errors in projects funded by the European Structural and Investment Funds". The method followed will be modified to reflect subsequent relevant changes in published Public Contracts Regulations. The six stages being:

1. Preparation and Planning
2. Publication/Invitation to Bid
3. Submission and the selection of bids
4. Evaluation of tenders/bids
5. Award of Contract
6. Contract Implementation

A Project Director, taking a senior/management role within the Council, will be procured on a fixed term contractual employment basis. The services of an expert Project Director, with a proposed start date in the 3rd quarter of 2020/21, is considered the most effective, efficient and appropriate approach to ensuring development, delivery and effective contractual risk management. Their role will be central to responsibilities for the delivery of the procurement plan.

1.4.2 Key Contracts

The main prospective delivery contracts and estimated contract sums in prioritised order to minimise risk being:

1. Main Coastal Civil Engineering Works (NEC 3 option A) & Bulk Material Supply (£1,400k)
2. St Mary's Bespoke Demountable Barriers (£115k)
3. Porth Hellick Dune Restoration (£65k)
4. Off-island Dune Restoration contracts -
    - St Agnes dune restoration+ 500m (£385k)
    - Bryher dune restoration 360m (£230k)
    - St Martin's dune restoration 200m (£100k)
5. Off-island coastal resilience stock & plant storage, maintenance & deployment
    - St Agnes (£14k)
    - Bryher – (£8k)

The combined approach to management, development and delivery offers significant overhead and contractual risk efficiencies, alongside ERDF PF contribution in enabling realisation. Both are essential to achieving financial viability.

A detailed Procurement Plan for the project, including the additional ERDF & Private Sector elements (not part of the FCERM GiA business case) is included in the Appendix.

1.5 Financial Case

1.5.1 PV whole life cost apportioning, to enable a separate economic appraisal for each island within a combined single project for delivery.

This combined business case proposes implementing the separately justified island-scale flood risk management sub-schemes into a single, coherent, affordable and deliverable FCERM scheme.

Combined proposed scheme summary financial breakdown

Whole life PV Costs after OBC	Construction	Fixed Overhead Costs
Existing Salary Costs		35,552
Cost of Project Director		180,360
Site investigation and survey		42,000
Supervision (Cost Consultant Fees)		49,430
Sub-total		***307,342***
St Mary's Construction costs (62%)	986,079	(187,805 apportioned overheads)
St Agnes Construction costs (19.6%)	358,275	(61,350 apportioned overheads)
Bryher Construction costs (15%)	251,550	(47,435 apportioned overheads)
St Martin's Construction costs (3.4%)	61,200	(10,752 apportioned overheads)
Sub total	***1,657,104***	
Optimism Bias		
OB St Mary's (30%)		352,165
OB St Agnes (40%)		167,850
OB Bryher (60%)		179,391
OB St Martin's (60%)		43,171
Sub total		***742,577***
Contingency (10%)		166,000
Monitoring, evaluation & reporting		35,000
Sub total		***201,000***
St Mary's apportioned		124,620
St Agnes apportioned		39,396
Bryher apportioned		30,150
St Martin's apportioned		6,834
Future cost (maintenance) all on St Mary's		**16,250**

1.5.2 Funding sources

The proposed project and the delivery of this business case is dependent upon securing two sources of financial investment – FCERM GiA and a sum of aligned EU Structural Investment Funds. This funding is available from the 2014/20 England ERDF Programme (for less developed regions) under the Priority Axis 5, Climate Change Adaptation Theme.

An initial first stage ERDF application was made in 2015. A second stage full bid, but for a much smaller programme of works than now proposed, was defined by the St Mary's (frontage) Study, was developed, submitted and approved in principle in 2016. However, it was not possible to progress it or finalise the agreed funding because IoS was the only District in England without any flood risk modelling and mapping (also, the necessary FCERM GiA grant application was not fully developed or submitted). This effectively put the funding and the project on hold. JBA risk modelling of flood risk has since been commissioned by the Environment Agency and completed.
In the meantime the change in exchange rate since the UK's EU exit referendum has made available an additional sum of ERDF funding, believed to be somewhere in the region of £1.4m.

A proposal to revive and extend the original project and seek to utilise the additional sum of ERDF secured support from Executive Officers & Members of the Council of the Isles of Scilly in May 2019. In response to an initial expanded project proposal, ERDF administrators MH&CLG invited preparation and submission of an extended full ERDF application. The revived ERDF proposal fully incorporates & mirrors the significantly larger programme of measures identified in this OBC. It also seeks funding for additional measures to help address water scarcity impacts on the local environment and economy and engagement with islanders to evolve a future Climate Change Adaptation Plan for adoption by the Council as (supplementary) policy and planning guidance.

The financial viability of this project is clearly dependent upon securing both FCERM GiA & ERDF investment.

If both sources of financial investment are committed and the scheme becomes financially viable for implementation, then the evidenced ERDF eligible expenditure can be claimed quarterly in arrears. It is understood that FCERM GiA grant claims can be made for work completed plus 3 months in advance within a financial year. Expenditure claim arrangements should limit the periods and sums during the project lifespan when additional funds will be required to bank-roll the project. During any such periods the Council of the Isles of Scilly will provide interim financing until claims can be made which meet these upfront costs through the overall Settlement Funding Assessment and the Council's General Reserves.

	%	Description	Total £k
Raw Partnership Funding score	44%	from (nominal) whole project PF calculator	
Funding:			
Contributions (list)		ERDF Funding	1,700,250
Other: (list)			
Local Levy			
Non GiA contributions			**1,700,250**
Adjusted Partnership Funding score	100%		
Grant in Aid			**1,356,162**
Project total cost (approval)			**3,056,412**

It is proposal to meet the estimated **£3,056,412** costs of delivery (October 2020 – February 2023) utilising £**1,356,162** of FCERM GiA grant & £1,700,250 of available, aligned but time-limited ERDF EU Structural Investment Funds.

This investment will deliver an estimated £8,864,000 (PV) economic flood damage avoidance benefits to the identified National Property Receptors.

Proposed measures across the four islands will benefit 94 households, including 81 at significant or very significant flood risk, moving 78 of them to medium or low risk. It will better protect and improve 45.4ha of designated habitat. Crucially, it reduces risk to the islands' sources of freshwater which are particularly vulnerable due to being located immediately behind the dunes.

1.5.3 Overall Affordability

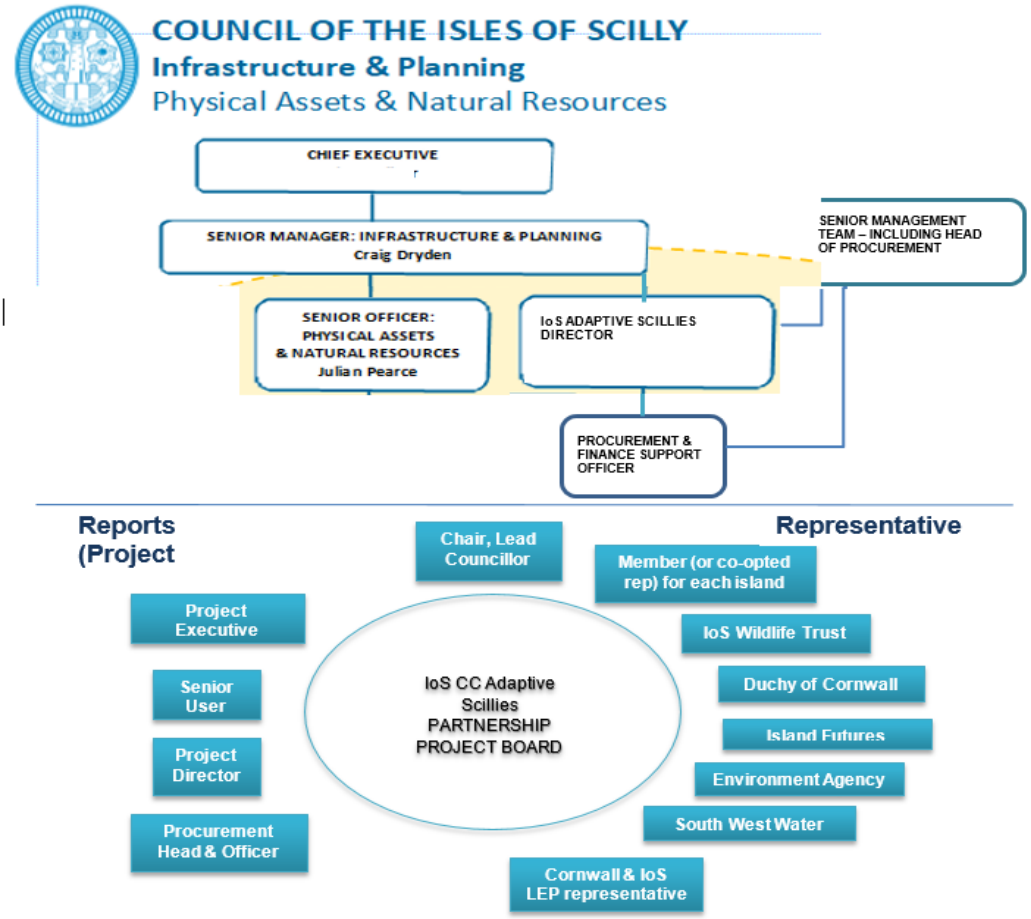
Annualised spend profile (£k)	Yr 0 2019	Yr 1 2020/21	Yr 2 2021/22	Yr 3 2022/23	Yr 4+	Total
Appraisal costs *(defrayed)*		61,420				
Existing staff costs		10,552	12,000	10,000	3,000	35,552
Construction & other costs		142,700	1,001,700	874,269	110,320	2,128,989
Optimism bias		49,000	348,249	300,000	45,320	742,577
Inflation			47,700	84,349	17,246	149,294
Project total cost		**263,672**	**1,409,649**	**1,268,618**	**175,886**	**3,056,412**
Less: Costs not eligible						
Less: Contributions of		**145,200**	**775,300**	**681,750**	**98,000**	**1,700,250**
Less: Local Levy being claimed						
Capital grant claim		**118,472**	**634,349**	**586,868**	**77,886**	**1,356,162**
Grant rate						44%

1.6 Management Case

1.6.1 Structure & Roles

Given the very limited size and capacity of the Council of the Isles of Scilly, resourcing and contracting the services of a suitable Project Director (who can provide the required expertise & leadership) has been identified as critical to effective delivery. This new appointee will work alongside the Council's LLFA lead officer (who will provide senior user responsibilities for the project) and the Council's lead procurement officer. They will report to the Head of Infrastructure (who will be the project executive), and to the Leader of Council (as project sponsor) and will liaise across the Council's senior management team to define and co-ordinate required legal, planning & financial management services.

A Partnership Project Board will be established to provide full executive accountabilities and oversight. The project delivery schedule identifies a series of gateway reviews during the development and delivery programme to ensure effective application of executive management responsibilities.



Benefit realisation is fully integrated into the development and delivery schedule and are reflected in the investment objectives. Benefits are cost-avoidance and non-financial and the primary ones can be realised and reported for each island once measures are completed. The delivery schedule timetables completion for all islands by March 2023. Monitoring and evaluation arrangements, which will be put in place prior to the delivery phases, will support and assure primary and wider benefit realisation.

1.6.2 Delivery Schedule

Events	Date DD/MM/YY
OBC & ERDF full bid approved	May 2020
FSoD sign-off & ERDF GFA signed	July 2020
Project Director appointed	August 2020
Full Project Start gateway review. Main works tendered	October 2020
Project Board established, tender evaluation & gateway review.	December 2020
Main civil engineering works contract let	January 2021

Events	Date DD/MM/YY
Civil Engineering preferred construction window 1	Feb – April 2021
Natural dune restoration research, consultation & specification report to Project Board & gateway review.	March 2021
Contract Old Town & Mermaid demountable barriers	January 2021
Follow-on St Marys dune restoration contracts let	May 2021
Natural dune restoration projects start, St Marys	July 2021
St Agnes dune contract let	Dec 2021
Civil Engineering preferred construction window 2	Sept – Dec 2021
Demountable barriers delivered	Dec 2021
Porth Hellick civil engineering & dune restoration complete & project board gateway review	Dec 2021
Civil Engineering preferred construction window 3	Feb- April 2022
Bryer & St Martin's dune contracts let	March 2022
Interim evaluation, coms plan & contract progress project board gateway review	May 2022
St Agnes Dune restoration + practically complete	June 2022
Civil Engineering preferred construction window 4	Sept – Dec 2022
Adaptive resilience stock arrangement & any remaining off island dune contracts let/put in place (MILESTONE, All contracts let)	Dec 2022
Civil engineering preferred construction window (reserved)	Feb – April 2023
All civil engineering works complete, gateway review	March 2023
Final supplies of adaptive resilience in situ stock to off islands. Closure of main civil engineering contract	March 2023
All dune restoration works practically completed & recorded, gateway review	March 2023

1.6.3 Risks

	Key Risks	H/M/L	Owner	Mitigation
1	Extent of Coronavirus lock-down arrangements obstruct project initiation/start, procurements and delivery timetable	H	HMG	The delivery timetable has been significantly set back so initiation/start is delayed until October 2020 with the main contract start on site/prelims in spring 2021.
2	Securing ERDF funding agreement for delivery within eligible ERDF claim window (currently until June 2023)	M	CIoS & EA	Progression of full ERDF bid & agreement in tandem with OBC assessment & FSoD approval. Ensure submitted ERDF bid is approved in time to enable both funding agreements by July 2020 and timetabled delivery by March 2023
3	The availability & cost of required granite bulk materials	M	CLoS	Incorporate QS & specifically direct supply investigations & assurance into interim project development arrangements
4	Sustaining the full and active support of range of stakeholders	M	CLoS	Early engagement & inputs strongly reflected in proposed approach. PM arrangements that can sustain active support & participation by stakeholders & partners
4	Relative complexity and compliance needs of procurement	M	CLoS	Having a clear risk-based & phased procurement plan, incorporating QS & main engineering contract preparation & putting in place robust PM
5	Weather impacts	M	CLoS	Measures & construction schedule (and changes) have been designed to accommodate and minimise these risks
6	Supply logistics	M	CLoS	Measures, delivery schedule & and procurement plan seek to minimise risk by working within known parameters

1.7 Recommendation

This Outline Business Case seeks approval of FCERM GiA in the sum of £1,356k towards the estimated total delivery costs of £3,056k

St Agnes, looking out towards the 'Hellweathers'.

R Walker April 2020

2. Strategic Case

2.1. Context

This archipelago of granite islands and rocks is located in the Atlantic Ocean 40km south west of Land's End. There are five inhabited islands with a population of 2203, living in 1388 dwellings (2011 census). The total land area is 16.37 km2, St. Mary's being the largest island with a land mass of 6.29 km2.

St Mary's has 1723 inhabitants, the remaining population live on Bryher, St. Agnes, St. Martins & Tresco. 30% of the land area, much of the residential and commercial development, and the majority of critical infrastructure is concentrated in coastal areas at or below 5m elevation. The centre of the main settlement, Hugh Town, is located on a narrow sandy isthmus.

Tourism dominates the local economy, approximately 85% of Gross Value Added (GVA) being dependant on the estimated 235,000 visitors p.a. The main attractions being the archipelago's natural heritage & wildlife. During the summer months the population rises to around 6000. The three main identified local economic constraints being; water scarcity & insecurity, transport difficulties & costs & the acute shortage of housing & commercial space.

The Duchy of Cornwall owns much of the islands, the main exception being the built-up area of Hugh Town.

Tresco is leased long-term and in its entirety to the Tresco Estate. Previously identified restoration measures at South Dune on Tresco remain a project aspiration, but the investment required to deliver them have not been included within this business case. This is in part because of the risk that inclusion could be contrary to FCERM GiA Grant and ERDF Structural Investment Fund eligibility rules. This does not preclude the opportunity to work with Tresco Estate & the Duchy of Cornwall to identify other sources of funding so that, as previously envisaged, the South Beach Dune could benefit from inclusion/expansion in the proposed wider programme of dune restoration. Any uninhabited islands or untenanted land is leased to the Isles of Scilly Wildlife Trust.

The Council of the Isles of Scilly (CIoS) is by far the smallest local authority (unitary) in the UK, yet it has some of the widest responsibilities. These include sewage and water services. However this is likely to change in the near future as a result of the Defra-proposed extension of South West Water's operating licence (subject to Ofwat).

The small size and distribution of the population across the islands, the separation of the district, logistical issues and, the environmental & economic seasonal constraints have been incorporated into the development & evaluation of potential measures and into the development, procurement and delivery of proposed measures.

While communities may be limited in size, especially on the off-islands, it is very important to recognise the value of, and opportunities to utilise, enhance and sustain their coastal resilience capabilities.

The development of this business case and its delivery has, and will continue to, benefit from and be dependent upon support, input of expertise, and the participation of islanders in the stewardship of their coastal natural assets and environments.

The case for investment is made through identification of sources of flood risk and of probabilities, of specific problems and issues of each context and of the development with stakeholders of potential solutions at an individual frontage and inter-connected frontage level. Across each island, modelled flood risk probability events are shown to hydrological connect.

A separate cost benefit assessment-based economic appraisal has been carried out for each island with the . The district-wide approach that is proposed across the islands is justified for such a unique context because of the strong social, economic and environmental inter-dependencies, because it offers a feasible and efficient way for the RMA to manage and deliver measures, and, a coherent multi-island project is essential to securing the 60% partnership funding, which is available but strictly time-limited and essential to any of the individual islands being financially viable.

2.2. Alignment with Business Strategies & Plans

The proposed programme of measures strongly align with and offers delivery of the Shoreline Management Plan, in particular the 2016 mid-term SMP2 Review (please see appendix) frontage policy objectives. This includes addressing the review's recognition of connectivity and linkage between Policy Unit & the vulnerability of lowland moors, meadows and related freshwater & groundwater supply areas on St Marys and on the off-islands.

Due to the lack of inland water courses, the islands are not features in any River Basin or Catchment Flood Management plans.

It seeks to meet the specific Isles of Scilly FCERM needs identified on the FCERM1 MTP National Capital Programme and deliver outcomes utilising budgets (nominally) allocated in that programme during the next three financial years.

The programme of measures will be consistent with the Council's statutory duty under the Flood and Water Management Act 2010. The project is strategic in that it delivers the IoS Local Flood Risk Management Strategy.

As the table below demonstrates, the Isles of Scilly's medium term flood and coastal risk management investment needs are indicatively identified, with nominal funding allocations, within the Environment Agency FCRM Capital Programme 2019/20.

IoS FCRM1 entries in the National FCRM (MTP) Capital Programme 2019/20

FCRM1 - National Capital Programme
Post Local RFCC Choices, IoS

REFERENCE		PROJECT TOTALS (calculated from relevant columns)				
National Project Number	Project Name	Total Project Expenditure - PROJECT TOTAL	Grant in Aid - PROJECT TOTAL	Public Contributions - PROJECT TOTAL	Further Contributions Required - PROJECT TOTAL	OM2 - PROJECT TOTAL
SWC501E/000A/067A	Isles of Scilly - 5 islands - Delivery of SMP Intent	12,812,796	218,622	0	12,594,174	34
SWC501E/000A/068A	Management Area 44 - Tresco - Delivery of SMP Intent	1,231,992	62,016	0	1,169,976	12
SWS005C/000A/048A	Porthcressa Sea Wall Repairs, St Marys	900,000	100,000	0	800,000	20
SWS005C/000A/078A	Mermaid Sea Wall Repairs, St Mary's	100,000	100,000	0	0	2
SWS005C/000A/080A	Town Beach Flood Defence, St Mary's	400,020	400,020	0	0	21
SWS005C/000A/044A	Church Sea Wall Repairs, Old Town, St Mary's	150,000	90,000	0	60,000	0
SWS005C/000A/077A	Lower Moors Catchment Management, St Mary's	675,000	200,000	475,000	0	20
SWS005C/000A/076A	Hell Bay Sea Defence Repairs, Bryher	100,000	100,000	0	0	5
SWS005C/000A/074A	Dune Management Plan and Works, Isles of Scilly	675,000	200,000	475,000	0	1
SWS005C/000A/075A	Great Pool Sea Defence Repairs, St Agnes	100,000	100,000	0	0	1

2.2.1 Critical Infrastructure

The Local Flood Risk Management Strategy for the Isles of Scilly identifies flood and coastal risks to local critical infrastructure, the selection below is for St Mary's. The extent of these vulnerabilities are reflected in the objectives and the development of the proposed measures aims to deliver reduced risks to critical local infrastructure across the islands.

Service	Location	Description
Water and Sewerage	St Mary's; Lower and Higher Moors.	Groundwater abstraction wells.
	St Mary's; Old Town, Porth Mellon, Porthloo.	Mains water supply.
	St Mary's; Old Town.	Mains sewerage and bio bubble treatment plant.
Waste	St Mary's; Porth Mellon / Moorwell.	Islands' waste management and recycling site.
Communications	Tresco; South Dunes.	Telecommunications link for the island.
Energy	St Mary's; Porth Mellon, Trench Lane Old Town.	Electricity Substations.
Emergency Services	St Mary's; Porth Mellon Business Park.	Fire, Ambulance and Coastguard stations.
Transport – on island	St Mary's; Porthloo.	Only road access to Porthloo and site of the principal boat park and associated maritime businesses.
	St Mary's; Porth Mellon (south west end).	Principal highway connecting the administrative centre of Hugh Town to the rest of the island.
	St Mary's; Old Town.	Beachfront principal highway connecting Hugh Town to Old Town.

2.2.2 The Local Plan

The draft Local Plan for 2015-2030 identifies settlement boundaries for St Mary's which include the sites for the proposed works at Porth Mellon (the eastern end of the Hugh Town Settlement), Porth Loo and Old Town. In addition it identifies Porth Mellon Industrial Estate as the prime employment/industrial site on St Mary's.

The extent of overlapping environmental & heritage designations and sensitivities, the need to avoid inappropriate/high risk coastal development, and, extremely limited availability of development land and sites, are clearly reflected. Aspirations identified in the Local Plan to address an acute shortage of locally affordable (and accessible) housing will not directly benefit. However, without investment in flood and coastal risk management measures which secure and sustain key infrastructure, especially water supplies, it will be difficult to develop and approve proposals which would comply with NPPF sustainability criteria because of additional stress and dependency on unsustainable critical infrastructure.

At present the Flood Zone 2 (1:200) NPPF flood map outline remains the 5m contour and given the lack of prior risk modelling and mapping (on which to base a flood risk assessment) , this has been another significant barrier to new development, inclusive of some contexts which might be appropriate.

The realisation of this project proposal offers an opportunity to refine flood zone mapping so as to more accurately reflect a reduced distribution of current and future risks. This would enable better differentiation between appropriate and inappropriate development opportunities in terms of flood risk.

2.2.3 Isles of Scilly Flood Risk Modelling Report (draft) JBA December 2018.

This has been a key input to the progression and definition of this project. It provides baseline mapped evidence of the pathways, extent & depths of (overtop) flood risk & property receptors counts, across a range of event

probabilities across all the inhabited islands. This enables the potential benefits of measures to reduce flood risk to be quantified, compared & appraised. Comparison with recent flood event gauge measurements, extents and depths (on St Agnes & Bryher) has enabled best possible recalibration to take account of the additional flood risk and consequential damages arising from (commonly occurring) breaches in dunes. This additional risk has limited impact on St Mary's and St Martin's where overtop TUflow modelled extents and depths reflect recent events but is of greater significance on St Agnes & Bryher with their greater dependence on damaged and vulnerable dunes which are exposed to greater wave action.

These additional risks has been highlighted by recent and historic storms, particularly 2014, 2004 & 1989, which exposed the vulnerability of low lying critical infrastructure across the inhabited islands.

2.2.4 St Mary's (&South Dune Tresco) Dune Management Study

Proposed substantive measures on St Mary's –

- Porthloo Dune Management Plan (CPW 3182)
- Porth Mellon Dune Management Plan (CPW 3179) &
- Porth Hellick Dune Management Plan (CPW3184)

Have benefited from an FCERM2 grant funded (£95k) study.

This Study (Arcadis) has investigated and informed long and shortlist options as well as providing outline design specification and quantified costing of a range of measures and dune restoration interventions to these frontages on St Marys (& Tresco).

Breakdown quantified costings of the range of measures across these frontages, suitably cross referenced and checked, have provided a basis (alongside initial surveying) for the development of natural dune restoration outline specifications and cost estimates across the other islands, where higher cost and risk, hard civil engineering works are not required.

2.3 Environmental Constraints, Sensitivities & Opportunities

2.3.1 Landscape Quality & Designations

The whole of the Isles of Scilly are an Area of Outstanding Natural Beauty, a Conservation Area and a Heritage Coast. Further designations apply including; RAMSAR sites, Special Area of Conservation (SAC) EU Habitats Directive, Special Protection Area (SPA) EU Habitats Directive, a Marine Conservation Zone, 26 Sites of Special Scientific Interest, 238 Scheduled Monuments, 129 Listed Buildings & a Grade 1 Registered Park & Garden.

The distinctive landscapes (& coastal contexts of some 200 islets) includes; lowland heaths & moors, grassland & pastures, small dry-stone walled & hedged fields, rocky outcrops, beaches, small harbour settlements & quays, scattered rural homes & enterprises and an extensive set of dune systems.

These dunes and their seaward and landward context are integral to the quality, distinctiveness and the functioning of the environment. Sensitivity, the need to work with natural processes and valuing the dunes as multi-functional natural capital assets are essential considerations.

2.3.2 Benefits of a Natural Capital & Working with Natural Processes Approach

These apparent environmental constraints have proved highly beneficial to the development of the proposed project with its focus on natural capital restoration of the dunes. This is especially the case regarding the need to simultaneously address modelled and un-modelled flood & coastal risk when eligible FCERM GiA investment requires consideration of all risks, but fundamentally is defined by the opportunity to deliver reductions in risk/s that are evidenced by modelling.

The overall project, and approaches to specific sites and off-islands, have been developed through discussions with relevant site owners, a selection of local communities, Members of the Council of the Isles of Scilly, the Duchy of Cornwall, the Isles of Scilly Wildlife Trust, the Isles of Scilly Area of Outstanding Natural Beauty Partnership, Natural England and the Environment Agency. There is widespread support and agreement about the need for the project.

An integral outcome of the project will be to protect, improve & sustain 45.4 hectares of coastal and freshwater habitats to attain better conservation status. In addition the work around the Lower and Higher Moors is being integrated with the water level management plans for these areas.

Strengthening, improving elevation profiles, raising crest heights, addressing the causes of damage, improving public access and appreciation of the dunes and their defensive function will all contribute to giving them the space and flexibility to naturally regress in response to sea level change and associated climate change impacts.

Investment in assisted and enhanced natural restoration, which integrates a larger and more diverse web of living biomass into the dunes, will provide enhanced habitat for invertebrates, birds and support the continued recovery of species such as the Scilly Shrew. It will also give the dunes and their ecosystems the capability to better recover and rejuvenate with less loss of crest height in the aftermath of future storm damage.

Restored sustainable dunes offer multiple benefits to beach environments and the inter-tidal zone on their seaward side as well as better protection of large hinterlands of designated sites from flood inundation and saline

intrusion. Key habitats include the islands freshwater wetland and native woodland which are vital for a range of bird species for both feeding and breeding periods.

Timely investment in the proposed blue/green infrastructure approach will minimise the materials needed, the generation of waste and the carbon emissions and costs, especially when compared to those that would arise from a deferred and perhaps reactive hard civil engineered approach.

Sustainable procurement & project management will minimise the footprint of the required bulk materials and the initial specification of works requires the re-use of all available in-situ materials.

The significant net gain environmental benefits on offer are recognised and supported by local stakeholders and more than offset the minor impact of implementing relatively static measures on St Mary's, required to deliver medium term protection of critical local economic infrastructure. A Habitat Regulations Assessment (HRA (screening) and an EIA were commissioned and the Screening Statement & the Assessment were completed June 2019. These conclude - *"given the location, nature and scale of the works proposed at each development site and the very limited scale and duration of the construction works required, the assessment has not identified any likely significant effects on the European sites. As such, no further assessment is required."*

Considerable, iterative discussions have been held with land owners, including the Duchy of Cornwall, and with a range of landscape management interests and stakeholders. The proposed approach and the mix of measures, which, as per the defined objectives, offer a sensitive approach to adaptive protection of designated landscapes, were very much shaped by and are reflective of that engagement and inputs.

This process has included a number of site visits with Natural England, the IoS AONB and the IoS Wildlife Trust – it is inclusion in the project objectives and engagement in considering options and shaping the proposed measures, which have ensured that further mitigation is not going to be required.

The Council of the Isles of Scilly has had to use its reserve funds to commission and progress this item at its own expense to ensure that the HRA Assessment (screening) & EIA are complete, available and will enable the Council of the Isles of Scilly, as the LPA, to consent and enact these works as per the proposed schedule.

2.3.3 Water Services, Scarcity & Insecurity

Until early 2020, the Council of the Isles of Scilly was the main provider of water and wastewater services, complemented by arrangements by the Duchy of Cornwall on some of the off-island and a range of evolved supplementary 'off-grid' arrangements.

Via negotiation by Defra and Ofwat South West Water's area of appointment has been extended to include the islands. Change to who provides water services, has been a matter of considerable commercial and political sensitivity and uncertainty. It is beyond the scope of this business case.

Consultative published plans, suggest that a transfer of services could result in investment by SWW of £13m into improvements to the quality of supply and wastewater treatment, potentially within the timescale of this project.

In terms of this business case, the prospective transfer of water services is not itself a significant issue.

What is clearly relevant, regardless of who provides water services, is the extent of flood and coastal risks to the limited primary water resources (as well as supply and wastewater infrastructure) across the islands, These vulnerabilities relate directly to the dune systems, because all the wetlands and most of the groundwater recharge areas, which supply low level wells and boreholes, are directly behind them. These vulnerabilities are acute because the Isles of Scilly has no water supply connection to the mainland or between the inhabited islands.

In recent years the Council, residents, businesses & visitors, especially on St Mary's, have again experienced severe water supply shortages and insecurities. Significant uncertainties remain about the extent and functionality resilience measures of these groundwater supplies.

The islands have a history of water scarcity and of implementing their own. Limited water supply 'catchments' and/or recharge areas due to the geology, topography, ecological sensitivities, historic contamination & risk of saline intrusion all combine to limit the run-off which can sustainably provide water supplies.
Increasing rainfall variation, as a predicted result of climate change, will increase water scarcity and shortages. Unsustainable groundwater abstraction & increasing desalination risks considerable environmental & economic consequences.

St Mary's 2018 (& 2019) water shortage and prior rainfall patterns exemplify the effects of climate change & demand projections by Water Companies for much of mainland England for just 25-30 years into the future. For the Isles of Scilly this is happening now.

Water scarcity, shortages and the environmental and economic consequences, are beyond the scope of flood and coastal risk management investment.

Uncertainties about the extent and functioning of supply resources and the unusual and sensitive changes happening to the delivery of water services make it difficult to separately quantify and apportion the economic value of flood risk to water supply resources, or of reduced risk damages from proposed measures.

However, they are included within a combined assessment of risk cost to the local economy via flood and coastal damage to Natural Capital assets and ecosystem services.

Flood and coastal risk vulnerabilities and the need and opportunities to reduce insecurity of existing supplies (in a manner compatible with change in supply arrangements) have been incorporated into this business case and appraisal through inclusion as a key objective and as an option selection criteria.

2.4 Climate Change

The modelled JBA flood inundation mapping includes assessment of the increasing overtopping risk arising from UKCP09 climate change predictions, utilising the related Defra sea level rise allowances. However, it does not include the uncertain but potential increased probability, frequency and severity of breaches and erosion or the resulting damage-consequences.

UKCP18 scenario projections (& allowances) for costal risk are based on mean sea level rise. The other potential effects of climate change, via the dynamics of low-pressure systems, the potential for greater tidal surges and increases in wind velocity & wave heights are not included. Sea surface temperature in this context has already risen by 1°C.

These further possible dynamic effects of a warming climate, beyond the current scope of predictions are a concern because of the particular vulnerability of the islands to any increase in the frequency, severity and track of (extreme) cyclonic Atlantic low pressure systems.

Increasing variance/unpredictability of rainfall is also a relevant factor in this context, specifically the risk of it compounding issues of isolation, scarcity and the coastal vulnerability of fresh water sources & supply infrastructure.

The conclusion being:

- The Isles of Scilly is the District in England with the greatest proportionate exposure to current & future climate change risks, especially water vulnerabilities.
- That assessment of the frontage flood risk problems, and analysis of opportunities to reduce those risks in a proportionate and cohesive way (and the assessment of this business case), should factor-in the uncertain but nevertheless significant extent of climate change vulnerabilities.
- Investment to reduce flood and coastal risks will be central to climate resilience for IoS.
- Investment in flood and coastal risk management should be complemented by (and benefit from) expert input and cross-sector civil participation in the development of a climate change adaptive plan for IoS. This would identifying the range of future climate threats, the relevant indicators/triggers and the required future resilience & civil contingency measures. Involvement in decision-making and shared ownership and responsibility for implementation will be critical to the worth of a climate change adaptive plan. This is beyond the scope of this business case, but is an element of the expanded ERDF funding bid.

2.5 Investment Opportunities

EU Structural Investment Funds, under the Promoting Climate Change Adaptation, Risk Prevention & Management Priority of the 2014-20 ERDF England Operational Programme, in particular the Less Developed Regional allocation for the Cornwall & Isles of Scilly Local Enterprise Partnership area, offers a substantial complementary source of investment needed to deliver this business case.

A clearly defined objective of the development of this project is realising the opportunity to combine FCERM GiA with this available, strongly aligned, but tightly time-limited EU source of funding.

The range of outcomes and outputs which the project offers are eligible from each of these sources of investment and both are required to make the scheme financially viable. Funding from both will enable delivery of a programme of measures which will better protect & sustain households & commercial properties as well as critical and environmental infrastructure, especially the vulnerable freshwater supplies (and habitats) which are essential to sustaining biodiversity, livelihoods and the local economy.

The primary output measure for Priority (Axis) 5 investment under the 2014-20 ERDF programme is the number of commercial properties directly (and indirectly) benefiting from reduced flood and coastal risk, the secondary output measure is areas of designated habitat which are improved and benefit from reduced risk.

The sum of ERDF available to this project, based upon a proposal and subsequent invitation to expand the £900,000 2015 IoS Dune Management initial ERDF bid, is believed to be around £2,350,000.

This extra sum of ERDF under the Cornwall and IoS 'less developed region' programme is something of a 'windfall' in that it has arisen because of the change in exchange rate since the 2016 EU referendum.

The broad objective of the PA5 ERDF theme is to invest in actions which better project vulnerable local economies and local businesses from the risks and constraints on their sustainable growth, which arise from exposure to flood, coastal and climate risks.

Certainties about time limits regarding these funds are inevitably effected by timing uncertainties regarding the UKs proposed exit from the EU –

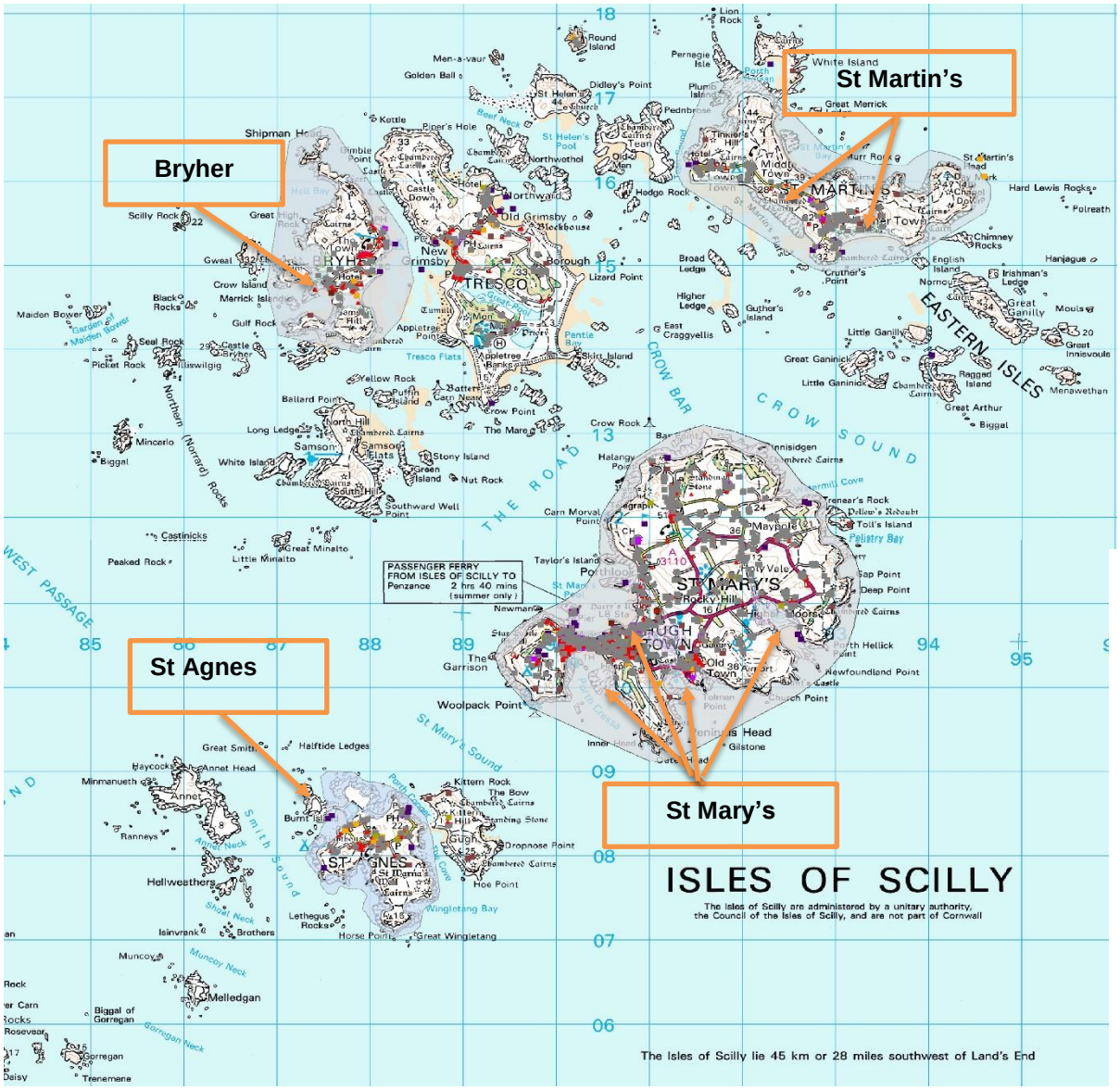
- Strong assurances have been given by Government that is will honour all EU Structural Fund projects which are agreed before the UK exits the EU.
- It is also likely that additional ERDF projects under existing programmes (and reserve fund arrangements) will be offered agreements during the transition period.
- Expenditure under the Structural Fund 2014-20 programme is currently allowable until March 31st 2023, so a three year delivery window is still potentially available.

It is intended to submit a refreshed and expanded full detailed ERDF bid in immediate follow-up to this FCERM GiA business case and to rapidly progress it in parallel with assurance and agreement of the financial sign-off of this business case.

The expectation beyond ERDF full bid submission and MH&CLG's consideration and approval of it, is that they will define the details which need to be supplemented or finalised and evidenced to enable the mutual signing of a General Funding Agreement with the Council of the Isles of Scilly. The expected timetable for this is for approval of the bid before 31st of January (so agreement is offered before the current UK EU exit date) and a General Funding Agreement signed by April 2020.

A range of local and wider partnership working and smaller/in-kind investment opportunities are available, and necessary, especially regarding the natural restoration of dunes. Examples of these opportunities include; working with the Wildlife Trust, AONB Partnership, the Duchy and tenant farmers on the re-routing of coastal footpaths across the islands as well as information, interpretation and participation in restoration. It is also anticipated that a variety of mutually beneficial resourcing arrangements & efficiencies will arise through further engagement with the Duchy of Cornwall, its leaseholders and with future water and wastewater service providers.

2.6 Contextual Maps – Islands and St Mary's frontages



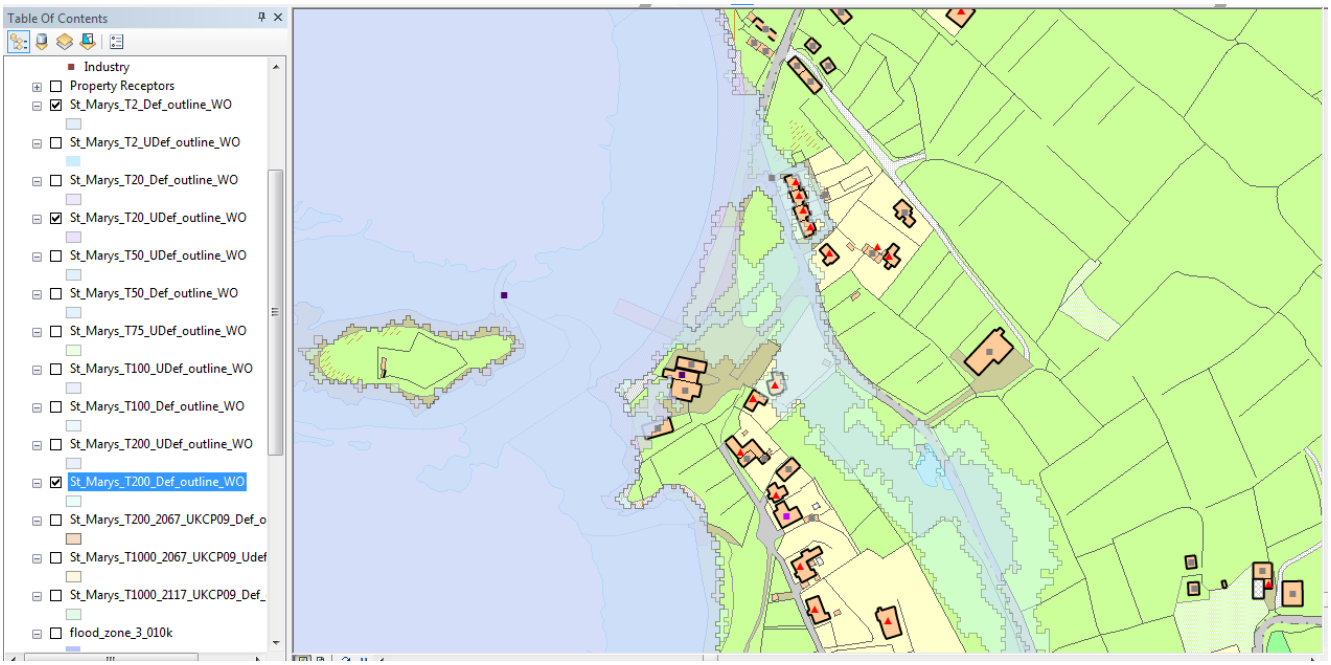
2.7 Current arrangements, assessment of problems & causes of risk

The specific problems and risks considered by frontages, for St Mary's & for each of the off-islands are as follows;

2.7.1 St Mary's

Porthloo

The stated approach in the SMP2 is for No Active Intervention (NAI). However it recognised recent damage and exposure from direct wave action due to its westerly aspect & the prospect of 30m of inland erosion by 2015. Modelling demonstrates the risk of over-topping impact on the Lower Moors SSSI and associated impact on the freshwater supply for the. The elevated presence of heavy metals have been identified at the northern inlet into the Lower Moors. Measures will need to consider water level management and ecological sensitivity of the Lower Moors SSSI, while maximising consistency with the SMP2.



Investment in sea defences in this area by third parties demonstrate that at a local level there is more value associated with this frontage than was determined by the high level economic assessment undertaken by the SMP (& borne out by recent JBA modelling). The area is the site of the only significant sized boat park on the island and is also the location of the only commercial marine workshops & slipway capable of managing the inter-island boats. There is such limited development space on the islands that there is no alternative site for such facilities. The inter-island boats are central to the visitor economy of the islands and are crucial in supporting inter-island travel and as such this area is central to the local economy and the sustainability of communities on the islands.

Debris from overtopping of Porthloo bank 1989 storm

Damaged Porthloo bank after 2014 storm

Porthloo was subject to erosion, breaching and overtopping of the embankment along the shoreline during both 1989 and 2014
The existing defence comprises a remnant dune at the top of the backshore section of the beach frontage. This remnant dune has been supplemented over the decades by a combination of building material and local rocks and boulders to develop an ad-hoc embankment.

During 2014-15 considerable responsive work was undertaken at the southern end of the bay, the construction of a new slipway and repair of embankment storm damage. This led to a structure at the southern end of the bay that was not clearly aligned to the SMP2 but reflects the importance of the boat-park and associated marine businesses at this location. These works have secured the slipway area as an important site for offloading bulk materials to the island via landing craft. However, these reactive works raised the defence height in the specific location by 750mm but don't address overtopping at the more vulnerable northern end of the bay and management of associated outflanking and flood risks to local receptors. The seaward face of the whole frontage is subject to continual wave action and the changed profile has increased the impact leading to exposure and amage to the geotextile matting that was used with the intention of enabling the bank to stabilise.

Slipway & embankment

Exposure of geotextile matting after 2 years

Demountable defence & south end of embankment

View along crest of embankment from north end

Estimated current SOP from overtopping (for residential receptors with 250mm thresholds) – 1:7

Number of residential & non-residential properties at risk for range of probabilities from flooding directly through this frontage

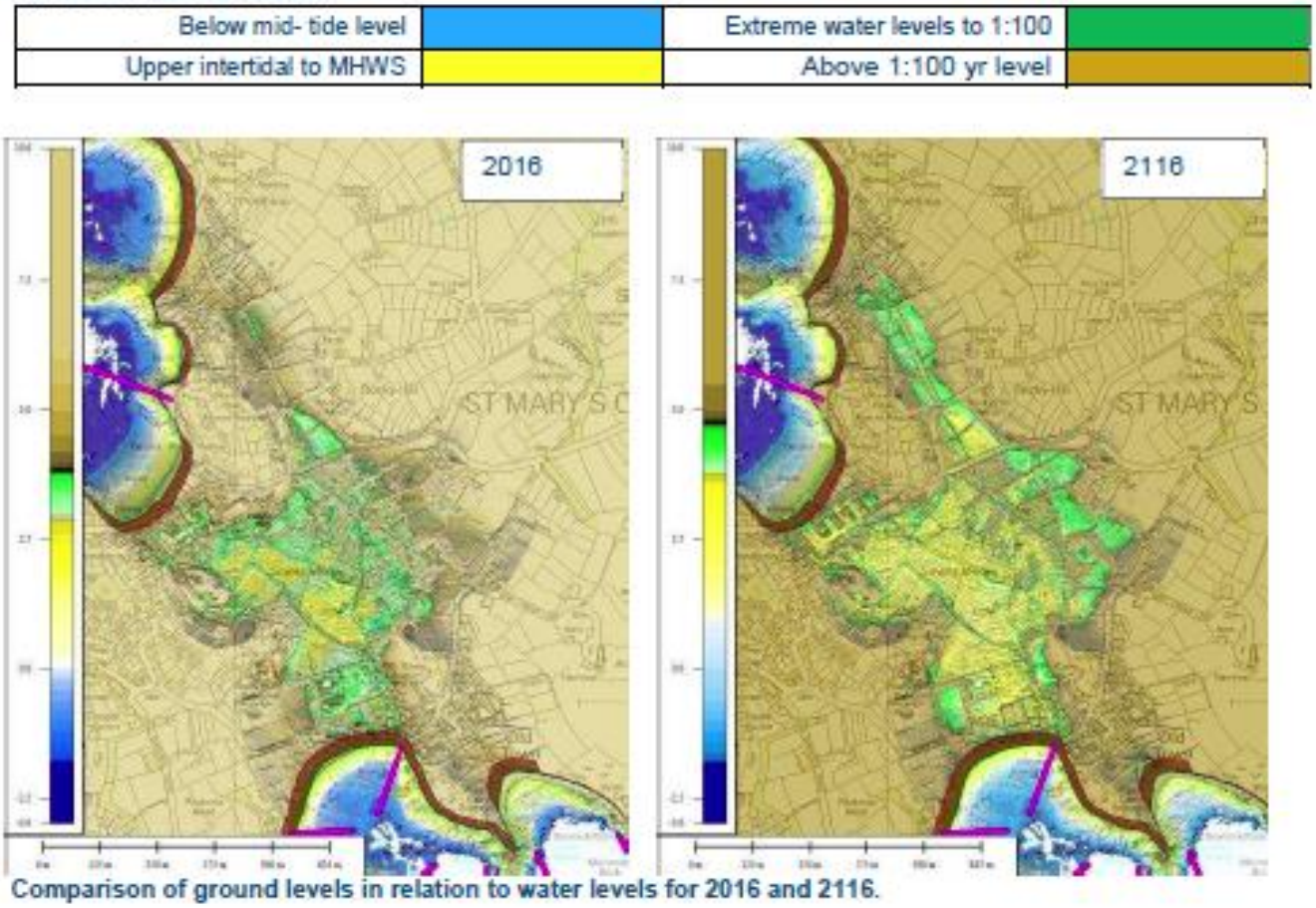
	Residential	Non
1:2		
1:5 – 0		1
1:10 – 5		1
1:75 – 6		2
1:200 – 7		4
1:200 2050 CC – 7		5

Porthloo – weak, low-level embankment overtops and 'breaches' at about a 1:7 threatening immediate small number of residential properties, infrastructure and inundation running into Lower Moor at greater than 1:100

Local frontage aims

- Protect Lower Moors SSSI from saline intrusion
- Protect residential properties
- Protect Porthloo's only road access
- Protect principal boatyard and associated maritime services
- Enhance the environmental quality of the beach and the remaining dunes

The aim is to reduce the vulnerability of Lower Moors SSSI (one of two freshwater source areas on St Mary's and location of the most productive freshwater extraction borehole on the island) to saline intrusion by formalising the de-facto defence on the beach. Further intervention could protect the access road at the northern end of the bay from being undermined and washed away. At the southern end of the beach, the commercial area risk of inundation during storm events can be managed by improving and sustaining the third party defences.



Comparison of ground levels in relation to water levels for 2016 and 2116.

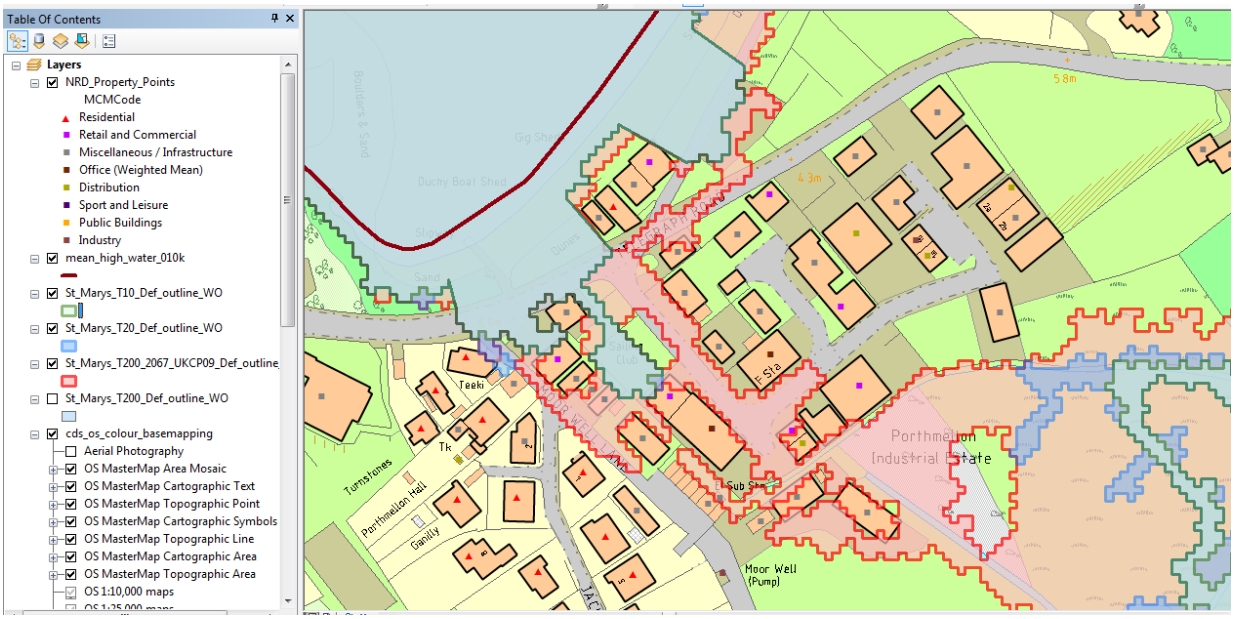
Porthmellon

Western end of Porth Mellon

Vertical soil section supporting the road above at western end of Porth Mellon

Porthmellon is a wide sandy beach facing NW onto St Mary's Pool. Natural sand dunes have developed around the head of the beach and across most of the area. These form a protective crest to the backshore and low lying vulnerable hinterland. At the south western end of the beach the ground behind rises towards Hugh Town and the road is located immediately above and behind the foreshore. The embankment at this location is a mix of sandy soil and vegetation and is not part of the healthy dune system which has developed to the north east of the slipway around the rest of the bay. There are some granite boulders around the head of the beach and across the foreshore which have been locally displaced leaving just a near vertical face of sandy subsoil supporting the road.

The flood water pathway also includes the potential inundation of an immediate cluster of properties behind the frontage. These include the island's only 'business park' the combined fire, ambulance and coastguard response centre, an electrical sub-station & St Mary's waste transfer and recycling facility.



Modelled flood event extents, Porthmellon

Although not a formal defence, the healthy sand dune protects the low lying hinterland behind the beach and for most of its length there is sufficient space for it to roll back responsively and continue to provide adequate protection for the foreseeable future. However, in the south west corner of the bay, erosion is already undercutting

the road and this, combined with the slipway & surrounds, plus a small section of the dune (which has been damaged by foot access) provide potential flood inundation pathways to Lower Moor.

The area suffered erosion undercutting of the bank during February 2014 storms and inundation via the slipway and its immediate surrounds.

The SMP2 review recognised the need for intervention to protect the road as the area passes from a HTL approach during Epoch1 to Managed Retreat during Epoch 2 – 2025 & beyond.

A potential breach point and secondary inundation pathway exists within the dune which results from beach access 'foot fall' erosion. This can be seen in the picture below.
There is also a small deteriorating seawall at the eastern end of the bay which protects the coastal footpath and a major water pipe.

Beach assess over the dune causing erosion

Sea wall at eastern end of Porth Mellon

Porthmellon – overtopping (and erosion) threatens the main road connecting Hugh Town (the administrative centre) to the rest of St Mary's. Lower level events disrupt access while Higher level events (1:200+) risk inundation of electrical substation, combined fire, ambulance and coastguard response station, waste transfer and wastewater treatment plant and some risk of saline inundation of Lower Moor SSSI.

Local frontage aims

- Protect Lower Moors SSSI from saline intrusion
- Protection of the main road connecting Hugh Town (the administrative centre) to the rest of St Mary's
- Protect properties including the business park, emergency response centre and an electricity sub-station
- Protect St Mary's waste transfer and recycling facility.
- Sustain the health and mobility of the dune system north of the Gig Shed
- Sustain and improve recreational access for water sports and marine activities

Redwing sailing dinghies

Estimated current SOP from overtopping (for residential receptors with 250mm thresholds) – 1:15

Number of residential properties at risk for range of probabilities from flooding directly through this frontage

1:10 – 0	**(5 non-residential)**
1:20 – 1	**"**
1:75 – 1	**"**
1:200 – 1	**"**
1:200 2050CC – 1	**22**

Lower level events disrupt access while Higher level events (1:200+) risk inundation of electrical substation, combined Fire, ambulance and coastguard response station waste transfer and wastewater treatment plant.

Old Town and Lower Moors Catchment Area

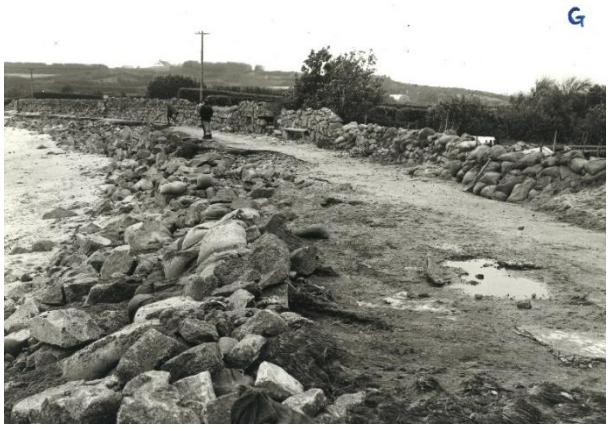
View of Old Town Bay

The picture above highlights how the hinterland behind the road is low lying, this area feeds directly into the Lower Moors SSI and across to the sites of Porth Mellon and Porthloo on the other side of the island. The whole of this Lower Moors area does not exceed a height of 5m above ODN, with an average height of c.3m ODN.

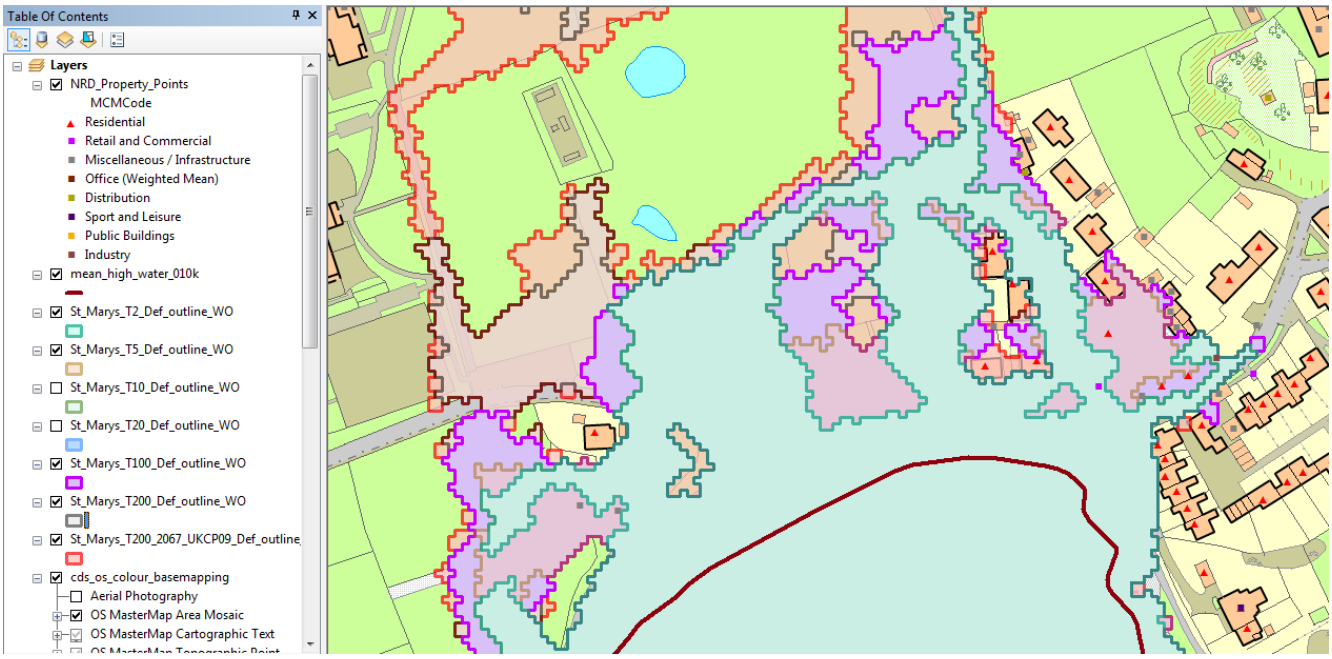
The original sea wall defences in Old Town were built in 1963, tied to a splash wall to the rear (landward side) of the road along the sea front. Further strengthening and improvements were made in 2000 and 2010. Overtopping is frequent (occurs on an annual basis). Erosion pressure (recession mapping indicates up to 30m of erosion by 2115) and risk of inundation of Lower Moors define this as one of the most pressurised frontages.

The SMP defined a HTL approach for the first Epoch while the SMP2 allocates a MR approach for Epoch 2 and beyond. However, it notes that the road is the high point of the surrounding area landward and that impacts on Lower Moors would need to be addressed. Clearly, delivering managed realignment in this context will be complex, potentially expensive and would lead to significant changes to landscape and the existing settlement.

Overtopping of the Sea Wall in the northeast corner of Old Town Bay during 2004



Damage to Old Town road from 1962 storm prior to construction of sea wall



Estimated current SOP from overtopping (for most vulnerable residential receptors with 250mm thresholds) – 1:2

Number of residential properties at risk for range of probabilities from flooding directly through this frontage

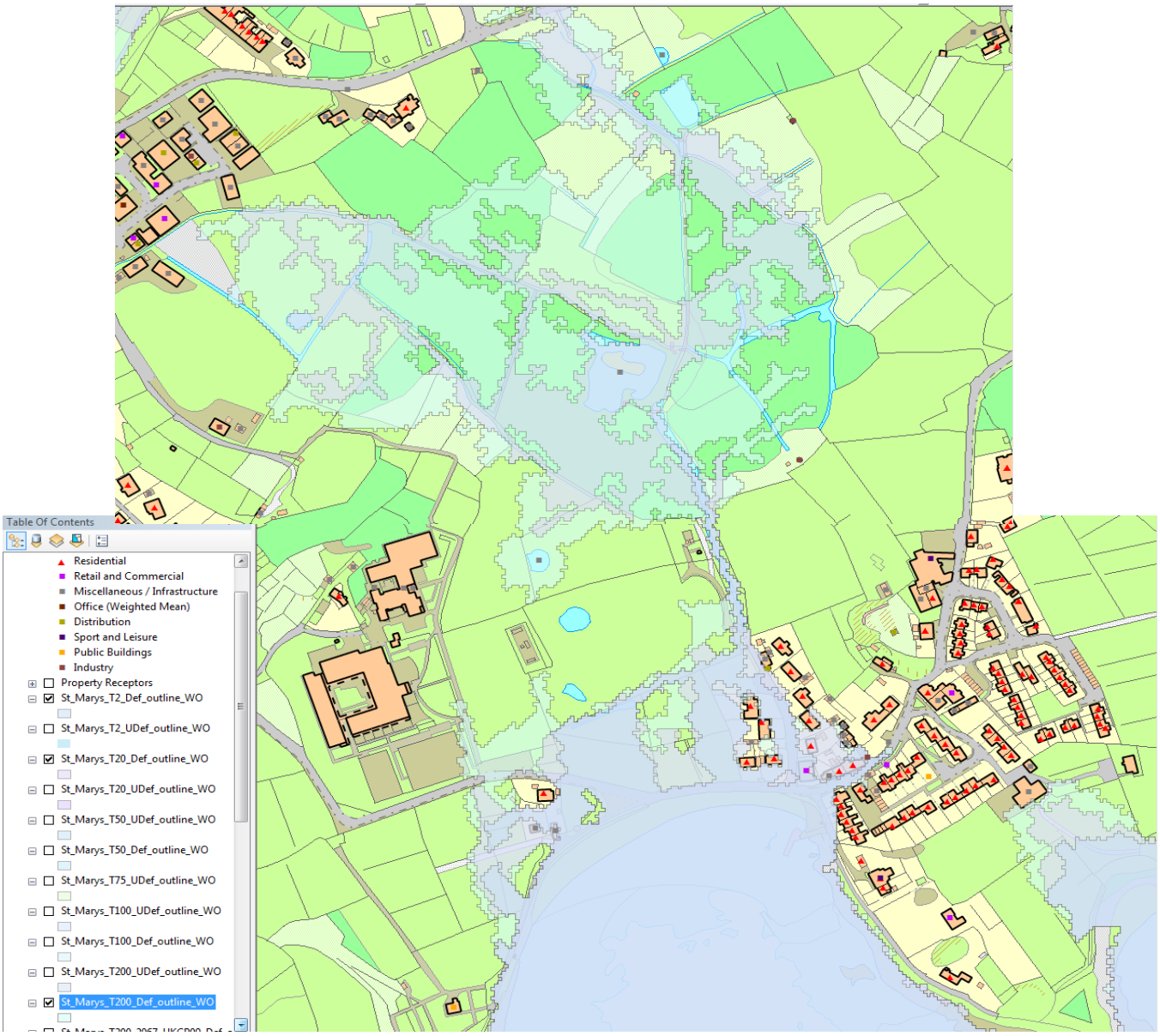
1:2 – 9	**(6 non-residential)**
1:5 – 11	**10**
1:20 – 11	**10**
1:75 – 11	**10**
1:100 12	**11**
200 – 12	**11**
1:200 2050CC – 12	**14**
1;1000 2050 CC - 28	**18**

Old Town – wave overtop accumulations and run-off threaten cluster of 12 residential and 10 non-residential as well as most significant saline inundation threat to Lower Moor & island's primary water supply.

Local frontage aims

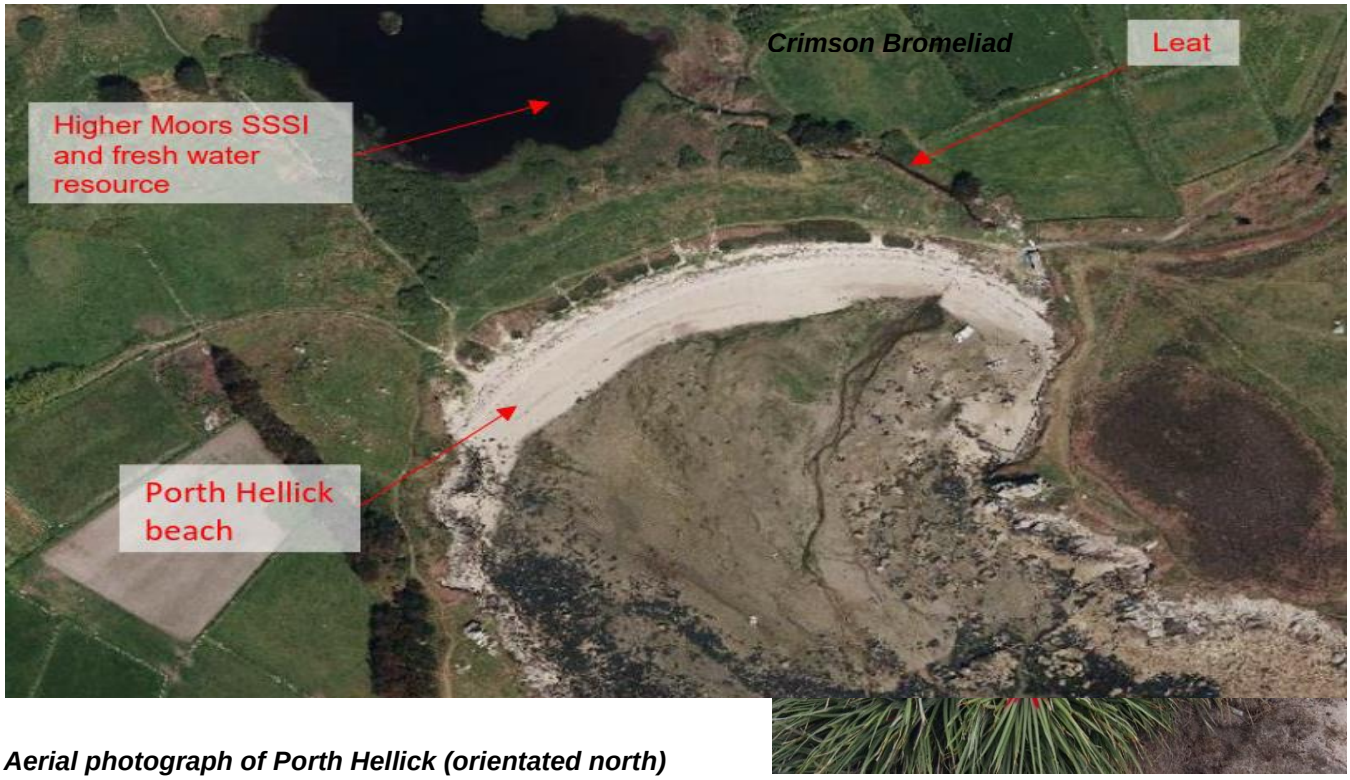
- Protect Lower Moors SSSI from saline intrusion
- Improve management of surface water and drainage from the Lower Moors to help sustain water supplies
- Protect domestic & business properties
- Protect sewerage Bio-Bubble treatment plant and electricity sub-station infrastructure
- Sustain historic quay and transport connections between Old Town and Hugh Town

Lower Moors, flood extents



Porth Hellick

Porth Hellick is located on the south-east coast of St. Marys. The 250-m wide bay is flanked on both ends by rocky outcrops. The substantial backshore storm ridge is made of coarse sand (4-10 mm particle size) and vegetation is well established along its crest including Crimson Bromeliad (Fascicularia Bicolour) & Hottentot Fig (C.edulis).



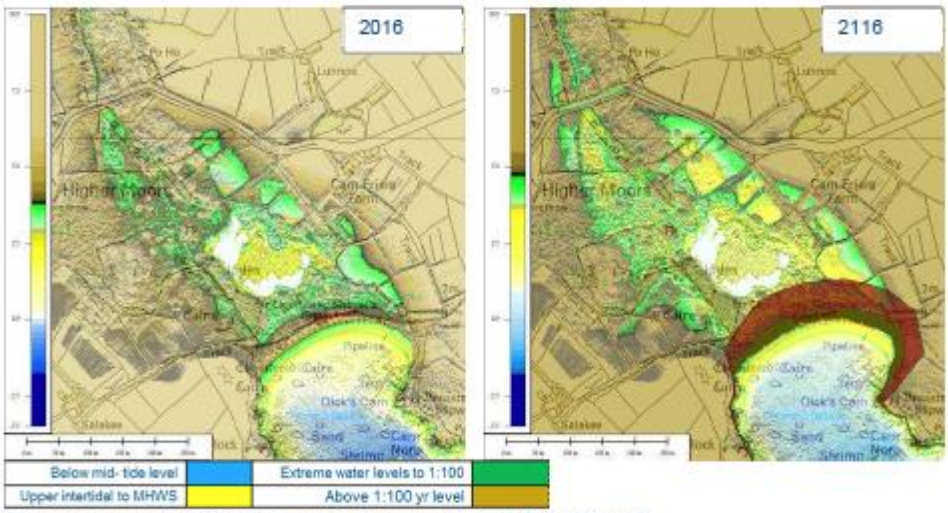
Aerial photograph of Porth Hellick (orientated north)

However, there are gaps and low points, the accumulated damage from storm events during the past decade. The far western end has suffered damage as a result of informal access and other storm damage points have been perpetuated by their use for beach access. At the eastern end, the dune has suffers from the action of boat launching, despite it being discouraged at this site. Additionally, the construction of the existing (leat) outfall from Higher Moors Pool required the excavation of dune which was not reinstated to match the existing dune levels.

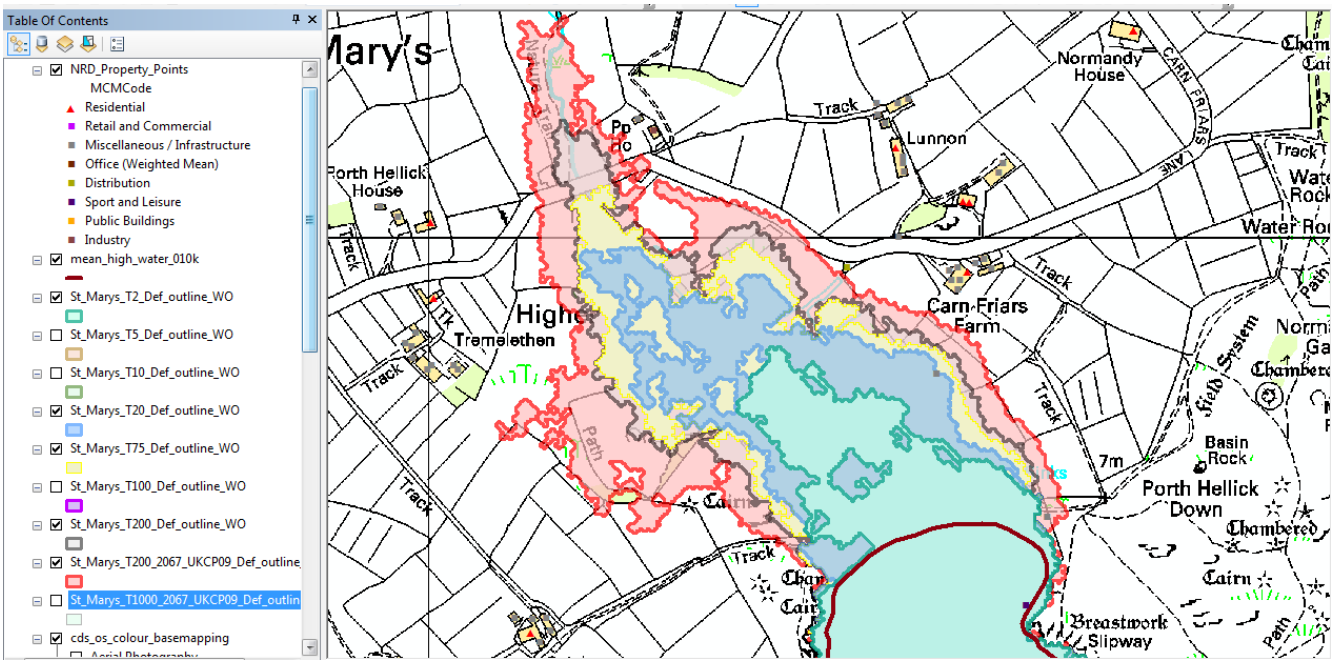
These low spots are potential pathways for saline intrusion into the Higher Moors Pool, one of two main fresh water habitats and drinking water supply sources for St. Mary's.

Over the period 2007 to 2017 the beach profile has seen a gradual 0-3% increase in cross section with around 5m2 of material accreting along the profile at the western end of the bay.

Porth Hellick is very exposed to south-easterly storms, waves and inundation. The SMP2 predicts up to 65m of erosion by 2115. Flood mapping indicates a very significant risk of salt water inundation of the freshwater pool, surrounding habitat and groundwater supplies. The SMP2 identifies an approach of HTL for the first Epoch and then MR with consideration given to the realignment of the embankment to provide improved, robust natural defence to the Higher Moors Area.



Comparison of ground levels in relation to water levels for 2016 and 2116



Estimated current overtop and inundation return period <1:1 but no property receptors. Freshwater wetland habitat damage and Islands 2nd most significant drinking water source at risk at 1:20 & inundated at 1:75.

Porth Hellick – damaged sections of dune are overtopped and further damaged by 1:1 events. Higher Moors Pool and larger SSSI wetland area and secondary source of island's freshwater supplies are vulnerable from 1:20 and inundated by 1:75 events. Landscape value is being compromised by inappropriate recreational access.

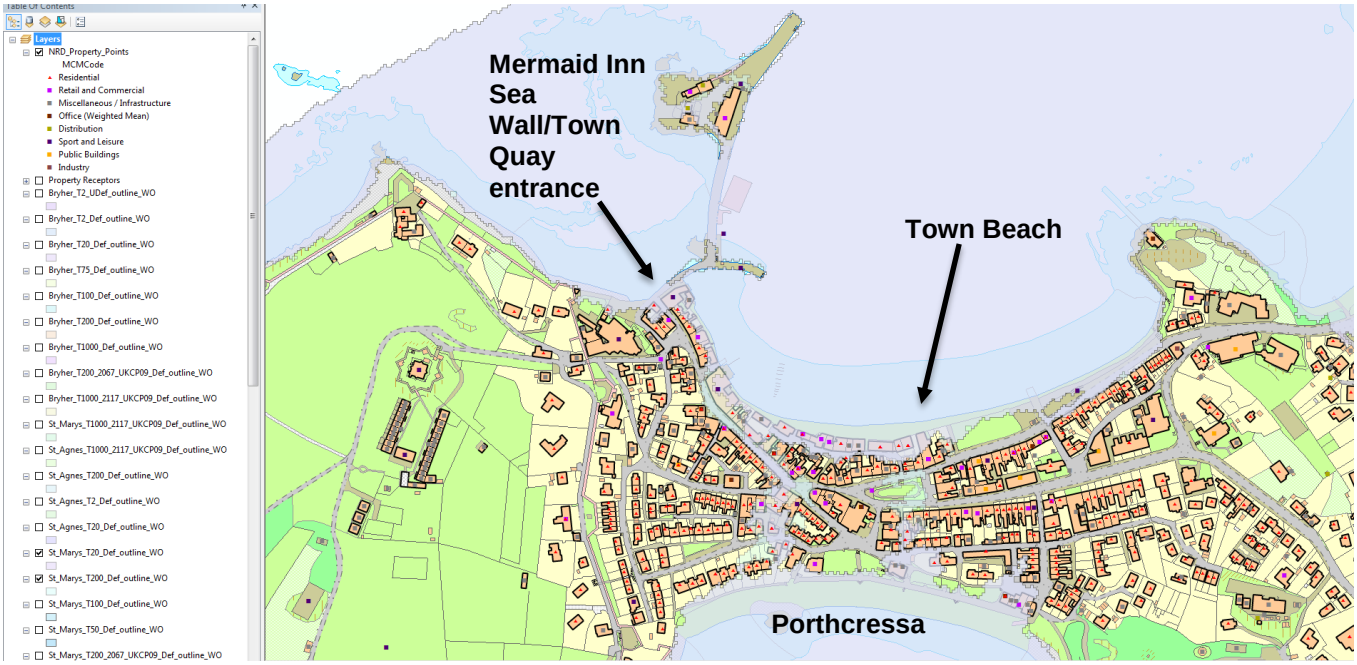
Local frontage aims

- protection of the Higher Moors Pool and larger SSSI wetland area from saline intrusion
- protection of freshwater resource for St Mary's.
- minimise the intrusive landscape impacts of any measures
- retain and improve public access and encourage sensitive appreciation

Hugh Town

Image: Clare Kendall.
Source http://geographical.co.uk/nature/climate/item/1481-scilly-s-changing-climate

The core of Huge Town, the largest settlement and the administrative centre of the Isles of Scilly, is located on a low lying sandy isthmus at the north end of St Mary's. This provides the only connection to the Town Quay – which itself provides the main maritime link to the mainland and transport services to all the off islands.



Inevitably the settlement on the isthmus is vulnerable to overtopping, in particular through the various slipway access routes onto either beach and also via the access to Town Quay.

Associated short duration surface water and drainage overloading is a contributory factor, and it has to be expected that a degree of percolation occurs through the underlying sands.

`de-facto' sea wall' along Town Beach

Significant recent investment along the Porthcressa frontage has reduced risks from south easterly surges but flood water ingress routes remain.

Recent events and JBA modelling provides evidence of significant risks from the volumes overtopping the Mermaid Inn sea wall and the related routeways around the entrance to the quay. This water then flows into the centre of the town

Although Town Beach on the north side is more sheltered and is better protected by recent substantial strengthening of Town Quay, it has a number of vulnerable low beach access points. These compromise the de-facto 'sea wall' which is formed by the run of historic beachfront properties (which themselves contain a concentration of the islands commercial services). As a result the core of the town is vulnerable to low pressure surge and tidal flooding via these 'gaps'.

Overtopping at the Mermaid Inn, St Mary's. 2 November

Overtopping of Mermaid Sea Wall, 2014 (photo courtesy of the Duchy of Cornwall)

2013 source: http://www.scillytoday.com/2014/01/02 & in February 2014, Source, Duchy of Cornwall

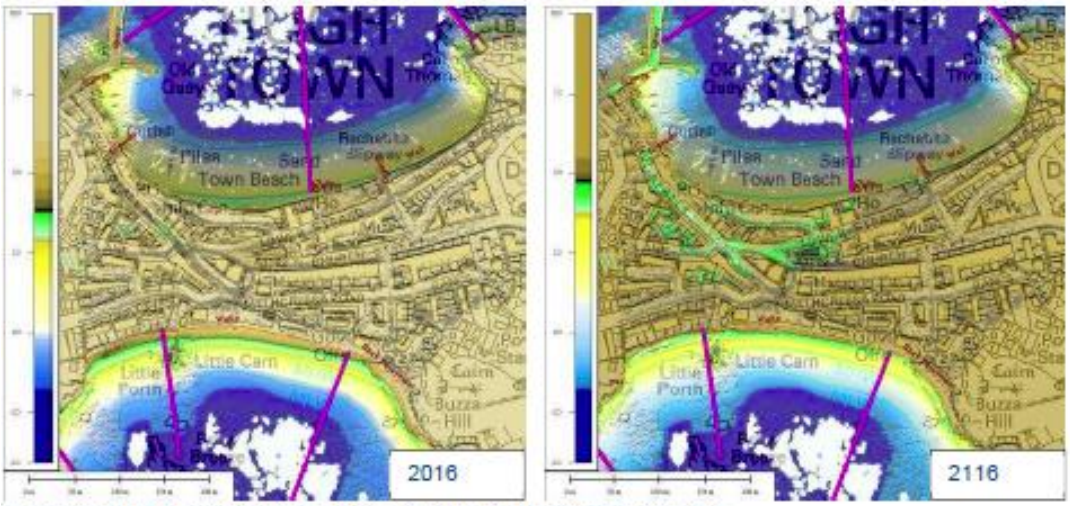
Fig. 5.6 Storm surge hitting Porthcressa on February 14, 2014 (*left*), and overtopping sea wall (*right*) (*Source* both, A. Martin, private photograph, 14/02/2014)

It is the threat from overtopping of the numerous low points/gaps and the extent and depths of resulting flooding in the core of Hugh Town which poses the greatest concentration of modelled direct threat to homes, businesses and infrastructure receptors (excepting the flood risks to the islands freshwater supplies and the habitation dependence upon them).

The SMP supports a hold the line approach across all these frontages beyond at least 2055.

Porthcressa frontage improvements
(warning, source unknown, image may be subject to copyright)

Below mid- tide level		Extreme water levels to 1:100	
Upper intertidal to MHWS		Above 1:100 yr level	



Comparison of ground levels in relation to water levels for 2016 and 2116.

Estimated current SOP from overtopping (for most vulnerable residential receptors with 250mm thresholds) – <1:1

Number of residential properties at risk across range of probabilities from flooding directly through these frontages

1:2 – 33	**1:5 – 40**	**1:100 – 65**
1:10 – 41	**1:20 – 43**	**1:200 - 65**
1:25 - 48	**1:75 – 64**	**2050CC – 84**

Hugh Town – eight low slipway/access routes through de-facto defences are flat-water overtopped, compounded by wave overtopping at Mermaid Inn sea wall creates accumulation in core of town that floods properties from the landward side affecting an estimated 40 properties at 1:7.

Local frontage aims

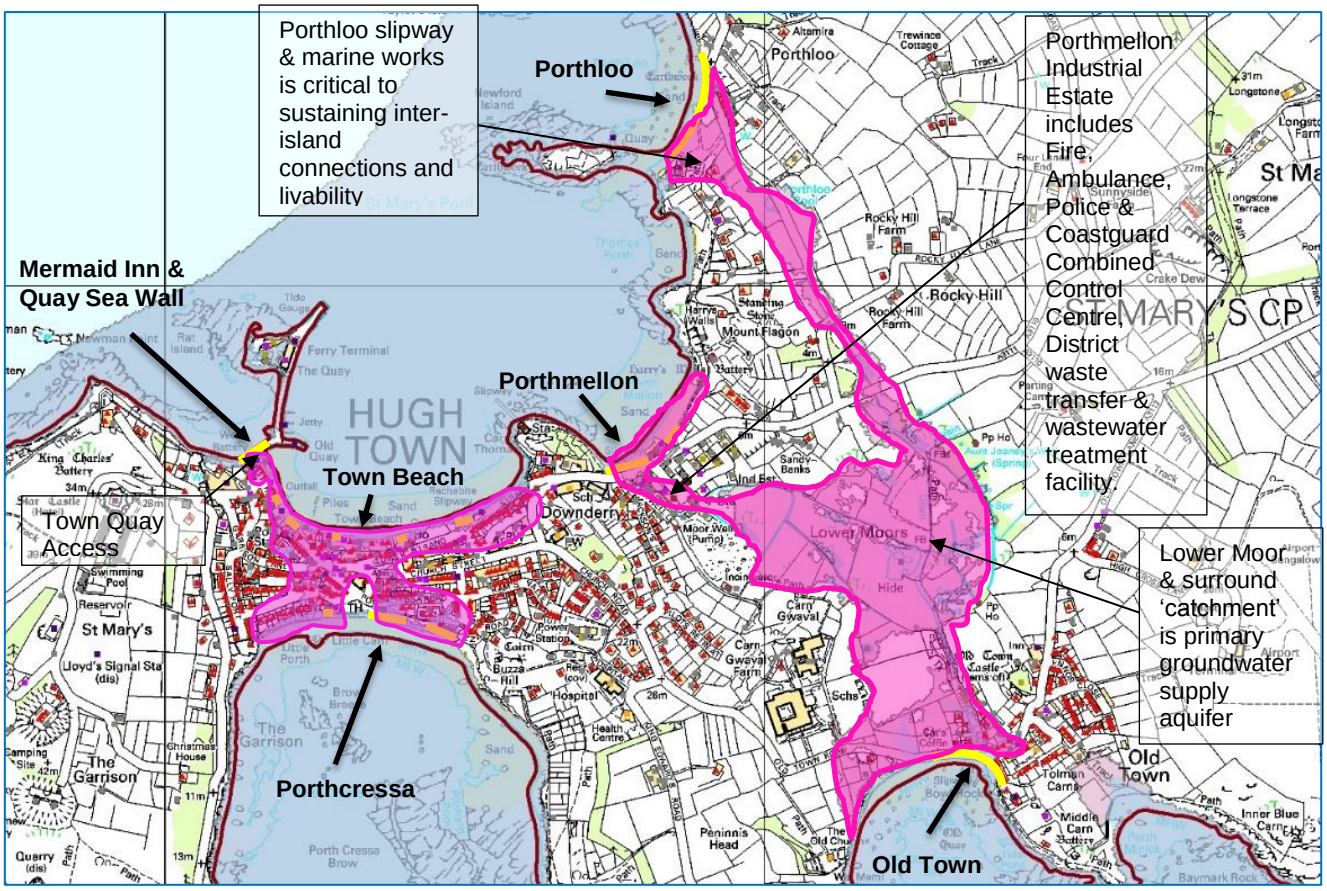
- Better protect the core of Hugh Town including essential commercial and administrative services from the risks and consequences of flooding
- Sustain access routes and all amenities at Town Beach and Porthcressa, complementing recent frontage improvements
- Sustain full access on/off Town Quay and protect its critical infrastructure and facilities
- Enable management of surface water and drainage systems to overcome period of tidal lock
- Ensure measures are in keeping with the historic townscape and character

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Non-Residential properties at risk	Mean depth of flooding	Average m²
2		-0.05		-0.05	400
5		0.00	4	0.00	400
10	54	0.00	44	0.00	400
25	72	0.08	64	0.08	400
50	73	0.15	67	0.15	400
100	81	0.22	78	0.22	400
200	85	0.33	80	0.33	400
300	85	0.35	82	0.35	400

St Mary's has an estimated SoP of 1:7 with current measures & arrangements

St Mary's property counts for return periods (assuming 250mm thresholds)

St Marys overview map



St Mary's

Benefit Area Light purple 1:200 with 2050 climate change allowance.

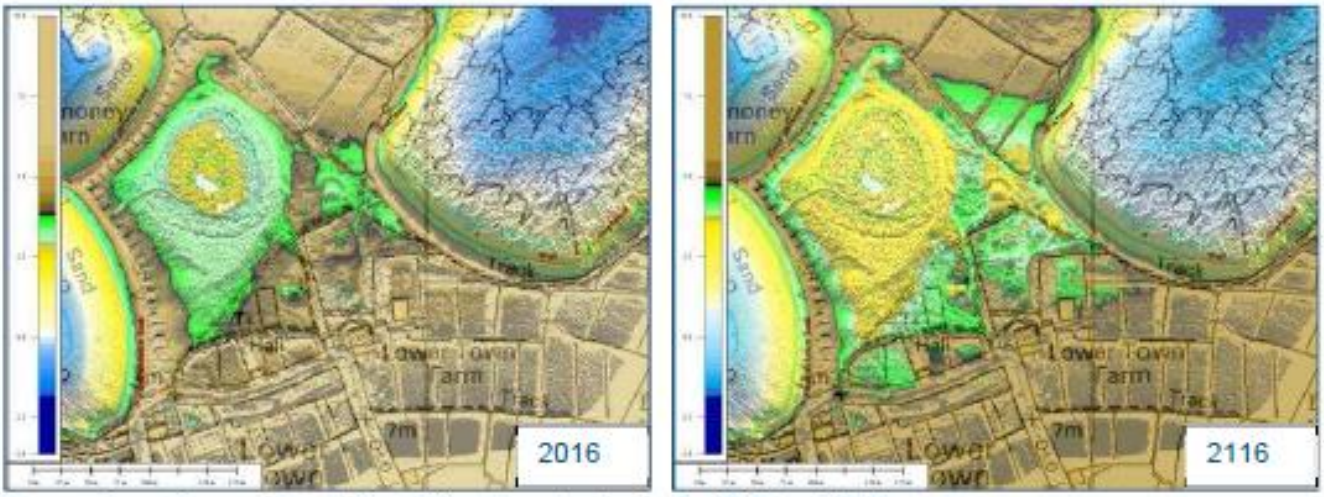
Location of Potential Measures Yellow

Mean High Water Brown line

2.8.2 St Agnes

The Isles of Scilly SMP2 review recognises connectivity and the linkage of policy units which are not necessarily continuous and considers each island as an individual Management Area. This is especially the case on St Agnes where PIA46a has been defined which groups together management of PU 46, 11, 12 & 14 focusing on the area around Big Pool, the Meadow & Lower Town and the risk from erosion, inundation and possible saline contamination of portable water supplies.

Below mid- tide level		Extreme water levels to 1:100	
Upper intertidal to MHWS		Above 1:100 yr level	



Comparison of ground levels in relation to water levels for 2016 and 2116.

The stated overall intent is to 'secure and maintain habitation and use of the island while aiming as far as possible to enhance the natural environment and landscapes'.

DELIVERY OF THE PLAN

SUMMARY OF SPECIFIC POLICIES

Policy Unit		SMP1 Policy	SMP2 Policy Plan			
		50 yrs	2025	2055	2105	Comment
46.10	Long Point to Pereglis slips	Do nothing	NAI	NAI	NAI	No risks identified shoreline is resistant to erosion.
46.11	Pereglis Slips to Ginamoney Carn	Hold the line	HTL	HTL	HTL	Risk to the Big Pool from erosion and inundation.
46.12	Ginamoney Carn to Browarth Point	Hold the line	HTL	HTL	HTL	Risk to the Big Pool from erosion and inundation.
46.13	Browarth Point	Do nothing	NAI	NAI	NAI	No risks identified shoreline is resistant to erosion.
46.14	Browarth Point to Kallimay Point	Hold the line	**NAI**	**NAI (with localised HTL)**	**NAI (with localised HTL)**	No risks identified shoreline is resistant to erosion.
Key: HTL - Hold the Line, A - Advance the Line, NAI – No Active Intervention MR – Managed Realignment						

The storms of February 2014 resulted in inundation of the Meadow from significant overtopping of dunes on the Periglis & Porth Coose frontages, as well as erosion damage to Porth Killier and breaching of the dune at Periglis.

It also resulted in localised erosion damage between Long Point (Troytown) & Pereglis Slip and inundation of much of the campsite.

Inundation of the Meadow poses a threat to the low-lying part of the island's main rain water catchment, it is this area, rather than just the Pool, that is understood to recharge low-level groundwater for the wells which supply the majority of the islands water (there is no piped connection between the inhabited islands or with the mainland).

Periglis Dune viewed from Ginamoney Carn

Porth Coose Dune viewed from Browarth Point

Porth Killier

Erosion storm damage, Porth Killier

Troytown campsite damaged frontage

Meadow is an important sport & cultural facility

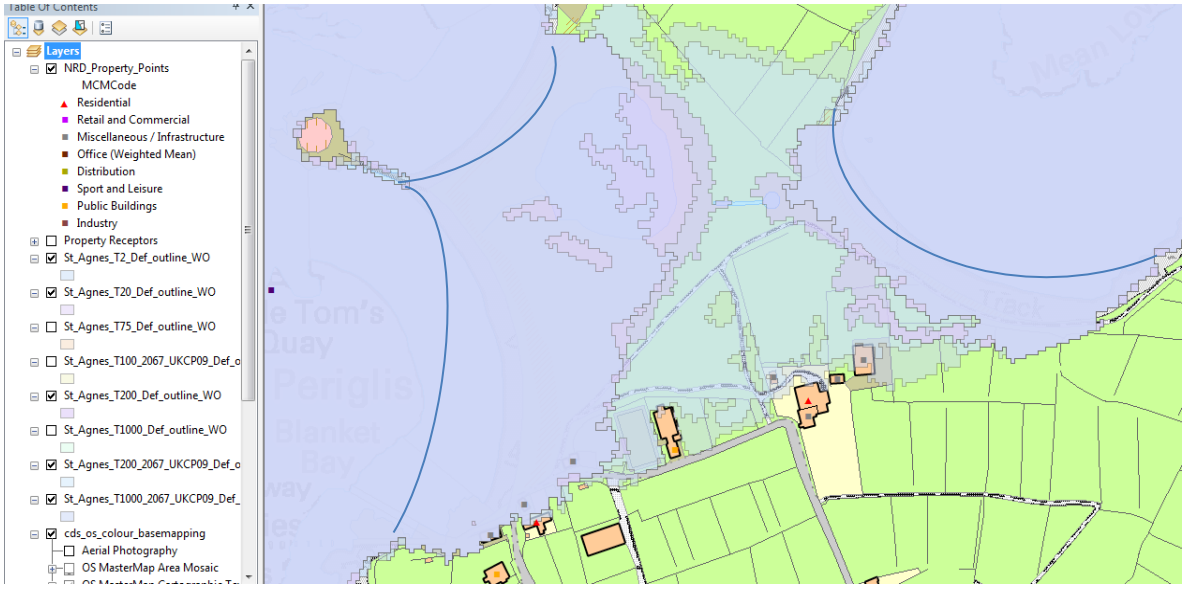
Southern end of Periglis from slip

Periglis slip which acts as a breakwater

Localised and landscape-sympathetic use of medium-sized rock armour at Ginamoney Carn is evident and for some 20 years has successfully sustained connectivity to dune embankments either side of it, at the northwest point of the Meadow. It also offers northern storm protection of Periglis Bay and its harbour moorings.

The exposure, erosion and relatively poor condition of the dune embankments, especially along Porth Coose are allowing regular wave overtopping from northerly and westerly storms (and it also carries the risk of breach inundation).

The outflanking of the substantial sea wall at the back of Porth Killier, both via continued erosion of glacial ram to the south east and/or overtopping and potentially breaching of a low bank of stones to the north east, also pose an additional risk of flooding of the Meadow. Foundations of a section of the sea wall is being undercut (although may have slowed as the back of the beach accredits eroded material from its southern flank).



Calibrating flood risk modelling to also reflect flooding from dune breach risk

JBA modelling only reflects the risk of inundation from overtopping rather than the additional and cumulative greater threat posed as a result of erosion and especially extreme storm dune breaches. However, as the above mapping shows, the modelled extents show coverage across the meadow, the pool and the threat to a number of small non-residential and one residential property. Also at risk are an electrical sub-station, the bio-bubble (water treatment) and the island's two main well heads (2 of 5 and which provide more than half of the island's supplies).

The flood modelling report identifies, that the TUFLOW model correctly predicts observed overtopping and outflanking at frontage locations identified above in a simulation of the February 14th 2014 event.

Utilising the St Mary's tide gauge data, it identifies this as a 1:20 probability event (and for St Mary's the 2014 recorded flood extents broadly correspond with the overtop-only modelled ones).

However, as is the case with Bryher, the vulnerable low-lying areas of St Agnes are much more dependent upon extensive natural & semi-natural dunes and modelling does not predict and identify the extent of significant extra

inundation of still water through multiple dune breaches which occurred during the 1:20 Valentine's Day 2014 storm (a relatively high probability event).

The JBA report recognises this under-estimating of extent and depths of flooding that occurs through both overtopping and breaches of dunes and the resulting damage under-estimates. By extension, modelled damages are very likely to be similarly under-estimating across the whole range of modelled events – at least for all the representations of more extreme storm events.

Unfortunately no reliable records exist of the numerous other overtopping and breach flood events (not even for 17-18 October 2012 which was used as a second modelling calibration event on St Mary's). Ideally a minimum of three recorded events would be used to calibrate modelling and create an adjusted probability damage curve.

In these circumstances, the additional breach flood risk has had to be estimated by matching the recorded actual event flood extent outline of the 2014 event to the JBA overtop-only modelled return period with the closest flood water extent outline. The 1:200 overtop flood risk extent offers a close match to the 2014 event reported extent.

This single 'adjusted to include breach impacts' 1:20 probability event extent outline, with its corresponding mean depth increase from 008m to 0.33m has been used as an adjustment factor to recalibrate the full range of lower probability extents, depths & damages to receptors, effectively maintaining the shape but shifting right the damage curve for the range of probabilities below 1:20

St Agnes overtop & breach adjusted depths & property counts with 250mm threshold Do Nothing existing baseline.

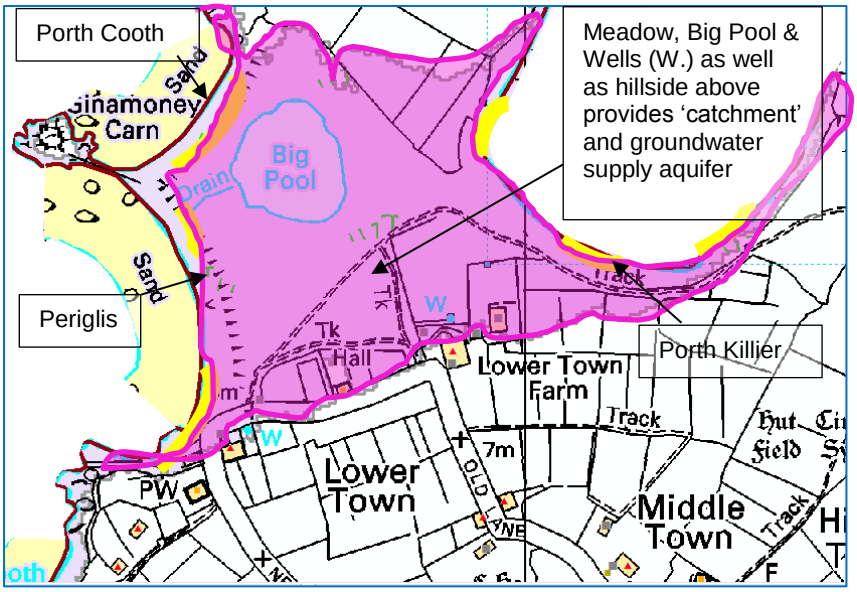
Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	0	-0.05			1	-0.05	400
5	0	0.00			2	0.00	400
10	1	0.08			2	0.08	400
25	2	0.33			7	0.33	400
50	2	0.35			7	0.35	400
100	2	0.37			7	0.37	400
200	2	0.40			7	0.40	400
300	2	0.45			8	0.45	400

TOTAL ANNUAL DAMAGES	£70,063
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,224,810

Incorporation of breach risk does not change the estimate of the current SoP which remains at an estimated 1:7

Porth Killier – scouring of toe and foundation of central section of 30 year old sea wall. Localised ram erosion & overtopping flood risk at a 5 metre section to SE of sea wall. Overtopping risk of embankment to NW side of Porth Killier. All risk inundation of Meadow, Pool, freshwater habitat, wells and aquifer recharge area of island's main rainwater catchment.

Periglis & Porth Cooth – damaged, compromised and lowered sections of these extensive dunes are overtopped and pose significant breach and inundation risks to the Meadow, a small number of properties, local infrastructure, important freshwater habitat, wells and aquifer recharge area. Core section of Periglis Slipway, which provides a protective breakwater, is suffering from scouring as is quay and beach entrance.



St Agnes

Benefit Area Light purple 1:200 modelled with 2050 climate change allowance.

Location of Potential Measures Yellow

Mean High Water Brown line

Local frontage aims

- Reduce flood risk to the Meadow, Pool, Lower Town & infrastructure from overtopping of dunes & embankments
- Reduce flood risk and consequences arising from erosion and breaches to dunes and embankments
- Sustain the island's freshwater supplies by protecting wells and the key aquifer recharge area of the island's main rainwater 'catchment'.
- Sustain and enhance Natural Capital, the recovery of biodiversity and the cultural amenity and local economy value of the dunes, beaches, harbour, the Pool & the Meadow

2.8.3 Bryher

2.8.3.1 Western & Southern Frontages

Stinking Porth & the South of Hell's Bay from Little Crow Island

As the SMP2 review states - SMP policy is driven in part by the need to sustain the island's economy & freshwater supplies. Both of these identified needs have been and will continue to be at risk from saline intrusion & flood inundation of the dunes & meadows around Popplestone, Great Porth & across the southern lowlands to the Green (area behind Green Bay in the south east of the island).

However, it goes on to state further - The primary intent is to maintain natural character and function and allow natural change in the long term.

It is the latter that is reflected in the over-arching Bryher Management Area policy, & also across individual frontage units of 'do nothing/no active intervention' beyond 2055.

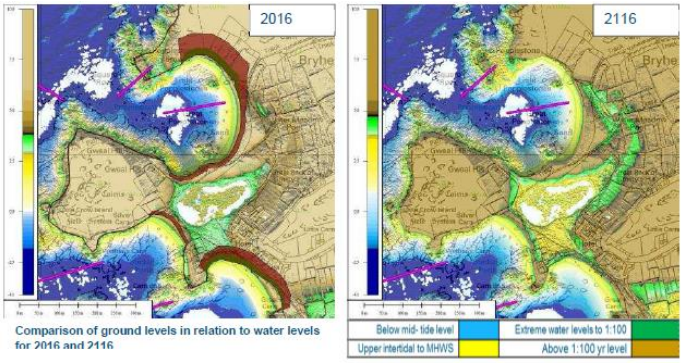
A southern section of Stinking Porth & the northern part of Great Porth have had mixed natural rock/dune embankments and their interface with dunes ‘re-enforced’ and formalised by the addition of a rip rap revetment and at Great Porth by the addition of a significant linear quantity of rock armour. Presumably these (third party) actions have been an attempt to sustain the island’s economy & previously compromised freshwater supplies.

DELIVERY OF THE PLAN

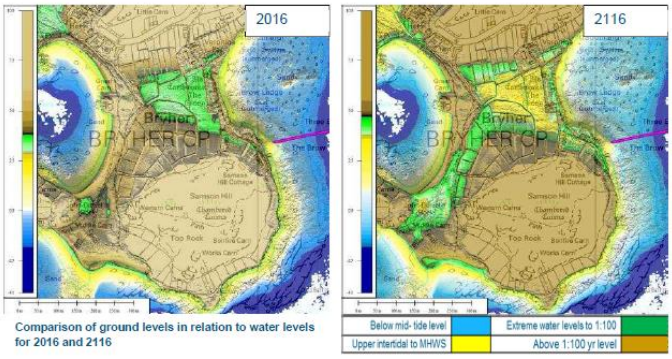
SUMMARY OF SPECIFIC POLICIES

Policy Unit		SMP1 Policy	SMP2 Policy Plan			
		50 yrs	2025	2055	2105	Comment
45.1	Great Porth North	Hold the line	HTL	NAI (with localised HTL)	NAI (with localised HTL)	Holding the line in epoch 1 would allow monitoring of the rate (predicted up to 35m over 100 years) of shoreline recession.
45.2	Stinking Porth	Do nothing	NAI	NAI	NAI	No significant risks identified.
45.3	Gweal Hill	Do nothing	NAI	NAI	NAI	No significant risks identified.
45.4	Great Popplestones	Hold the line	HTL	NAI	NAI	Initial hold the line should monitor rate to test, but longer term aim would be to move to NAI.
45.5	Little Popplestones	Hold the line	NAI	NAI	NAI	The preferred policy therefore would be NAI, which should satisfy objectives relating to the AONB
45.11	Southward	Do nothing	NAI	NAI	NAI	No significant risks identified
45.12	The Brow to Works Point	Do nothing	NAI	NAI	NAI	No significant risks identified
45.13	Works Point to Great Carn	Retreat the line	NAI	NAI	NAI	No significant risks identified

Key: HTL - Hold the Line, A - Advance the Line, NAI – No Active Intervention
MR – Managed Realignment



Comparison of ground levels in relation to water levels for 2016 and 2116



Comparison of ground levels in relation to water levels for 2016 and 2116

At Great Porth, in front of the hotel and neighbouring development, erosion from an informal beach assess route appears to be compromising the embankment and its crest height. Landward cut-away and a roadway, adopted amenity use of the top of the remaining dune and efforts to resist dune recession (tight against the bottom of the developed hillside) appear to be compromising the functioning of the dune. This is likely to increase flood and breach risks from the prevailing south westerly direction, although presumably rocks within Hells Bay provide a form of partial breakwater sheltering this area.

Further south along the frontage of Great Porth, up to the gig shed (restored and converted into a studio, 1-3 tonne stones provide the decreasingly constrained dune with a form of wave energy absorbing/reflective toe, at least in the short-term. Presumably these rocks have been reclaimed from the foreshore of the bay. South of the gig house the dune is more naturalised and relatively free to recess. However the hinterland is relatedly low lying here to the immediate south of Tommy's Hill and the remains of a 900m2 breach offers evidence of the relative exposure of this section of frontage.

South of Great Carn the dunes appear unrestrained although it has a low crest height and an apparent weak low point which appears to being exacerbated by pedestrian access.

To the North of Hells Bay on Great Popplestones, abutting Gweal Hill, a rip rap and also a section of masonry/concrete crest wall have been added to what was understood to have been a natural part rock, part dune embankment.

More recently a significant quantity of rock armour has been added all along the southern half of Great Popplestones, presumably this was done with the intension of slowing or fixing and formalising this alignment. It is observed that this section now has (if not before) a significantly lower crest height than the adjacent more healthy and 'free to recces' dune at the rear of the bay (although a range of other contributory factors may bear responsibility).

However, In the middle of Great Popplestone, where the rock armour addition finishes, another flood vulnerable low point was observed. It appears from its profile and connection to vehicular access that it has been used for access and this may have compressed the dune, significantly lowered its crest and thus protective height.

More generally the vehicular track which runs parallel and cuts into the back of the dune probably doesn't help the dune's natural adaptive regression.

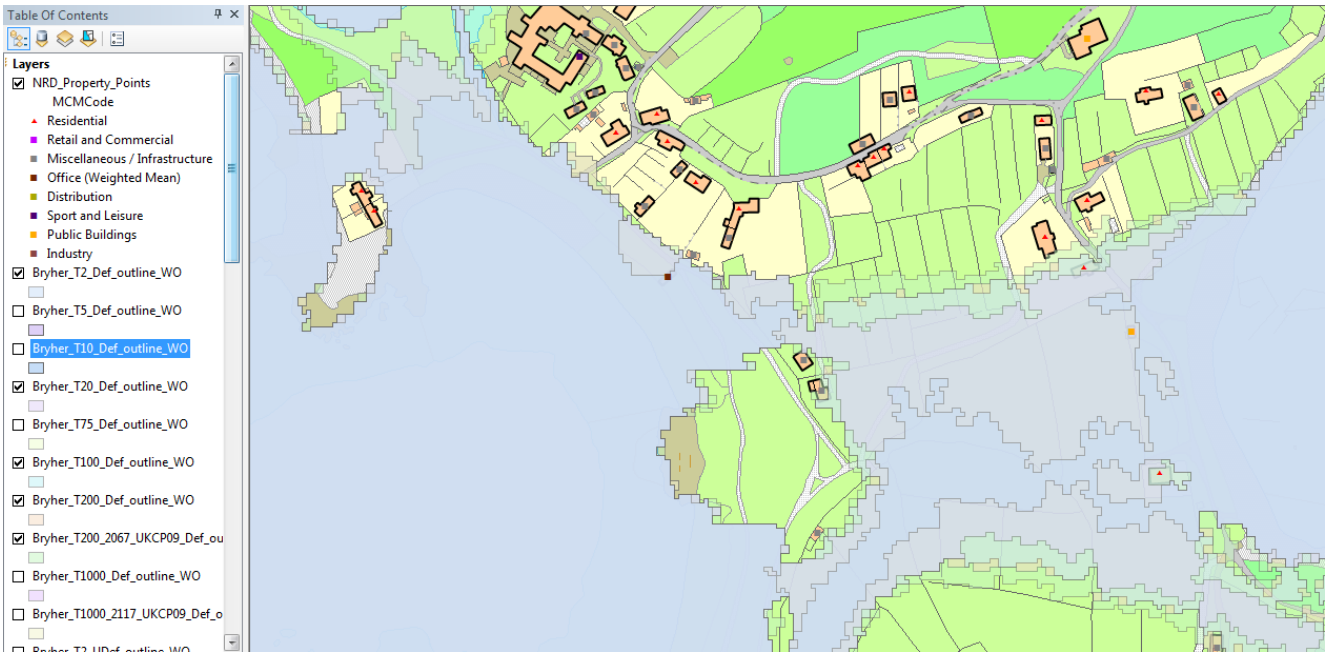
Flood Risk Modelling – Bryher Western &Southern frontages

JBA modelling, just of overtopping flood risk and the mapping of the extents of inundation, broadly correspond with extent of flood risk as identified in the SMP2 review.

The modelling provides a progression towards clearer and stronger evidenced, although specific to overtopping flood risks to a small number of property and local infrastructure receptors. These include the (volunteer) fire station, electricity sub-station (although a new back-up facility exists on higher ground), two wells and the water abstraction and existing micro-desalination and treatment plant.

Flooding of the lowland behind Great Porth, 2014 (photo courtesy of Gareth Tibbs)

Bryher Western & Southern frontages overtop only JBA modelled flood extents - T2, T20, T200 & T200 with 2050 Climate Change sea level rise allowance



Bryher Western & Southern frontages. Do Nothing Baseline (re-checked & corrected) property receptor counts for range of JBA overtop only flood risk modelled return period extents & depth estimates.

(Multi-Coloured Manual BCA Tool – return period, property receptor count & mean depth input table)

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	1	-0.05			3	-0.05	400
5	1	-0.05			3	-0.05	400
10	2	0.00			4	0.00	400
20	2	0.10			5	0.10	400
50	2	0.15			6	0.15	400
100	2	0.20			7	0.20	400
200	2	0.40			7	0.40	400
300	2	0.45			7	0.45	400

(The MCM BCA Tool summary output of damages table)

TOTAL ANNUAL DAMAGES	£20,784
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£363,337

Calibrating flood risk modelling to also reflect breach risk

The flood modelling report identifies, that the TUFLOW model correctly predicts the overtopping which was observed across all the western frontages in a simulation of the February 14th 2014 event.

Utilising the St Mary's tide gauge data, it identifies this as a 1:20 probability event (and for St Mary's the 2014 recorded flood extents broadly correspond with the overtop-only modelled ones).

However, as was the case on St Agnes, The vulnerable low-lying areas of Bryher are much more dependent upon extensive natural & semi-natural dunes and rock/mixed embankments, and modelling does not (it cannot) predict and identify the extent of significant extra inundation of still water through multiple dune breaches on the western side of Bryher. This is what occurred during the 1:20 Valentine's Day 2014 storm, which was a relatively high probability event.

For Bryher (again, like St Agnes) the JBA report recognises that modelling results under-estimate the extent and depth of flooding that occurs through both overtopping and breaches of dunes on western frontages and the resulting damage estimates. By extension, modelled damages are very likely to be similarly under-estimating across the whole range of modelled probable events.

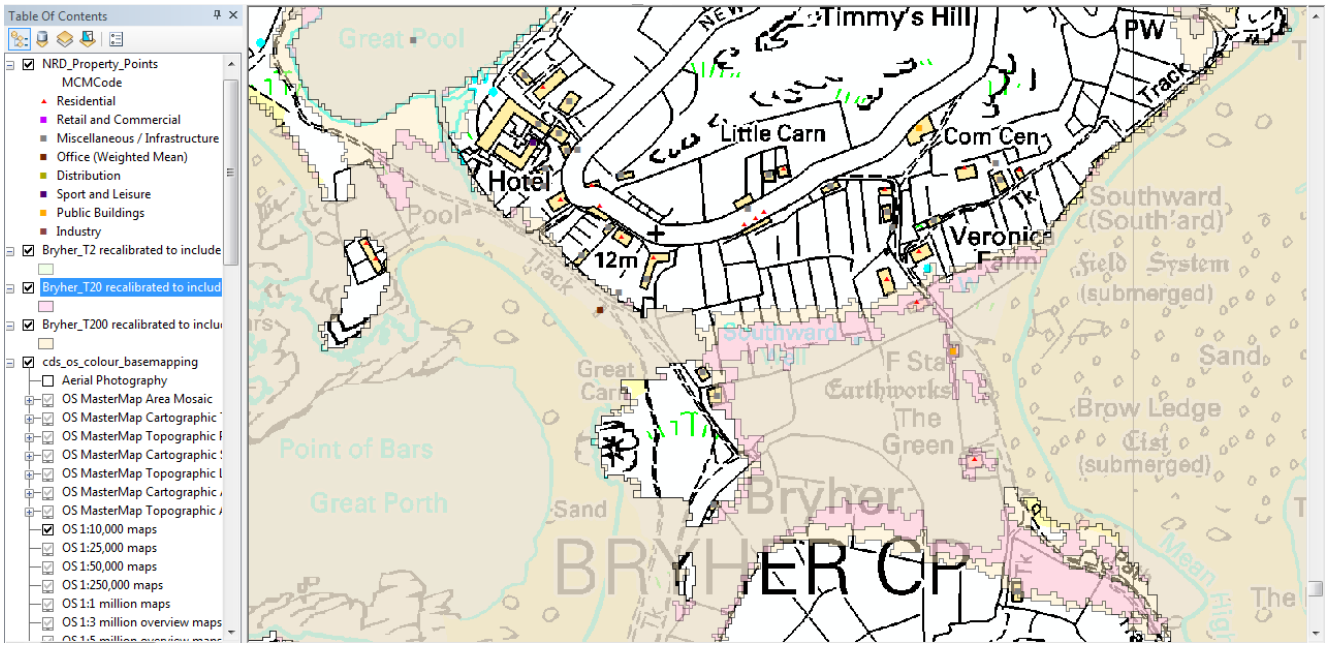
Unfortunately no reliable records exist of the numerous other overtopping and breach flood events (not even for 17-18 October 2012 which was used as a second modelling calibration event on St Mary's). Ideally a minimum of three recorded events would be used to calibrate modelling and create an adjusted probability damage curve.

In these circumstances, and following the same approach taken on St Agnes, the additional breach flood risk has had to be estimated by matching the recorded actual event flood extent outline of the 2014 event to the JBA overtop-only modelled return period with the closest flood water extent outline. The 1:100 overtop flood risk extent offers a very close match to the 2014 event reported extent.

This single 'adjusted to include breach impacts' 1:20 probability event extent outline with its corresponding mean depth increased from 0.1m to 0.2m has been used as an adjustment factor to recalibrate the whole range of probability extents, depths & damages to receptors, effectively maintaining the shape but shifting right the damage curve across the full range of probabilities.

As the only available single point of reference the 1:20 event damages increased from an estimated £135,660 (overtop only) to £155,625 (overtop & breach).

T2, T20 & T200 modelled flood extent shapefiles (& NRDs) - recalibrated to incorporate dune breach as well as overtopping flood risk.



Adjusted receptor counts, depth estimates & discounted annual estimated damages for overtopping <u>& breach</u> flood risk for Bryher's Western & Southern frontages

The approach has been to simplistically apply the adjustment to the range of extents (& depths) across the full range of probabilities. Then redo the property receptor counts for each, and then input them into the MCM BCA tool entry table below –

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	2	0.00			5	0.00	400
5	2	0.00			5	0.00	400
10	2	0.10			6	0.10	400
20	2	0.20			7	0.20	400
50	2	0.30			7	0.30	400
100	2	0.40			7	0.40	400
200	3	0.45			7	0.45	400
300	3	0.45			8	0.45	400

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

TOTAL ANNUAL DAMAGES	£73,956
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,292,862

Green Bay Frontage

The Green and the frontage of Green Bay host locally important community, cultural and commercial activities but the low-level embankment which runs around the bay is virtually non-existent in numerous places.

This east-facing bay, in contrast to Hell's Bay has a sheltered orientation within Tresco Sound and is not subject to significant wave action which is also constrained by the extensive sand flats at the south of the 'sound' and shallow sea water depths between Bryer and Tresco.

Flood vulnerability along the Green Bay frontage arises from a westerly low pressure system sea-level height 'surge' into the sound (rather than more generally dissipating around the islands), coinciding with a spring tide.

Floodwater pathways which inundate the Green are largely from overtopping & breaches of western frontages but also from beach access pathways through and potentially over the low level-embankment around Green Bay.

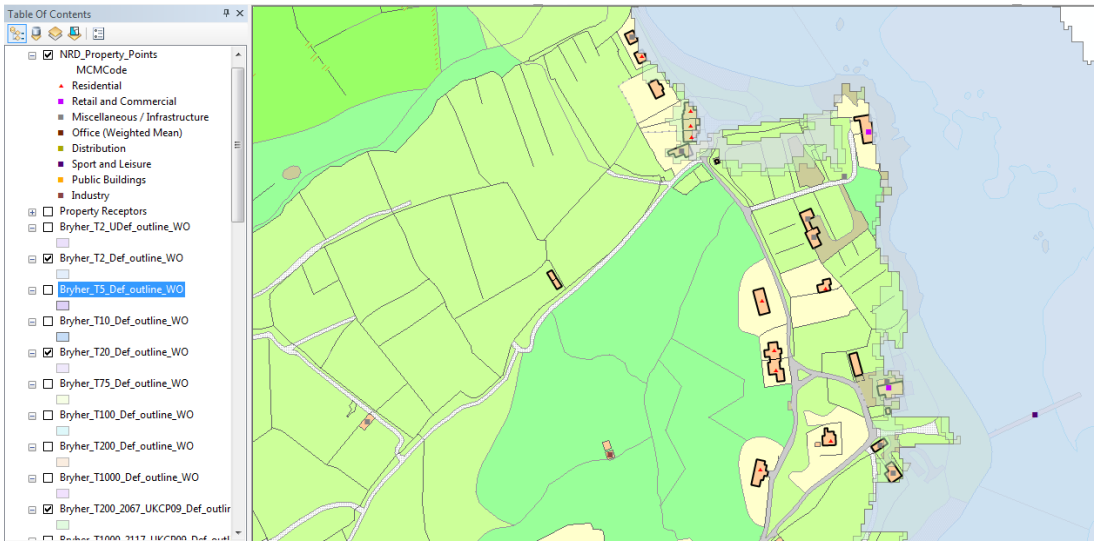
The remnant embankment at the back of the beach, even where it has not been compromised, provides a less than 250mm rise above the landward ground level.

The height of the raised area around the Boathouse at around 350-400mm above the height of the 'roadway' immediately behind the beach does not, according to the modelling, get flooded on return period events up until 1:200 with 2050 of climate change allowances.

Green Bay frontage host an array of water recreation

Bryher Festival, on the Green, attracts large numbers of visitors and locals from across the islands

Norrard & Kitchen Porth Frontage



Kitchen Porth – T2, T20, T200 2050CC

This frontage on the north east side of Bryher has a small cluster of modelled at-risk properties (identified when cross-checking the JBA receptor counts). as shown below –

Property receptor counts

Return period (overtopping)	Residential	Non-residential	(of which) considered water- resilient
T2	3	4	2
T5	4	4	2
T10	4	5 (the pub)	2
T20	4	5	2
T75	4	5	2
T100	4	5	2
T200	4	5	2
T200 2050CC	4	6	2

Anecdotally at least, properties identified by the modelling as at very significant overtop flood risk don't appear to have suffered during recent events, although as elsewhere across the islands flooding is under-reported (& until very recently unrecorded, not least because of the isolation of the off-islands in particular during storm events which makes recording events very difficult).

A number of the non-residential properties are associated with water transport, fishing and & water-sport activities & are considered relatively water resilient & even the Fraggle Rock Public House is orientated so it is substantially on the 1st floor.

As is the case further south on the east side, they are at increasing risk as a result of sea level rises and surge impacts.

The conclusion drawn is that no uplift for breach risk should be added to the overtop modelling for these property receptors and that 2 of the non-residential properties should be considered water compatible and not included in property counts for the sake of calculating estimated damages.

Whole of Bryher overtop & breach adjusted depths & property counts with 250mm threshold Do nothing existing baseline.

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	5	-0.05			7	-0.05	400
5	6	0.00			7	0.00	400
10	6	0.05			8	0.05	400
20	6	0.15			9	0.15	400
50	6	0.25			9	0.25	400
100	6	0.35			9	0.35	400
200	7	0.40			9	0.40	400
300	7	0.40			10	0.40	400

TOTAL ANNUAL DAMAGES	£89,8145
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,570,078

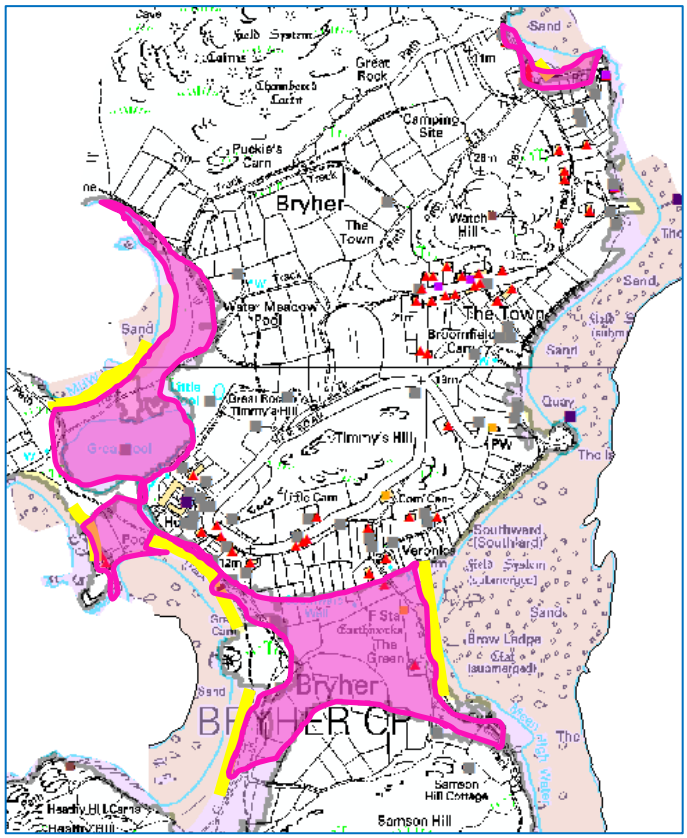
Local frontage aims

- Protect and help to sustain the island's economy
- Protect remaining water supplies from further saline intrusion & flood inundation
- Maintain, sustain and if possible enhance the natural landscape character, natural process and natural changes to the landscape to the Meadow, Pool, Lower Town & infrastructure from overtopping of dunes & embankments
- Protect and sustain Bryher's key social, cultural and recreational facilities and amenities

Hell's Bay – at Stinking Porth, Great Popplestone and the north of Great Porth, sections of mixed rock/dune embankments have had rip rap, rock armour and a concrete crest wall added, presumably as an attempt to fix alignments, resist recession and sustain protection. Across these frontages amenity access has eroded some dune sections and where damage and interventions have taken place crest heights are significantly lower than adjacent section where dunes have been relatively free to recess**.** Further south along Great Porth the dune is less constrained but more exposed. In areas vegetation is poorly established and crest heights are low. A 900m^2 area of breach remnant exists to the immediate south of Tommy's Hill. Access through weak points and tracks cutting into the backs of dunes appear to be hampering natural recession.

Green Bay Frontage - the low-level embankment (250mm) which runs around the sheltered east-facing and shallow sandy bay within Tresco Sound is virtually non-existent in numerous places. Flooding of 'The Green' is largely from overtopping & breaches of Hell's Bay frontages but it is also vulnerable from a westerly low pressure system sea-level height 'surge' into the sound (rather than more generally dissipating around the islands), coinciding with a spring tide.

Kitchen Porth – modelling identifies a cluster of 4 residential and 8 non-residential properties (2 are considered water resilient) at flood risk from overtopping of a similar low level embankment at the northern end of the sheltered Tresco Sound. The access roadway to the high-tide quay runs through it.



Bryher - Benefit area Light purple.
Location of Potential Measurs Yellow

2.8.4 St Martins

SMP intent

The overall intent of the policies within the SMP for St Martin's are to maintain and allow enhancement of the natural environmental landscape. As such the SMP2 aims to continue the policy developed in SMP1 of NAI. While this provides the main aspect of management, locally it is important to support the continued habitation of the island where this can be achieved in a sustainable manner without disrupting natural process.

The SMP2 Review also highlights the longer term potential risk to Higher Town Quay, however it makes clear this is beyond and independent of the dune frontage. The scope of this project, with its medium term focus can realistically only consider dune management which is not interdependent with future needs and decisions about the quay.

The SMP2 review provides a high level framework for considered management that balances compatibility with natural landscape processes, while sustaining the community, economic viability and accessibility.

The SMP2 review suggests that erosion rates may be 8m within 25 years and 25m within 100 years.

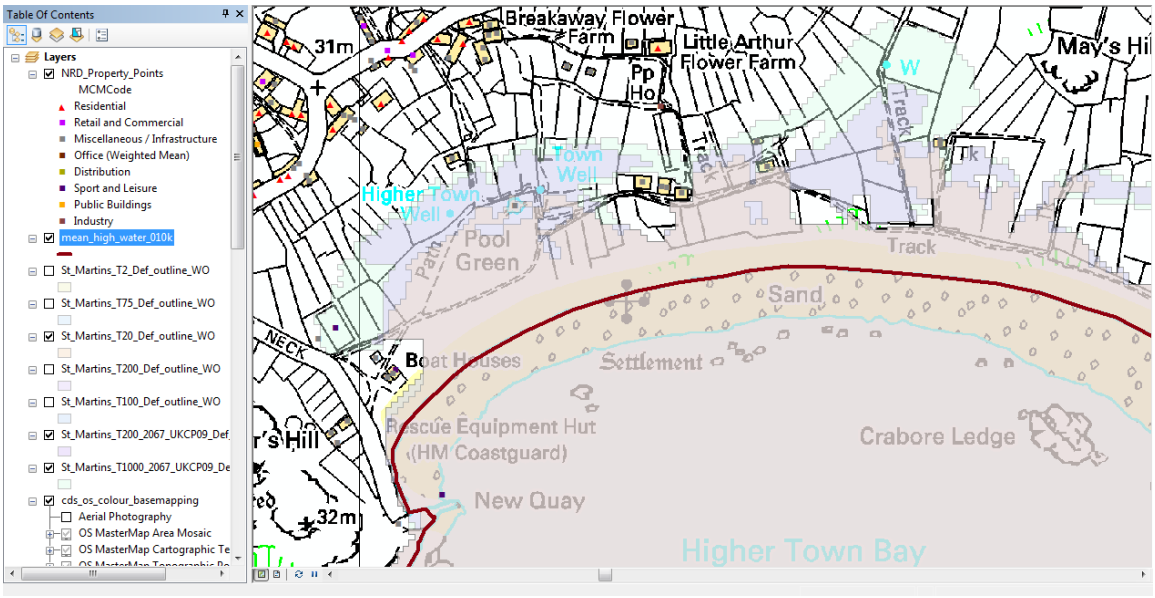
Jonathan Smith, is standing on the beach that lies next to his field. Lucky man, you might think. But the problem for Smith, an organic farmer on St Martin's in the Isles of Scilly, is that the beach is about ten foot closer to his fields than it was 18 months ago. Sand and salt are not good for crop production.

Fierce storms hit the Isles of Scilly in February 2014. They coincided with high spring tides and low pressure. The result was extensive erosion along the coastline and sand being thrown half a mile inland. A thick Pittisporum hedge used to shield Smith's potato, carrot, squash and leek fields from the storms. Half of it has gone.

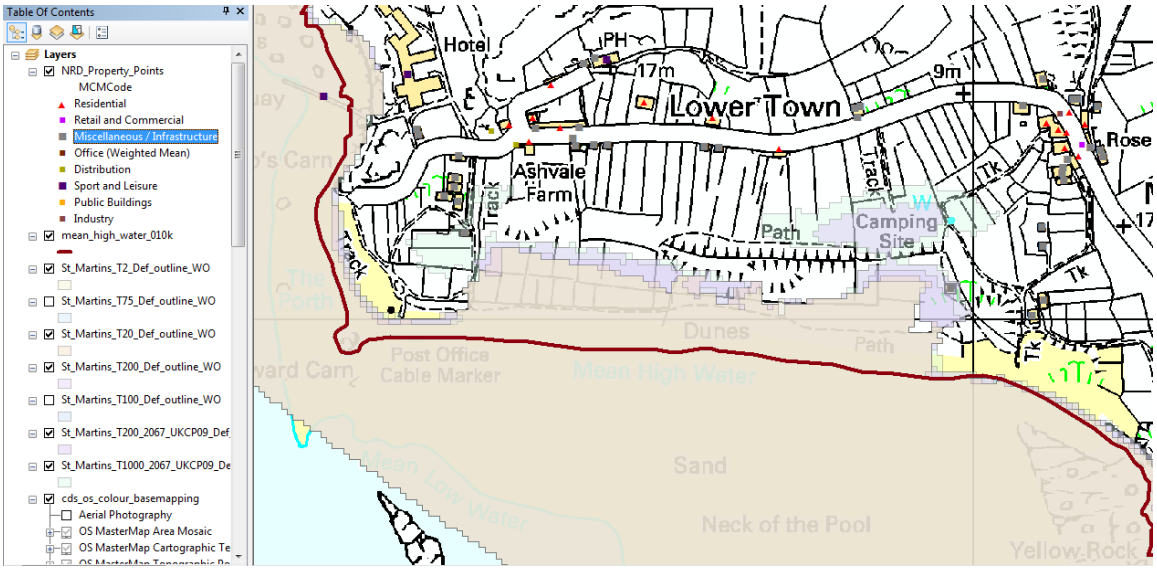
(Image: Clare Kendall)

Source http://geographical.co.uk/nature/climate/item/1481-scilly-s-changing-climate

The SMP and JBA flood modelling of overtopping risk, initial engagement and analysis all suggest that two sections of dune, the campsite frontage and the Higher Town frontage, are at least worth exploring in terms of viable opportunities to provide enhanced management, improved natural resilience, better protection and valuing of the dunes so as to naturally slow but enable their retreat. This has strong potential to provide increased medium term flood protection. As with the other islands, a significant flood and coastal risk issue is the threat to water supply wells at both Higher Town and at the campsite.



Investment in these frontages is likely to deliver relatively little in terms of eligible FCERM GiA benefits, however it could deliver significant local environmental and especially economic and financial damage avoidance benefits. These are primary outputs required of ERDF investment. It is under these circumstances in which it is proposed to consider options for these dune frontages.



the approach taken to development of potential measures also includes opportunities to deliver adaptive resilience by considering the additional risks from erosion and breaches in the dune systems. Again, the approach will favour opportunities to work with natural processes to enhance, protect and support ecosystems and help to sustain communities, access and the economies of the islands.

2.8 Main Potential Benefits

These are fully reflected in the defined strategic objectives -

Reduce current and future flood & coastal risks to households, businesses, natural capital & infrastructure across the inhabited islands to better protect and help sustain the environment & the local economy.

Do so by identifying measures, securing the required investment and establishing delivery mechanisms which;

- Reduce the modelled flood risk and damages from overtopping of dunes and sea defences
- Deliver increased resilience and reduce risks from erosion and breaches
- Take account of the uncertain impacts of climate change, incorporate opportunities to better understand potential impacts, mitigate them & enable adaptive responses
- Align with and deliver the policy objectives of the Shoreline Management Plan and be reflective of and fully compatible with relevant national and local guidance, policies, plans and strategies.
- Protect fresh water habitats and wider ecosystems, contribute to the conservation of the biodiversity & character of the land & seascape of the islands while enabling adaptive natural change.
- Sustain the islands' scarce freshwater supplies by better protecting wells, vulnerable groundwater source recharge areas and wastewater treatment infrastructure in a manner compatible with future changes to the delivery of water services
- Help to sustain inter-island & mainland transport links, local community & visitor amenities and support recreational and tourism businesses, many of whom have strong dependencies upon the accessibility and quality of coastal environments
- Generate strong support from engaged communities & stakeholders (including visitors), who value and share ownership of sustaining flood, coastal and climate resilience, and who are enabled to develop longer-term adaptive plans.
- Secure and realise an expanded, available but time-limited remaining sum of RDF Flood Risk & Climate Change Adaptation (priority theme) EU Structural Fund Investment.

2.9 Main Risks & Dependencies

	Key Risks	H/M/L	Owner	Mitigation
1	Extent of Coronavirus lock-down arrangements obstruct project initiation/start, procurements and delivery timetable	H	HMG	The delivery timetable has been significantly set back so initiation/start is delayed until October 2020 with the main contract start on site/prelims in spring 2021.
2	Securing ERDF funding agreement for delivery within eligible ERDF claim window (currently until June 2023)	M	CIoS & EA	Progression of full ERDF bid & agreement in tandem with OBC assessment & FSoD approval. Ensure submitted ERDF bid is approved in time to enable both funding agreements by July 2020 and timetabled delivery by March 2023
3	The availability & cost of required granite bulk materials	M	CLoS	Incorporate QS & specifically direct supply investigations & assurance into interim project development arrangements
4	Sustaining the full and active support of range of stakeholders	M	CLoS	Early engagement & inputs strongly reflected in proposed approach. PM arrangements that can sustain active support & participation by stakeholders & partners
4	Relative complexity and compliance needs of procurement	M	CLoS	Having a clear risk-based & phased procurement plan, incorporating QS & main engineering contract preparation & putting in place robust PM
5	Weather impacts	M	CLoS	Measures & construction schedule (and changes) have been designed to accommodate and minimise these risks
6	Supply logistics	M	CLoS	Measures, delivery schedule & and procurement plan seek to minimise risk by working within known parameters

3. The Economic Case

3.1 Overview & methodology

FCRM GiA investment of £1,356k is sought to deliver an estimated £8,864k (PV) economic flood damage avoidance benefits to National Property Receptors across four of the five inhabited islands.

Proposed measures across the four islands will benefit 94 households, including 81 at significant or very significant flood risk, moving 78 of them to medium or low risk. It will better protect and improve 45.4ha of designated habitat. Crucially, it reduces risk to the islands' sources of freshwater which are particularly vulnerable due to being located immediately behind the dunes.

3.1.1 Estimation of present value damages

The national economic damage estimates used to make the case are based on application of current MCM standard damage estimates for the number, type and size of directly at-risk properties which are identified by the JBA flood risk modelling.

The residential and non-residential property counts for each island, by return period modelled event (with existing defences), as defined in the JBA flood risk (overtop) modelling report, were cross-checked using JBA's event GIS shapeflies and the current NRD dataset and only the non-residential were altered to include/combine all the relevant Environment Agency NRD bulk class receptors.

A 250mm threshold adjustment was universally applied & all non-residential property size was capped at 400m2 (only 25% of mainland averages) to reflect local circumstances.

These checked property receptor counts have been fed into the 2019 MCM BCA Tool. The tool outputs define the modelled evidenced baseline do nothing option PV damage value estimate for the current modelled flood risk for these islands.

The 2019 MCM BCA Tool has also been used to provide consistent assessment of the PV damages to receptors of the estimated reduced extents and depths as a result of different levels of investment in cost-estimated management measures - as have been defined for each shortlisted do-something option. Again these are provided at an individual island scale.

3.1.2 Calibrating flood risk modelling to also reflect flooding from dune breach risk

The JBA flood risk (overtop) modelling report and return period shapefiles provide baseline mapped evidence of the pathways, extent & depths of (overtop) flood risk & property receptors counts, across a range of event probabilities across all the inhabited islands. This enables the potential benefits of measures to reduce flood risk to be quantified, compared & appraised.

Comparison with recent flood event gauge measurements, extents and depths (on St Agnes & Bryher) has enabled best possible recalibration to take account of the additional flood risk and consequential damages arising from (commonly occurring) breaches in dunes. This additional risk has limited receptor impact on St Mary's and St Martin's where overtop TUflow modelled extents and depths reflect and thus retrospectively 'predict' recent events, but is of greater significance on St Agnes & on the western side of Bryher with their greater dependence on dunes which are exposed to greater wave action.

The case for investment for St Mary's (& St Martin's) is made in relation to, and evidenced by, the 2018 JBA modelling of wave overtopping & the resulting flood risk inundation extents and depths as they directly impact on residential and non-residential property receptors.

JBA TUflow modelling only reflects the risk of inundation from overtopping rather than the additional and cumulative greater flooding threat posed as a result extreme storm dune breaches. For St Agnes (and similarly for Bryher) the modelled extents show coverage across the meadow, the pool and the threat to a number of small non-residential and one residential property. Also at risk are an electrical sub-station, the bio-bubble (water treatment) and the island's two main well heads (2 of 5 and which provide more than half of the island's supplies).

The flood modelling report identifies, that the TUFLOW model predicts observed overtopping and outflanking at identified frontage locations in a simulation of the February 14th 2014 event. Utilising the St Mary's tide gauge data, it identifies this as a 1:20 probability event (as above, for St Mary's the 2014 recorded flood extents broadly correspond with the overtop-only modelled ones). However (as with Bryher), the vulnerable low-lying areas of St Agnes are much more dependent upon extensive natural & semi-natural dunes and modelling does not include, predict and identify the extent of significant extra inundation of still water through multiple dune breaches which occurred during the 1:20 Valentine's Day 2014 storm (a relatively high probability event).

The JBA report recognises this under-estimating of the cumulative extent and depths of flooding that occurs through both overtopping and breaches of dunes and the resulting damage under-estimates. By extension,

modelled damages are very likely to be similarly under-estimating across the whole range of modelled events – at least for all the representations of more extreme storm events.

Unfortunately no reliable records exist of the numerous other overtopping and breach flood events (not even for 17-18 October 2012 which was used as a second modelling calibration event on St Mary's). Ideally a minimum of three recorded events would be used to calibrate modelling and create an adjusted probability damage curve.

In these circumstances, the additional breach flood risk has had to be estimated by matching the recorded actual event flood extent outline of the 2014 event to the JBA overtop-only modelled return period with the closest flood water extent outline. The 1:200 overtop flood risk extent offers a close match to the 2014 event reported extent.

This single 'adjusted to include breach impacts' 1:20 probability event extent outline, with its corresponding mean depth increase from 008m to 0.33m has been used as an adjustment factor to recalibrate the full range of lower probability extents, depths & damages to receptors, effectively maintaining the shape but shifting right the damage curve for the range of probabilities below 1:20

Calibrating to include breach risk, and its effect on property counts across the range of flood probabilities is detailed for St Agnes and for Bryher in 2.8.2 and 2.8.3.

3.1.3 Working with natural processes

The value of working with natural processes – an integral outcome of the project will be to protect, improve & sustain 45.4 hectares of coastal and freshwater habitats. This can be achieved by strengthening, improving elevation profiles, raising crest heights, addressing the causes of damage, improving public access and appreciation of the dunes and their coastal defence function. These will all contribute to giving them the space and enhanced structural flexibility to naturally, steadily regress in response to sea level change and associated climactic impacts. The proposed measures are to manage flood risk (not resist coastal erosion). They do not seek to 'hold the line' against dune regression, instead they will enable the dunes, as repaired and restored eco-systems, to adaptively regress (as a 'system') in a manner that maximises environmental and habitat adaptation.

Investment in assisted and enhanced natural restoration, which integrates a larger and more diverse web of living biomass into the dunes, will provide enhanced habitat for invertebrates, birds and support the continued recovery of species such as the Scilly Shrew. It will also give the dunes and their eco-systems the capability to better recover and rejuvenate with less loss of crest height in the aftermath of future extreme storm events and damage.

Restored sustainable dunes offer multiple benefits to beach environments and the inter-tidal zone on their seaward side as well as better protection of large hinterlands of designated sites from flood inundation and saline intrusion. These include the islands freshwater wetland and native woodland which are vital for a range of bird species during migration, feeding and breeding periods.

Timely investment in the proposed blue/green infrastructure approach will minimise the materials needed, the generation of waste and the carbon emissions and costs, especially when compared to those that would arise from a deferred and perhaps reactive hard civil engineered approach. Delaying these relatively modest investments in dune restoration could result in the opportunity to harness their adaptive coastal defence capabilities being lost for good (along with the habitats and essential to life eco-services they provide).

The significant net gain environmental benefits on offer are fully recognised and supported by local and statutory stakeholders.

Habitat Regulations Assessment (HRA) screening and Environmental Impact Assessment (EIA) - have been completed for the proposed frontage works on St Mary's, the Screening Statement & the Assessment were completed June 2019. These conclude - *"given the location, nature and scale of the works proposed at each development site and the very limited scale and duration of the construction works required, the assessment has not identified any likely significant effects on the European sites. As such, no further assessment is required."*

The originally proposed works on St Mary's, & iterative process of expanding the prospective scheme to include the off-islands, has included a number of site visits with Natural England, the IoS AONB and the IoS Wildlife Trust.

Explicit inclusion in the project objectives, direct involvement in consideration of and shaping the proposed measures and direct involvement in executive management of the project have ensured that further mitigation is not going to be required.

The Council of the Isles of Scilly has used its reserve funds to commission and progress the HRA & EIA for the works on St Mary's. These are complete, available and will enable the Council of the Isles of Scilly, as the LPA, to consent and enact these works as per the proposed schedule. Off island works will be subject to an additional/extension of the EIA if/when funding is committed.
This will take place in advance of the tender specification, procurement and delivery of these works (2021-22) via additional contracting.

3.1.4 Environmental and local economy considerations

The extra natural capital & local economy benefits and dis-benefits for each option have been considered and factored into options appraisal.

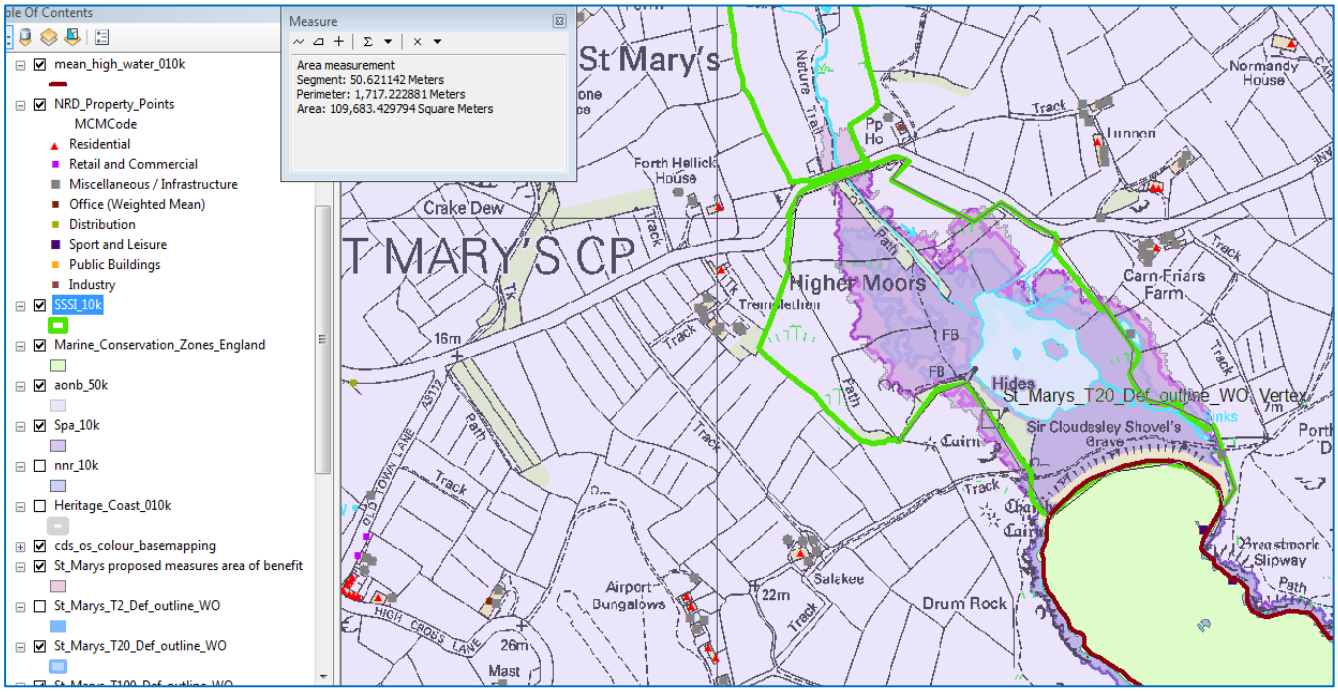
Investment (especially via the preferred natural process enhancement and resilient capacity-building approach), offer further protections to critical local infrastructure and considerable indirect flood and coastal protection benefits which are required to sustain and adapt the local economy, It reflects the considerable dependency on threatened natural capital assets.

Estimates of these natural capital and ecosystem service damage avoidance benefits are identified in very simple monetary terms. This has been done by using a high level estimate of the potential losses as they impact upon income from visitor expenditure as a result of a combination of flood (& flood recovery) damage to landscape quality, habitat and accessibility, as well as to essential visitor economy key infrastructure. The islands biodiversity and landscape and its visitor economy are strongly inter-dependant, and both have a fundamental dependency on the dune systems and the flood protection services they provide - protecting the freshwater habitats and the water supply 'recharge' areas (essential to freshwater supplies) which are immediately behind the dunes.

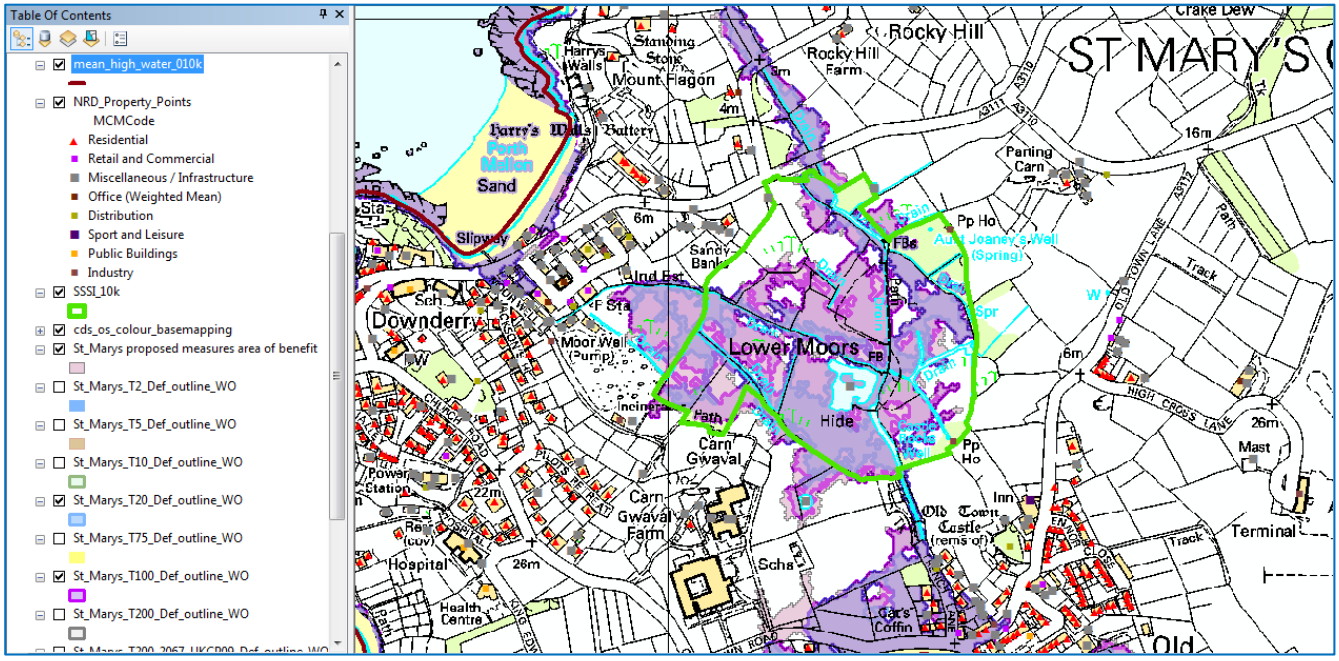
These local economy (& financial loss avoidance) benefits are important and are a significant part of the justification for the £1,700,250* of aligned and prospective (but time limited) ERDF investment into the costs of the proposed measures.

This ERDF contribution makes it financially viable to deliver an accelerated, coherent & proportionate programme of measures, which sensitively address current risks and short-medium term adaptive needs on a strategic basis across all the inhabited islands.

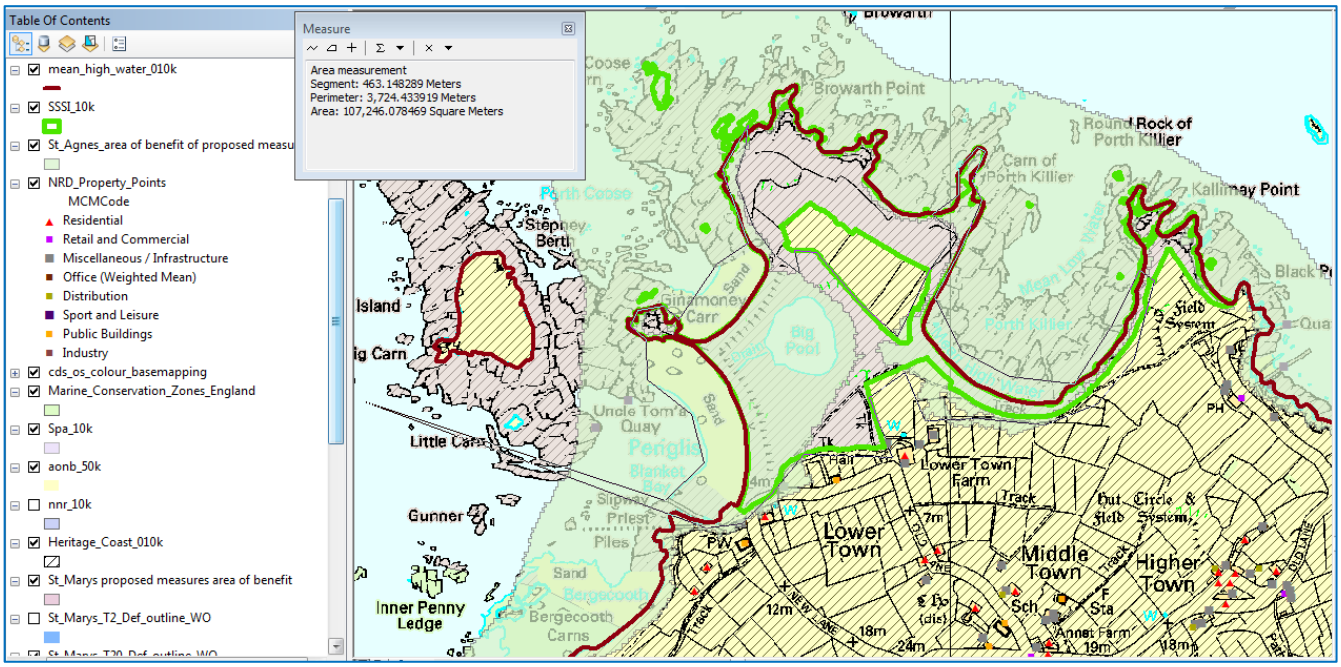
St Mary's – outline of *Higher Moor SSSI overlaid with prospective area of reduced flood risk.* ***10Ha***



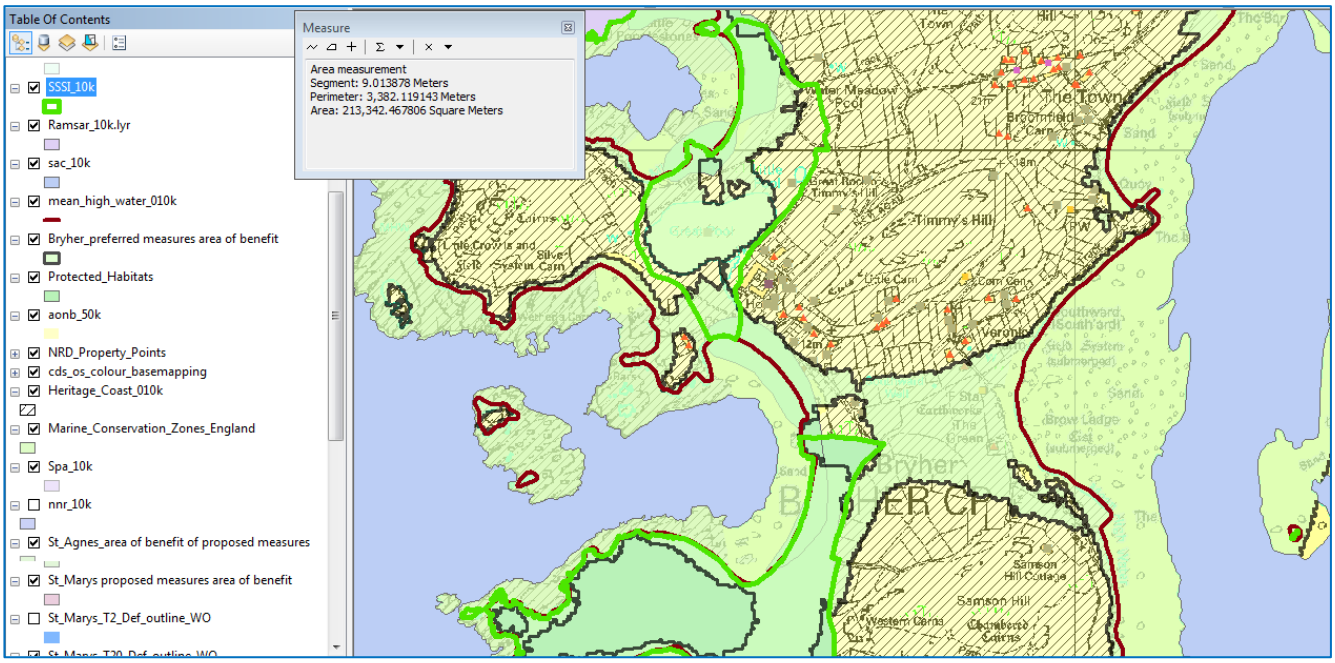
St Mary's – outline of Lower Moors *SSI overlaid with prospective area of reduced flood risk.* ***10Ha***



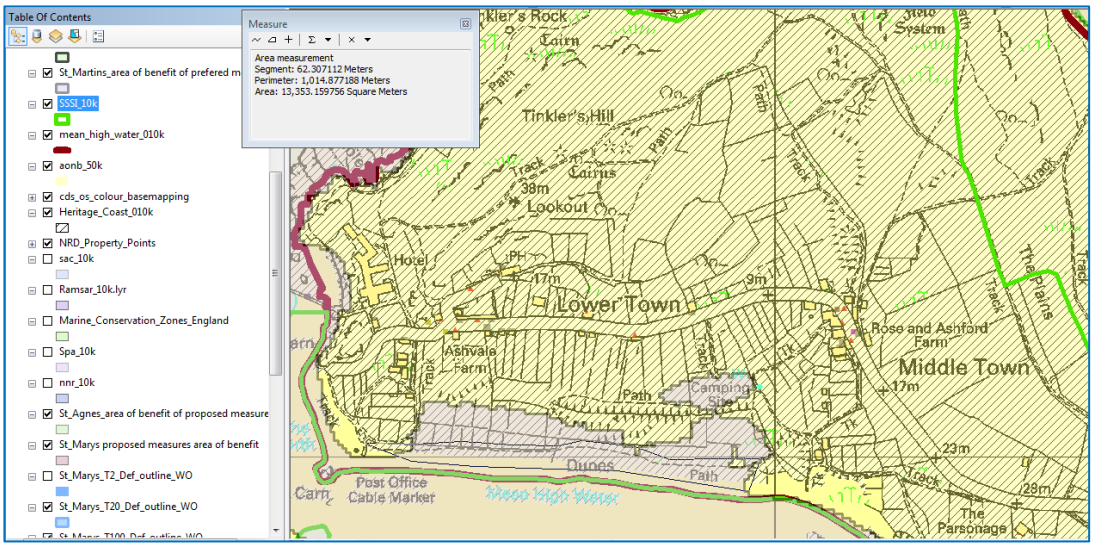
St Agnes – *in addition to restored biodiversity of dune ecosystems, reduced risk of saline inundation across freshwater habitat, which is also essential to whole SSSI & fauna of much wider surrounding designated land & seascapes.* ***10Ha***

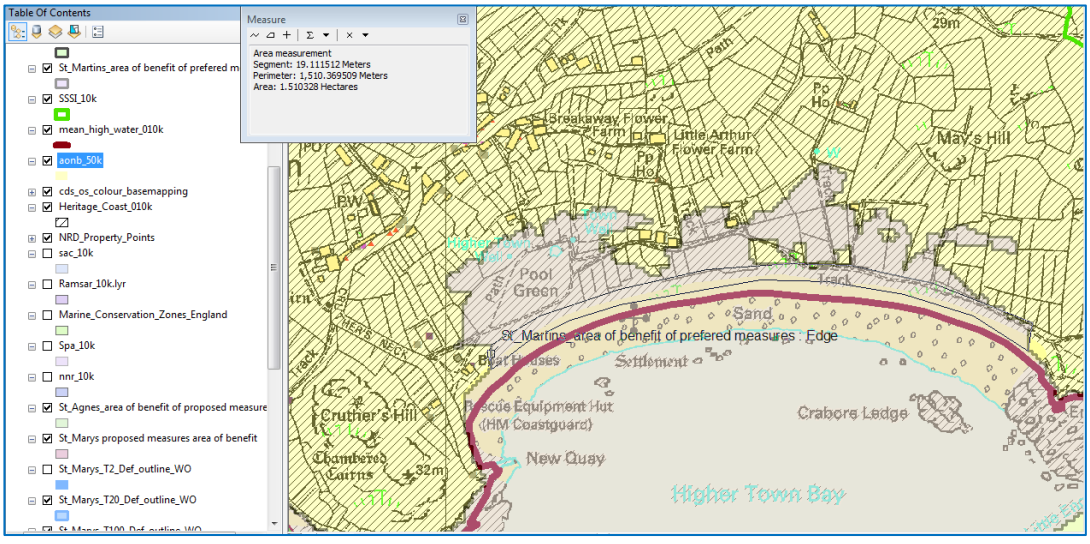


Bryher – *opportunity to reduce SSSI damage from saline inundation.* ***12Ha***



St Martin's – ***counting just the dunes, moved path & curtilage****. 3.4Ha*





3.1.5 Accounting for Natural Capital and Local Economy Potential Damages & Benefits

Risk & damage avoidance benefits to specific local economy NRD receptors are captured in the above option assessments of PV damages.
Damages to Natural Capital including fresh & groundwater supplies and impacts upon the dependent tourism economy, both of which are important options assessment criteria, are difficult to disaggregate and fully quantify. However, given the degree of physical separation of the Isles of Scilly as a tourist destination (& an 85% economic dependency on tourism), that there is no water supply connection with the mainland, that the island's already scarce & stressed supplies are both finite (like no other District experiences) and also of an unknown quantity and is one of the Island's major economic constraints – it is essential that risks, however uncertain, & opportunities to protect scarce supplies, and the ecosystems that enable them, are taken into account.
Natural capital assets and the ecosystem services delivered to the tourism economy by dunes, coasts and wetlands are far greater than just coastal protection and freshwater supply recharging, they are also fundamental in providing the exceptional quality and accessibility of land and seascapes, wildlife habitats and cultural heritage which are the main visitor attractions.
The proportionate approach taken has simply estimated the combined additional/replacement costs of lost ecosystem services (focused on fresh water) required to sustain the tourist economy and/or the scale of probable local economic losses arising from flood damage to natural capital assets and lost ecosystem services that would arise as a result of 1:20 & 1:200 events under overtopping and also under the test breach & erosion scenarios.

Rat-free
A near-unique attribute of the environment and the eco-tourism 'offer' of the Isles of Scilly, one that is of global significance, is the rat-free habitats offered by St Agnes, Gugh and a number of the uninhabited islands. This has resulted in a remarkable revival of wild fauna and flora (& opportunities to experience) especially a number of threatened species of birds & grey seals).
St Agnes is the world's only unrestricted access, rat free island which has a permanent human community (Lundy is rat free but its 20+ inhabitants are Landmark Trust staff & volunteers). The impact on wildlife & its recovery following a major flood that inundates freshwater habitat & disrupted the island's water supplies is likely to be compounded by the import of bulk water supplies from the mainland. This would be necessary to avoid partial evacuation of the community/closing it to visitors but would probably result in the re-introduction of rats.

These have been estimated and considered for St Mary's and for St Agnes
The tourism economy for St Mary's, based on 85% of current GVA, is £54m p.a. & for St Agnes £2m p.a.

On St Mary's a 1:20 probability event (overtopping only) is likely to result in significant level of inundation of Higher Moor with impact on the island's water supplies being an increase from 35 to 50% dependence on desalination. The financial cost implication of this for a summer would be in the region of £90,000 (so perhaps similar to impacts of shortages of water in summer 2018). **£90,000**
If we factor in additional breach risk the combined additional probability and consequential damage costs to water supply and impacts on the tourism economy are likely to escalate but probably only by 50%, perhaps pushing desalination to costs 50% higher. **£135,000**
On St Mary's a 1:200 event (overtopping only) would likely result in both lower and higher moor and the islands two most productive wells suffering significant inundation with salination, contamination & loss of more than 50% of the island's freshwater supplies. Alongside other damages and effects on visitor confidence, this is likely to translate into the loss of 10% of annual tourism expenditure for a year. **£5.4m.**
Factoring in the additional breach risk may increase consequential damage costs, but its main effect is to increase the probability of this scale of inundation to perhaps 1:100. This doubling of risk could be expressed as a doubling of probable damage.

St Agnes 1:20 event (overtopping only) as depths will be less than 0.02m across inundation area and it is assumed that this can be absorbed without ecosystem or economic damage effects.
However, when breach risk is factored in the net effect is likely to be loss of around 5% of water supplies for a year translating into - **£100,000**
A St Agnes 1:200 probability event (overtopping only) could inundate the Meadow and potentially result in the loss of 10% of water supplies **£200,000**
However if breach risk is added (or a 1:1000 modelled event with 2067 climate change allowances) inundation is likely to be above a metre deep across the meadow and 2 of the islands 5 wells would be directly flooded. This could result in the loss of 50% of the islands water and recovery could take more than 2 years **£1,000,000**

Please Note; for the sake of this business case, these simple estimates of the impact of events have been used to check options and inform investment choice. However, they have only been counted as local economic and financial risks and damage costs, and not as national economic damages.
As a result they are not included in the OM1, economic benefit estimates.

3.2 Critical Success Factors

No	Critical Success Factor	Measurement Criteria	Importance (1-5)
1	Reduces medium term flood risk & damages from modelled overtopping of dunes & defences	nPV Benefits based on JBA overtop flood risk modelling	5
2	Takes account of uncertain climate change vulnerabilities, offers adaptive resilience & reduces erosion and breach risks & damages	nPV Benefits based on 'test' erosion & breach uplift scenario & climate change sensibility testing	4
3	Aligns with and delivers SMP policy objectives & fully compatible with relevant national and local plans	Rate the degree to which options align and deliver	3
4	Protect fresh water ecosystems & contribute to the conservation of the biodiversity & character of land & seascapes while enabling adaptive natural change.	Comparative area of reduced flood risk of options which are sensitive habitat & landscape of character Comparison of degree to which options work with natural process & change	3
5	Sustain the islands' scarce freshwater supplies by better protecting wells, vulnerable groundwater source recharge areas & wastewater treatment infrastructure in a manner compatible with future change to water services	Comparative reduced risk to vulnerable areas that recharge groundwater sources & benefit supply and wastewater treatment receptors	3
6	Help to sustain inter-island & mainland transport links, local community & visitor amenities & the tourism economy which has strong dependencies upon conservation, accessibility & the quality of coastal environments	Comparison of options in terms of reduced risks to transport, amenities and tourist economy receptors as well as landscape quality and access impacts, including during construction	2
7	Generate strong support from engaged communities & stakeholders (including visitors), who value flood coastal & climate resilience measures & are enabled to develop longer-term adaptive plans	The preference of CIoS representatives of communities & engaged stakeholders	2
8	Secure & realise an available but time-limited remaining sum of approximately £2.4million of ERDF Flood Risk & Climate Change Adaptation (priority theme) EU Structural Fund Investments	Enables & is enabled by parallel submission of full ERDF bid which is & approved and followed by successful progression of a Funding Agreement	3

These factors closely reflect the Objectives and enable the assessment of options at a frontage, island and whole-district project scale. At the initial frontage scale on St Marys & for each of the off-islands, these are complemented by the identified frontage aims.

3.3 Options

3.3.1 Long list options

An array of potential long-list interventions were considered, many being incorporated into short-listed 'combined measure' options at a frontage and island scale via an engaged and iterative process. These included –

- Managing and moving receptors through changes in land use and relocations
- Educational & behavioural change
- Property level and incident management resilience measures
- Temporary defences
- Working with natural processes
- Adaptive approaches
- Range of physical measures which could potentially reduce probabilities and/or consequences

These were screened with many considered environmentally inappropriate or technically unfeasible in the context.

The identified project objectives by which long and shortlisted options (combinations) have been considered also came largely out of the process of extensive, iterative stakeholder engagement. The evidence and process is described at a frontage scale, across all islands within ***2.8 Current arrangements & assessment of problems & causes of risk.***

St Mary's - A longlist assessment of possible management, interventions & investment in measures was carried out at a frontage level (summarised for each in 3.5 St Mary's frontage option reviews) and the most feasible elements where clustered as elements of four distinct comparative options. The same approach was taken on each of the Off-Islands – St Agnes, Bryher & St Martin's and in the same wa, frontage options and single island approaches were clustered into four do-something options at a frontage and island level for St Agnes, Bryher & St Martins.

3.3.2 Short list options

The short-listed options for each island being:

- **Do Minimum** – continue managing and maintaining what defences exist and rely on responsive and reactive, often third party incident management and post event repairs with very limited available materials, and continued maintenance of at least aspects of dunes as part of coastal landscape management.
- **Do Something 1** – seek to reduce risk through raising the crest height (by nourishing) and FCERM performance of the dunes, complemented where required, and to the degree feasible and compatible with access arrangements, with passive/fixed measures to plug gaps in de-facto defences.
- **Do Something 2** – Incremental actions in addition to DS1 that further reduce risk through enhancing the FCERM & Natural Capital value & sustainable eco-system performance of the dunes, not just nourishing them but restoring their biomas, anchoring and fixing nourishment materials and re-establishing the structural integrity of each so they function as whole, flexibly regressing eco-systems (enabling them to walk backwards slowly and with their crests held high). Complement where required with robust active measures that plug gaps in de-facto defences in a manner compatible with context and access requirements and which offer a height consistent with delivery of a higher/more suitable SoP for the urban core of Hugh Town*. Complement and assure these enhancements by providing for and better enabling adaptive resilience and the response capacity of local communities. This will assure that any breaches from extreme storms are rapidly repaired (before next tide) in a manner that re-establishes and sustains the integrity of dunes. Do all with a strong focus on protecting and sustaining key environmental and economic infrastructure.
- **Do More** – consider alternatives and additional measures, often 'harder' more 'traditional defence' hold the line approaches regarding dunes, and more formalised (and obtrusive measures) with less focus on environmental and socio-economic benefits.

**In this context, at least in terms of local choice and when negative impacts and practical, legal and time constraints are factored in, active measures (offering at least 750mm of raised defence) are preferable to (350mm realistic limit) passive measures.*

3.4 Costs

Estimating of construction costs of measures included in options has been done using the Study that defined and quantified prospective costs of designed measures for Porthloo, Porth Mellon, Old Town & Lower Moor & Porth Hellic - by Arcadis (please see St Mary's (frontage) Study Report appended for more details).

The breakdown to individual quantified Actions, and their identified costs, as defined in the Study, have been extrapolated and then used to provide cost estimates of the same actions across the other islands to build-up and provide total construction cost estimates per frontage across each of the islands.

The extrapolated construction costs have been checked and tested by cross referencing them to MCM cost examples and construction cost estimating guides. The main estimated construction costs are summarised in the cost matrix tool below.

One-off site specific potential measures and estimates of the costs of frontage and island maintenance and management options are individually identified in the options assessment tables for each frontage and island.

Cost Estimation Matrix

Quantities - Unit prices of quantities of the various types of measure, materials, implementation labour & plant. These are inclusive of logistics, groundworks other prelims, & IoS factor. These are drawn from Arcadis cost summaries for works on St Mary's (& Tresco) and cross-referenced through range of FCRM scheme costs and cost estimation tools.	**Dune Restoration & natural enhancement 100 linear metres** of frontage (non-rock armour toe'd). Inclusive of non-bulk material supply, labour, prelims, IoS factor	£30,500 per 100m
	Enhanced level dune recharging, labour and plant supplement (assuming 4-10mm crushed granite supplied to site)	£500 per 10m3
	Dune restoration with inserted rock-armour toe & semi-natural enhancement 25 linear metres of frontage. Inclusive of material supply, labour, prelims, IoS factor & with localised recharge of front (4-10mm granite)	£64,750 per 25m
	Rock Armour heavy grade supply only to local island contexts (1-3 tonne & 2.75 tonnes = 1M3). Price reflects bulk purchase & transportation price.	£180 per tonne*
	Granite Gravel 4-10mm supply only in 'big bags', imported, to island context/storage (for dune repairs & recharging)	£160.00 per tonne*
	Full Rock Armour Revetment to 6.2 ODN & foundation of 0.5m with tie-in	£9,000 per linear metre
	Rock Armour Gabion Wall to 2.5m high with 0.5m (gabion) submerged toe	£3,700 per linear metre
	Full structural retaining sea wall with granite face & copings to 6.2 ODN with foundations & wave reflective toe	£26,500 per linear metre
	Localised placement of supplied rock armour & geotextile (i.e. labour & plant) under supervision	£1,300 per 10m3
	Sea wall simple repair & repointing as/of existing	£235m2
	Floodgates, supply & install into existing 'gaps' between buildings 1x5m	£7,750

3.5 Long-list Option Summary & Short-list Review (St Mary's frontages & for each Island)

3.5.1 Porthloo long-list option summary

Do Nothing
This approach does not address any of the flood and erosion risk management issues. Failure of the existing defence is possible at any time, as evidenced by previous storms and the requirement for preventative measures during the storms and subsequent emergency repair costs will continue to be incurred.

Replenish 'dune' and raise the crest of the embankment
Due to the absence of any locally sourced material this will involve sourcing and importing appropriate material. Previously handling and delivery of small grain sized material would involve shipment to the islands in ton bags and has proved a costly exercise. Existing erosion and wave activity has resulted in a 5% loss of beach material along this frontage from 2007 to 2017 (source; SW Regional Coastal Monitoring Programme 2017). A continuation of that trend would result in this measure, at least in isolation, having a limited impact due to the rapid loss of the imported material**.** This suggests that in this context stand-alone localised 'nourishing' may be ineffective

Rock Armour
Strengthen the dune/bank crest and front with rock armour at northern end of beach and tying structure into recently constructed works (storm repair works and slipway strengthening in 2014/15) could increase defence integrity along the frontage, reducing the energy of the waves at this point, the amount of overtopping and also protect the bank from breach. The re-profiled frontage will absorb significant amounts of wave energy so reflected waves are smaller. This should help accretion, prevent beach loss and slow erosion rates that have been observed over the last 10 years. This and complementary measures could fully mitigate for impact of rock armour on the beach. Accretion or increased stability in this northern part of the bay could increase protection to the geological SSSI defined as the cliffs to the north of the bay. These cliffs are protected from direct wave action by Newford and Taylors Islands and accretion around the proposed rock armour would potentially decease reflected wave activity here as well. The use of rock armour of a size that could be handed by plant on the island would maintain future adaptability and redeployment if conditions or the mid-term approach to sea defences at this location were to change, in the meantime providing improved flood and coastal protection.

Extend Existing Defence
Extend the recently constructed timber wall backed embankment defence from the boat yard to the north end of the beach. This would result in a crest level rise of approximately 1m to the northern most end of the bay. The embankment crest and face could be strengthened with a geotextile and planted with marram grass.
The timber wall is mounted in a concrete base. Previous surveys and trial pits, in 2015, at the northern end of the bay revealed large amount of general building waste and problematic conditions for the timber wall.

This approach would define a fixed HTL approach to this area, which conflicts with a more adaptive approach suggested by the original SMP. The erection of a raised and hard back wall to this defence will have a significant impact on the immediate landscape and seascape, it will be out of keeping loss of material and steepening of the embankment has already been noticed on the southern end of the bay where the geotextile intended to secure vegetation in the bank face and help stabilise the defence has already become exposed and suffered damage.

St Mary's –Porthloo Short-list Options Review

Specific risks & objectives	Options	Description	Cost estimate	Assessment
Porthloo **Local frontage flood risk management aims** Protect Lower Moors SSSI from saline intrusion Protect residential properties Protect Porthloo's only road access Protect principal boatyard and associated maritime services Enhance the environmental quality of the beach and the remaining 'dune.'	Do Nothing	Don't address the very poor condition and performance of the embankment at the north of the bay or the erosion, compromise, constraint & outflanking of the central section. Don't maintain or manage third party slip floodgate. Don't provide measures during extreme storms or subsequent emergency repairs	No cost	Increasing very significant risk of flooding from overtopping, erosion & breach to immediate property and Lower Moors from very poorly impromptu rebuilt northern embankment. Won't address erosion and squeeze impacts or reduce overtop and breach risks to timber-backed section or inundation pathway through gated slipway. Continued risks to eight properties, access road, critical inter-island transport infrastructure, water supplies & SSSI
	Do minimum	Maintain & manage 2015 3rd party improvements & provide impromptu event response, post-event reactive repairs to poorly performing low crested & eroding embankment, constrained middle section and slipway flood gates.	Gate & reactive 'make do' repairs to embankment p.a. estimate £1,300 **£32,000** cost for 25 year period)	2015 slipway, M&M of installed floodgate and '3rd party formalised section plus reactive repairs will sustain estimated 1:5 SoP in short term from relatively frequent storm events but leave properties including 5 households, critical infrastructure & habitat at risk and wetlands from any more irregular events
	Do Something 1	Protect, strengthen & tie into existing embankment with 2m3 per linear metre rock armour and granite gravel topping & retrofit 1m3 rock armour 'toe' to recently formalised defence at southern end	**£200,000**	Rock armour 'toe' to absorb wave energy and granite gravel topping offers additional crest height but likelt to be compromised by greater than 1:75 extreme storms.
	Do Something 2	Rebuild, strengthen & raise to consistent height Northern section of embankment. As above but with geotextile & 1-4mm granite gravel, mixed with full reuse of existing materials. Soften and stabilse with suitable planting & establish. Tie enhanced bank into recently formalised defences at southern end and retrofit 1m3 rock armour & geotextile 'toe' to timber backed section and provide localised recharge and planting to soften and stabilise interface with beach.	**£264,250**	Offers a pragmatic balance in which the underpining rock armour 'toe' absorbs wave energy and combined with height rise, tied into 2015 works, reduces significantly overtopping and breach risks. This is complemented by existing material reuse, recharging and planting. This balance of materials will deliver improved protective performance as well as 'dune' aesthetics and minimise erosion. It will help to retain some adaptive flexibility and offers consistency with the SMP2, given existing 3rd party interventions which have taken place.
	Do More	Construct as extension to 2015 works as above but with full rock armour revetment and fix and dress the back with a timber wall	**£458,175**	While potentially offering less breach risk, given same crest height it offers no higher level from modelled overtopping risk. It would not be in keeping with the SMP2 or context, it would encroach on the boatyard and coastal path alignment. It is unlikely to be supported.

3.5.2 Porthmellon long-list option summary

Do nothing
This approach does not address any of the flood and erosion risk management issues in particular the undercutting of the bank in the south western corner where all that remains is a vertical face of sandy soil supporting the road above. It will continue to be undercut and is expected to collapse within 10 years. This would result in scouring and increased flood risk to the hinterland.

Use gabions
A defence line of steel gabions could be placed in front of what remains of the bank, tied into the retaining wall by the side of the slipway entrance to the beach and run across to the existing cliffs and rocks. However, a vertical face could increase the amount of beach loss at this location and increase erosion and undercutting around the site leading to outflanking Lifespan and impacts, including when it fails would be unsuitable for a prime beachfront and the island's centre for watersports.

R**ock armour revetment**
Creating a rock armour revetment at the western end of the beach would provide increased protection to Telegraph Road from continued erosion as well as protection to the industrial estate to the rear of the beach. Setting the revetment crest to a minimum level of 6.19m ODN would protect what remains of the existing bank and would prevent overtopping at this location. The rounded flanks and slope of 1:3. tie-in and 'Dutch toe' with a foundation level of 0.5m ODN will reflect wave energy ,minimise beach loss, be resistant to scour holes and material leaching. A layer of site won rock, ideally from the vicinity of the slip, will offer some protection to the cliff toe and give an aesthetic consistency although not be integral to the performance of the underlying revetment. Where rock armour has been used this way before it tends to lead to accretion of sediment which will further help reduce the wave energy and protect this area.

A sea wall
A sea wall could be built in front of the existing embankment. Any material gained during construction could be used as backfill to strengthen the integrity of exposed vertical faces that currently support the road. Ground conditions from trial pits on the area indicate that significant excavation would be required to provide the foundations for the wall, such that it may have to be positioned further out in advance of the bank to prevent any impact on the integrity of the road. This would position the wall closer to the MHWS line. The siting of a vertical defence line at this positon would result in increased loss of beach material at this location and increased wave energy along with an associated risk of increased overtopping. The sea wall would need to tie into the cliffs in the south west corner and the edge of the slipway.

Dune protection/repair, boardwalk & sea wall

Temporarily fencing off of access routes across the dunes, repair and re-establish flora and install a timber walkway to provide sustainable access. By installing timber/recycled plastic boardwalk

Repointing the undermined stone seawall at north eastern end of the beach and repair using locally sourced granite stones and cobbles, secured with rapid set mortar. The toe of the wall shall be exposed along its full length to assess the underpinning required. This wall cannot be sited further inland due to the existence of the water mains to Hugh Town in the path immediately behind, which this structure helps protect.

A demountable stop log defence has been installed at the slipway

Porth Mellon Beach, showing areas of vulnerability

St Mary's - Porthmellon short-list Option Review

Specific risks & objectives	Options	Description	Cost estimate	Assessment
Porthmellon **Local frontage aims** Protect Lower Moors SSSI from saline intrusion Protection of the main road connecting Hugh Town Protect properties including the business park, emergency response centre and an electricity sub-station Protect St Mary's waste transfer and recycling facility. Sustain the health and mobility of the dune system north of the Gig Shed Sustain and improve recreational access for water sports and marine activities	Do nothing			No reduction in flood risk to domestic & commercial property, main road & critical infrastructure, including freshwater supplies & deterioration of habitat value of Lower Moors SSSI. Collapse of main arterial road out of Hugh Town. Risk of collapse/wash away of north eastern sea wall which 'protects' mains water pipe
	Do minimal	Move some of the previously dislodged rocks off the immediate low-tide foreshore to offer minimal protection to the base of the remaining bank in SW corner Temporary fencing off of access-damaged section of dune to encourage natural recovery. Maintain & operate stop log barrier across slipway	**£2,600** £500 £500 £1,600	Will deliver an estimated 1:10 localised frontage SoP
	Do Something 1	Reinforce bank at the south western end by creating a rock armour revetment (to 6.2m ODN & foundation of 0.5m) where the road is currently at risk of being undermined.	**£204,000**	Reduces wave energy & protects to stop undercutting of the road, overtopping & risk of breach inundation impacting on properties, infrastructure and through to Lower Moor. Use of several dislocated granite boulders from this specific frontage, which are scattered in the vicinity of the bay, can be utilised to 'front' the revetment, ensuring it is in-keeping with context. This would reduce hazards that obstruct recreational boater. 1:75+ SoP
	Do something 2	As per DS1 create revetment to protect road, overtopping and breach. Complement with measures to assist dune recovery, beach access and repoint & repair 25m section of stone sea wall at NE end of beach.	**£221,500** - Repoint & repair NE sea wall - £8,800, Boardwalk - £8,585, tied-in revetment to re-enforced bank - £204,115	Will deliver an estimated 1:150 SoP by sustaining dune and avoidance of damage, breach and overtopping alternative flood water pathways outflanking DS1 measure.
	Do More	Construct a road-retaining sea wall with foundations in SW corner	**£608,550**	Involves unacceptable seaward encroachment and potential to be outflanked. Increased reflected wave energy will increase loss of beach material in area leading to increased incidental wave energy and increasing risk of erosion, breach and flooding via dune to the NE. Would deliver an estimated 1:200 SoP

3.5.3 Old Town and Lower Moor long-list option summary

Do nothing
Continued annual overtopping flood risk to immediate domestic and commercial property. Critical infrastructure and SSSI at risk from lower probability events, including freshwater supply to the island.. Erosion pressure and risk of inundation of the Lower Moors area dictate that this is one of the most pressurised frontages on the island.

Maintain current approach
Saltwater intrusion is one of the biggest threats to the hydro-ecology of the Lower Moors SSSI. Although the current approach has been successful in recent years at minimising flood damage to properties, Overtop modelling and a reliance on impromptu incidence response suggests that the integrity of the islands freshwater supplies and the environmental condition of the Lower Moors would remain at risk.

Demountable Barrier
The design identified by the study would reduce the amount of overtopped seawater which currently finds its way to the southern part of the Lower Moor through Trench Lane. The principal elements being:

- Provide containment of overtopping within the beach section of Old Town Road by providing temporary flood barriers (e.g., demountable barrier deployed within permanent fixing points) at the corner of Old town Café and at the high point at the entrance to Trench Lane.
- Improve the effectiveness of drainage at the low spot within the road at Old Town Cottage Improve the effectiveness of drainage at the existing gully at the bottom of Trench Lane.

The existing sea wall has regular drainage holes along its length which will allow a degree of overtopped water to drain away in between waves. Should the level and quantity of overtopping be too great to effectively drain then the sea wall, the splash wall at the rear of the road and the defence will hold a reservoir of overtopped water until high tide conditions recede. The lay of the road is such that if this reservoir fills it will drain away to the west before the height of the barrier at the eastern end is reached.

Whilst the temporary flood barrier will reduce flows running down to Old Town Cottage, there will still be some overtopping to deal with in this area. It will therefore be necessary as part of this scheme to improve the existing drainage at this low spot by reinforcing the double gully and providing a larger diameter pipe to return flows to the main surface water outfall pipe [subject to confirmation of tidal flood levels].

Community consultation has already taken place, due to the number of interested parties during site visits and because overtopping at this location is a regular event. A community group has already been formed to act as a focal group for any further discussions. They have indicated a desire to receive training and being involved in the deployment of any barriers should this approach been taken forward.

Increased water level management across Lower Moors (hydrological study)

- Undertake Topographical and Hydrographical surveys to understand the water levels in the Lower Moors SSSI and what factors affect them.
- Undertake clearance of the leat in the lower section of Lower Moor (up to Telegraph Road) and possibly introduce stop logs to manage water levels upstream. This will be subject to consultations with environmental and other concerned parties.

Bull nose return on sea wall

An alternative and possibly longer term option, would be to fit precast concrete recurved units to the existing wall (a bullnose) to reflect waves back to sea which would help reduce the amount of overtopping. Perhaps it could be bolted into the top of the wall and its 2m face front the existing seawall. This is likely to be the subject of a great deal of community consultation. There is also concern with regards the construction of the original sea wall which dates back to 1963. The wall has been tied to the road and the back splash wall on the landward side of the sea wall. There is a possibility that this structure will not be strong enough the take the additional load and pressures associated with the bull nose return.

Alternative approaches for this site would be the development of an offshore breakwater or to re-route the road inland and create a new frontage for Old Town. Due to cost, wider implications and unlikelihood of feasibility in such a designated context (Marine Conservation Zone, Special Protection Area, SSSI, Special Area of Conservation, Area of Outstanding Natural Beauty) neither of these options have been explored further.

Assumptions:

- It is assumed that site operatives are familiar with the site and will be trained to deploy the barrier.
- Wall fasteners for the tie-in detail of the barrier shall be used.
- It is assumed that the Geodesign EUR150 and EUR65 barrier is stable enough to withstand intense winds and spray associated with storm events.
- It is assumed that the integrity of the support walls is sufficient to withstand hydrostatic pressures.
- It is assumed that the kerb detail at the bottom of Trench Lane is sufficiently high to prevent water from flooding adjacent land.
- It is assumed that the existing drainage system in Trench Lane can cope with the seepage flows.

Design Basis / design method:

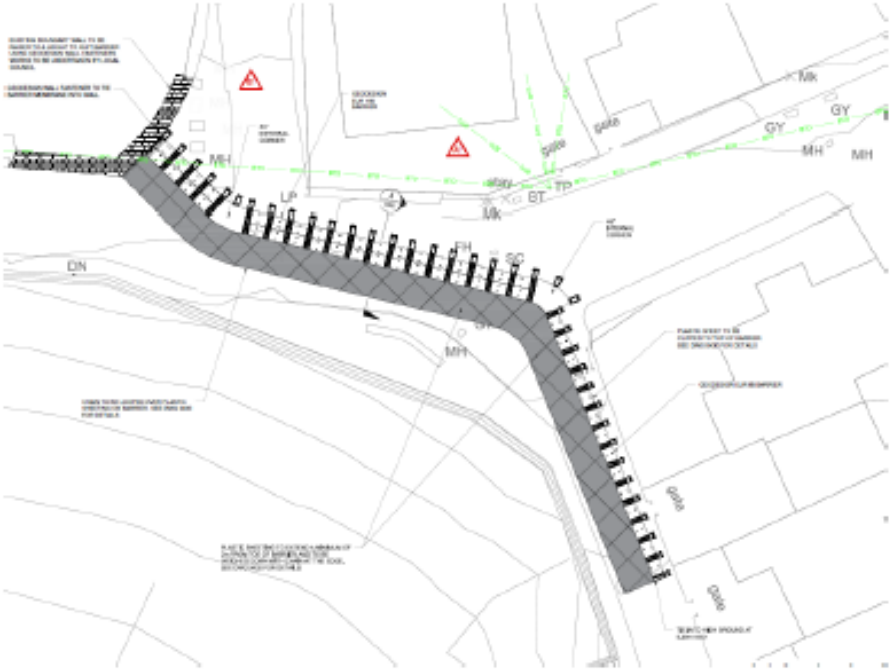


Figure 2. Layout of the EUR150 and EUR65 barrier system protecting Trench Lane and Old Town Road

An options study was undertaken to identify the most suitable solutions for the flood events in Old Town. The initial approach was to assess overtopping through the application of the EuroTop manual criteria. The input parameters were extracted from the wave propagation model and used to determine the discharges in impulsive conditions. However, the results obtained from the analysis were not representative of the observations from past storm events.

Consideration was given to raising the existing seawall with PCC units, though this was discounted on the basis of cost.

The deployment of a proprietary demountable barrier (Geodesign EUR150 and EUR65) has been determined to be the optimum mitigation measure against flooding. This system is approved by the Environment Agency and is being used to protect vulnerable sites as part of a nationwide project being led by the EA. The reasons for the adoption of this flood defence system are:

- Quick and easy to assemble
- Withstands overtopping and hydrostatic pressure
- Adaptable to varying ground levels and geometries
- Offers connection details to existing structures
- It is extendable, should the freeboard requirement need increasing

St Mary's - Old Town and Lower Moors Catchment Area short-list Option Review

Specific risks & objectives	Options	Description	Cost estimate	Assessment
Old Town **Local frontage aims** Protect Lower Moors SSSI from saline intrusion Improve management of surface water and drainage from the Lower Moors to help sustain water supplies Protect domestic & business properties Protect sewerage Bio-Bubble treatment plant and electricity sub-station infrastructure Sustain historic quay and transport connections between Old Town and Hugh Town 3	Do Nothing			Cluster of 10 homes will remain at significant risk as do sewage & electricity services to rest of this community & 10 businesses & wider island's water supplies
	Manage & maintain	Try to maintain current emergency response approach - deploying one ton big bags and sand bags to act as barriers, supplement if possible with pumps and hoses, to direct accumulated overtopped seawater away from homes, businesses & vulnerable infrastructure. This does not avoid most saline inundation risk to Lower Moor.	**£26,500** Estimated plant, labour and material incident deployment costs p.a. £2,300	Requires uncertain availability of plant etc. to distribute 1 ton sand bags. This reduces flood damage to commercial and domestic property. Salt water inundation into Lower Moors impacting on the quality of the SSSI condition and as volumes rises, the risk of contamination of island's main freshwater supply increases. Offers (uncertain) estimated SoP of 1:5 to homes but not to SSSI.
	Do Something 1	Buy, provide training & local storage for an 'off-the-shelf' demountable barrier which can be deployed along the rear of the coastal road	**£55,000**	Offers maximum localised SoP of 1:75 but may not be feasible/suitable for community use
	Do Something 2	Specify the manufacture, supply, mountings and training manual of high performing bespoke demountable barrier for installation at the rear 'high-line' of the coastal road to hold flood waters along Old Town frontage. *Increased water level management across Lower Moors (hydrological study). Lower Moor hydrological study (as per Arcadis spec & costing was contracted June 2019)*	**£75,714** (as per Arcadis specification)	Provides a means of containing overtopping, enabling flood waters to be released during lessened tidal conditions. A water tight physical barrier would protect property from wave & overtop flood waters and address medium term threats to critical infrastructure, saline inundation of SSSI & water supplies. The existing sea wall & slipway would allow drainage & the local community has potential capacity and capabilities to deploy it with CoS support. Expected to deliver a 1:100-150 SoP.
	Do More	As a passive alternative implement full required PLP to the 15 directly at risk residential and equivalent commercial properties	**£420,810**	Costs would be significantly above FCERM GiA eligible investment for PLP, ERDF funding could not be used to support residential-specific measures and it offers no benefits/protection to Lower Moor SSSI and does not deliver OM4s

3.5.4 Porth Hellick long-list option summary

Do nothing

No reduction in flood risk to the eco-hydrology of the Higher Moors area or to the protection of the island's freshwater supply. Deterioration of the Higher Moors SSSI due to flooding from salt water ingress.

Develop responsive approach to events

This will involve repairs to any significant breaches of the backshore storm embankment, including local redistribution of beach material if required. The drainage leat for the Higher Moors Pool was repaired and upgraded after damage during the 2014 storms, this important drainage structure requires ongoing maintenance and repair.

Replenish bank and strengthen areas of weakness

This design aims to reduce the amount of overtopping into the Higher Moors by raising the consistency of the crest height across the low areas of the backshore embankment. Do so sensitively and consistently with natural processes, minimising disturbance to the site. This will principally be achieved by:

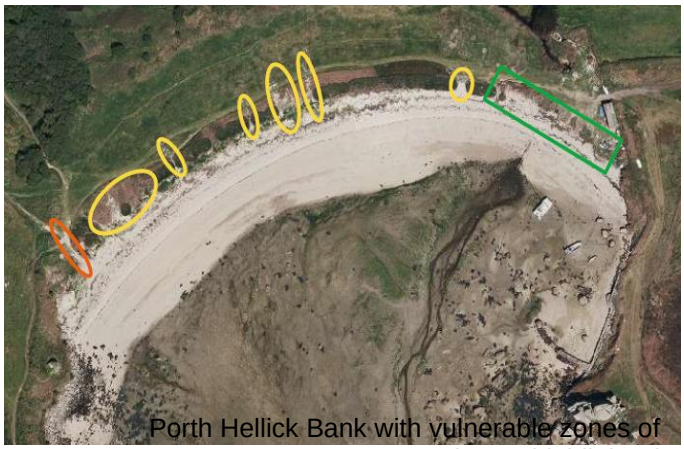
Raise crest levels with beach material at eastern end of the dune where there are low and vulnerable weak spots & infill localised flow routes across the crest. Localised recharging will require imported granite crush.

Extend the bank to reinstate its presence at the eastern end of the backshore area. Formalise (or divert) vehicular launch access onto the beach to prevent further damage and enable effective outfall drainage and management access to the leat. A concrete slipway with stop logs was considered, but a flexible concrete mattress following the newly raised profile of the bank is more appropriate to the existing land and seascape as well as requiring less disruption to this environmentally sensitive area.
At western edge of the beach provide an up & over timber walkway to formalise beach access and reduce human erosion, aligning the access in such a way as to prevent it acting as a route for flood water.

Fascicularia are firmly established on the bank and their removal would do irreparable damage to the integrity of the bank's structure. Furthermore, their salt tolerance and development at this site has added a good metre of height to the bank and have helped stabilise and protect it during storm events. The Fascicularia plants are not encroaching on land beyond the bank and the approach includes the opportunity to retain and extend them with other vegetation along the central crest. This will not include distribution beyond. Its use is with the aim of infilling and strengthening weak, lowered sections within the existing distribution area and help provide those bare sections in the bank with a greater degree of protection so it delivers more consistent protection. Fascicularia plants also provide shelter on the landward side of the bank for other local vegetation. At present, some of these sheltered landward areas have been populated by C.edulis (Hottentot fig). None of this invasive non-native species will be transported or propagated at this area. Where possible areas with little or no vegetation on the landward side will be planted with species such as Sea Campion, Sea Holly, Sea Kale and Sea Rocket to help prevent the opportunist spread of C edulis and to further strengthen & heighten the dune while enhancing its natural capacity to regress in response to sea level rise and coastal processes. Over the period 2007 to 2017 the beach profile has seen a gradual 0-3% increase in cross section with around 5m2 of material accreting along the profile at the western end of the bay.

Hard Engineering solutions

These options include the potential construction of a rock armour revetment on the seaward face of the backshore storm ridge, the construction of a sea wall either in front of or behind the backshore ridge and the creation of a breakwater at the entrance to the bay to reduce wave energy within the tidal and storm zones. None of these options have been considered in detail as they have been discounted either on the basis of cost, or environmental impact and proximity and intrusive impacts upon the Higher Moors and Porth Hellick Pool SSSI, Peninnis to Dry Ledge Marine Conservation Zone, Special Area of Conservation, and AONB and Heritage coast.



Porth Hellick Bank with vulnerable zones of weakness highlighted

Furthermore the construction of a hard engineering solution would suggest the long term adoption of a HTL approach, which conflicts with the intended approach of the SMP where MR and NAI is considered for the 2nd and 3rd terms.

Porth Hellick short-list Option Review

Specific risks & objectives	Options	Description	Cost estimate	Assessment
Local frontage aims protection of the Higher Moors Pool and larger SSSI wetland area from saline intrusion protection of freshwater resource for St Mary's. minimise the intrusive landscape impacts of any measures retain and improve public access and encourage sensitive appreciation	Do Nothing			Very significant risk of inundation and increasing risk pf breach resulting in loss of significant proportion of island's scarce fresh water supplies & loss of important freshwater habitat - with considerable knock-on effects to wider pollinator, insect, sea & songbird populations
	M&M	Fence off and restrict access onto beach and dune and of use of slipway to reduce wear and tear	**£3500** for cost of fencing, installation & blocking off vehicular access	If it was successful in reducing human impacts it may allow a degree of natural recovery and some reduction in overtopping, inundation and breach risks and consequences, but, that is very uncertain and does result in a loss of local & visitor amenity.
	Do Something 1	Nourish/recharge 150m damaged section of dune to increase consistent dune height. Raise and strengthen slipway and interface with leat to address floodwater pathway	**£121,375**	Although offers raised crest height it does not strengthen nor is it likely to sustain enhanced protection through major storms above 1;75
	Do Something 2	Invest to recharge, regenerate, strengthen, heighten & improved the mobility of 150m of most damaged dune and its shingle back. This by adding crushed granite into dune with biomatting and varied planting plus transposing. Complement with improved, controlled access measures to protect the heightened dune, stop inward inundation and impacts and enable the dune to build its natural strength and 'walk backwards' with flexible resilience.	**£167,125** - £66,000 for supply to site of 412 tonnes of extra recharge crushed granite. £1,950 for three extra days of plant & crew £45,750 for 150m of dune restoration and replanting works, £53,425 for slipway and public beach access routes connected to footpath and bridleway network.	Offers opportunity to deliver strengthened consistent dune with flexible resilience which protects and enhances the value of the critical natural capital asset in a manner consistent with the contextual constraints and in accordance with the SMP2. Metre crest height rise of damaged section , with adaptive strength and flexibility will deliver an estimated 1;150 SoP sustained for at least 25 years without extra maintenance costs.
	Do More	In addition to recharging, incorporate rock armour revetment to protect toe and stabilise position of dune in weak sections.	**£509,875**	Doubtful that such a higher level of intervention would be feasible in a context of such variable rates of erosion & accreditation or it being consistent with seeking to manage the natural process of landward retreat in the SMP2. If rock armour was 'left behind' it could undermine the front of the dune & 'scar' the beach.

2.5.5 Hugh Town long-list option summary

The commercial and residential core of the only urbanised area of the district, inclusive of its; administration; maritime mainland, off island and haulage transport links; and; 30+ residential & similar number of non-residential properties are currently at very significant risk. Recent events and flood modelling evidence the (increasing) risk from near annual overtopping and flood inundation events.
The identified main flood-water pathways being:

- The 8 low-point slipways and access routes between existing 'sea walls' onto Town Beach & Porthcressa
- Wave overtopping of the Mermaid Inn sea wall and associated low point gap at the Town Quay entrance

While inundations are localised at 50% probability events (depends on storm direction) they become inter-connected beyond 5%, leading to flood extents and increased depths across the vulnerable core of Hugh Town.

No Nothing
Don't warn, prepare or trigger incident response to protect property thresholds, don't put in place impromptu high-tide 'plugs' in defence gaps, seek to manage wave overtopped sea water or deliver immediate clean-up and make-safe reactive repairs to avoid next-tide repetition.

Manage & Maintain
The assumption is of continuation of the combined council, emergency services + community response – advanced intelligence & warnings, pre-preparations, incident and post-event responses and that the plant, expertise and relevant materials continue to be made available and volunteered, including sand bags across thresholds and big bags into main gaps & the pumping of overtopped water.

This set of responsive measures are highly cost effective, reflecting the level of resilience and community cohesion. In practice it is difficult to distinguish between responses and resources of the authorities and those of the community because so many islanders have voluntary or part-time responder roles, relevant equipment and expertise. Many Islanders lives and livelihoods are weather-dependant and they are conscious and constantly alert to the threats from storms. The estimated cost of sustaining this is somewhat nominal in that it only reflects direct council costs of activities such as drain jetting.

However, this should not be taken for granted and some significant inherent and residual risks should be factored into investment decision-making, such as –
The assumption is that events only occur outside of the tourism season (i.e. not when an extra 4,000 people are staying, many in Hugh Town). If such an event was to occur between May and October the response would probably need to be re-directed towards managed evacuation and keeping the wider public safe rather than protecting homes, commercial properties & minimising disruption to the local economy.

Estimates don't include the health, safety and threat to life risk costs of responders, especially in circumstances where an event exceeds expectations and/or where responsive resources are over-stretched beyond M&M assumptions by overtopping and breaches occurring simultaneously across multiple frontages.

Town Beach & Porthcressa slip and access gaps

These are the primary flood water pathways and are gaps in existing 'sea walls. This measure is about progressing no regret opportunities to plug these gaps and realise the full benefits of the historic de-facto 'wall' of properties along Town Beach and the two relative low-point public access routes onto Porthcressa through the recently regenerated sea wall and promenade/embankment.

In all these situations, 1m flood gates, set within foundations and their own tie-ins to surroundings, which sustain all existing access arrangements and deliver a consistent net minimal increased defended height of 750mm (with 250mm freeboard) would provide an effective and consistent level of flood defence from modelled events with a probability of around 1:200.

Fit bullnose as aspect of rebuilding Mermaid Inn sea wall & associated quay entrance works
Significant wave overtopping (westerlies) volumes flowing down into the core of the town are the other main pathway. The risk of the wall collapsing with the result of far more significant inundation is an additional risk factor. A bullnose or similar wave reflective re-profiling would dissipate the wave energy directing it back out to sea. This would reduce the volume of overtopping and risk of breach to the sea wall. However, an initial visual inspection strongly suggests that the wall does not have the structural integrity as it is to have these measures retro-fitted to it without a substantial rebuild.

Hugh Town short-list Option Review

Specific risks & objectives	Options	Description	Cost estimate	Assessment
Local frontage aims Better protect the core of Hugh Town including essential commercial & administrative services from the risks and consequences of flooding Sustain access routes and all amenities at Town Beach & Porthcressa, complementing recent frontage improvements Sustain full access on/off Town Quay and protect its critical infrastructure and facilities Enable management of surface water and drainage systems to overcome period of tidal lock Ensure measures are in keeping with the historic townscape and character	Do Nothing			Even at 50% annual probability, around 30 residential, 10 retail & commercial (including the Co-op, the only 'supermarket on the islands' and thus is viewed as critical local infrastructure) & 30 other non residential buildings are in areas of inundation (mostly at 0.2 but some at 0.4m). Damages rise sharply beyond 5%. This is consistent with reports of events in 2012 & 14.
	Manage & Maintain	Emergency service + community response - sand bags & big bags if possible into gaps and pumping overtop water away to minimise damage.	**£26,500.**	Such responses, especially up to 5% events are effective at reducing damages. However, they are intensive & carry inherent risks - not least over-stretched demands on limited capacity along a number of frontages simultaneously outstripping availability. Analysis of previous events suggests that a full council, emergency services and community response more than halve damages in Hugh Town up to the 5% event, but at the risk of diminished response benefits on other frontages. Beyond that, damage costs escalate.
	Do Something 1	Raise height of slipway 'gaps' by 350mm with concrete additions, drainage and suitable tie-in arrangements to adjacent properties Mermaid Inn section of Harbour sea, retrofit wave deflector to top of strengthened wall to reduce volume of wave overtopped water, commission set-back demountable temporary barrier for across A3111 outside Mermaid Inn. PLP measures for rear of Mermaid Inn & front of adjacent house	**£168,800** £33,620 for slipways £28,000 of tie in wall works, Mermaid Inn sea wall deflector 64,700 Demountable barrier 6.6m £15,500 PLP £27,000	Modelling, mapping & events suggest that the properties along Town Beach act as an effective 'sea wall' (tidal events are short enough that inundation rates are unlikely to be more than a very localised problem). Recent investment in the promenade at Porthcressa provides a sea defence but same issue with gaps applies. Passive approach being to raise with concrete but can't get above 350mm without significant problems. Sop only offers around a 1:75 SoP
	Do Something 2	As DS1 but instead of concrete Install a set of (1-1.25m height) floodgates & associated tie-in structures at eight 'walled-in' locations across Hugh Town. 1x5m floodgates @ £7,750 + wall infill and tie-in works + Mermaid Inn Harbour seawall actions as DS1	**£204,180** £69000 for flood gates instead of slipway concrete,	This suggests that a series of floodgates across eight gaps in the promenade and town beach 'slipways' complemented by measures to reduce overtopping and avoid water running down Hugh Street into core of town could deliver significant reductions in damages, providing estimated SoP of around 1:150.
	Do More	In addition to the installation of floodgates, further strengthen/rebuild as needed to raise the existing Mermaid Inn sea wall and also install a bullnose reflector at its base	**£353,000** - £69000 of flood gates, £28,000 of tie in wall works, Mermaid Inn sea wall 256,000	

3.5.6 Combined into a whole-island short-list options assessment

St Marys - As the SMP2 identified and JBA modelling confirms, flood risks at Porthloo, Porthmellion & at Old Town are inter-connected via inundation of the freshwater assets of Lower Moors. The frontages on the Hugh Town isthmus are also strongly inter-connected.

Options	Description	PV Cost estimates	Assessment
Do Nothing Estimate of SoP <1:1	Without maintenance or incident response - very poor condition 'dune' at Porthloo, undercutting of embankment at Porthmellon & regular overtopping of sea wall at Old Town - all risk Lower Moor SSSI & water supplies, via flooding of frontage properties. Compromised dune at Porth Hellick risks Higher Moor SSSI & water supplies. Gaps in sea walls & overtopping threaten core of main town and essential services.	No cost	No reduction to risk of flooding from overtopping to 85 residential & 82 non-residential properties as well as additional risks from erosion and breaches. Doesn't protect fresh water supplies or ecosystems. Won't address squeeze impacts or enable natural change. Doesn't deliver SMP objectives. Doesn't protect mainland link and inter-island transport or tourism economy Doesn't deliver or support resilience Won't realise available ERDF
Manage & Maintain Estimate of SoP 1:7	M&M of 3rd party 2015 works at Porthloo & existing flood gates. Install gabion at Porthmellon & repoint sea wall to sustain water supplies & road. Fence off & restrict access across damaged dunes. Assumed continuation & effectiveness of impromptu cross-sectoral responses to major winter (only) storms won't be overstretched across multiple frontages simultaneously. Post-event 'make safe' reactive repairs will continue to be afforded (including by 3rd parties).	**£91,100** £32,000 £2,600 £26,500 £3,500 £26,500	Impromptu responsive measures are effective, halving damages to properties up to 5% events, but are intensive and carry inherent risks. Don't protect freshwater supplies and ecosystems Don't address squeeze or enable natural change. Don't deliver the SMP Offer limited protection to transport, amenity & tourism infrastructure. Does value, but takes for granted (?) community resilience. Won't realise available ERDF.
Do something 1 Estimate of SoP 1:75	Recharge embankments, protect with rock armour, plug gaps with raised(passive) slipway measures to protect core of Hugh Town and complement with 'off-the-shelf' temporary barriers (Old Town)	**£745,175**	Potentially offers consistent reduction in risk to moderate category but island, infrastructure, habitat and fresh water supplies will remain vulnerable to more extreme storm events.
Do something 2 Estimate of SoP 1:150	Restore, & enhance (soften, strengthen & raise natural resilience) dunes, protect freshwater & key infrastructure from overtopping and erosion impacts & plug gaps in existing defences on isthmus to protect core cluster of homes and services in island's only urban settlement	**£986,079** Porthloo £264,250 Porth-mellon £221,500 Old Town £75,714 Lower Moors £53,310 Porth Hellick £167,125 Hugh Town £204,180	Offers a tailored, sensitive approach to dune restoration & enhancement complemented by measures to avoid inundation of wetlands, protect vulnerable key water, waste, transport & tourist infrastructure. It will deliver risk reduced to vulnerable properties & the urban core of Hugh Town protecting 85 households & 82 non- residential receptors from at least 1:100 (modelled) overtop flood risk. Measures also offer medium term sustained reduced risk from breaches, erosion & climate change. It protects freshwater supplies & ecosystems. It is consistent with the SMP2 review & enables & works with natural processes & change. It values & enables redirection of community resilience expertise. It will realise available ERDF funding.

Do More Estimate of SoP to Hugh Town property receptors1: 150-200 but does not deliver for Lower Moor	Add wave defecting strengthening & seek to fix the position to fully formalise dunes as defence embankments. Build new or fully rebuild existing sea walls and hard defences with wave deflectors installed at Old Town, along Town Beach & by Town Quay.	**£2,350410** £458,175 £608,550 £420,810 £509,875 £353,000	While offering a similar, initially slightly higher, but potentially deteriorating level of flood protection, at least in medium term (if not outflanked), it would not be in keeping with the SMP2 or contextual constraints. It would encroach, work against costal process resisting natural change & generate coastal squeeze. While it would protect at risk properties freshwater ecosystems and water supplies, actions would compromise & damage natural capital assets. It would protect infrastructure but significant construction impacts would damage tourism as would long-term effects on landscape character. It risks 'replacement' & undermining of community resilience. The high costs could not be met by FCERM GiA and the available sum of ERDF so time-limed ERDF could not be realised.

The JBA modelling, which was specified and commissioned by the Environment Agency in 2016 (to provide the island's first and previously missing such assessment), does not offer granularity or provide separation of mapping, modelling or property counts at a below individual island scale, including for St Mary's.

Flood risk to St Mary's secondary freshwater asset, Higher Moor, via Porth Hellick, and via Porthloo, Porthmellion, & Old Town to the island's primary source of freshwater at Lower Moors are not directly connected (hydrologically) to the core of Hugh Town. However, they, and the case for investment to reduce flood risks to them, are strongly hydrologically inter-dependant. This is because of the fundamental dependency of the viability of Hugh Town on the protection of the island's scarce freshwater supplies. Uniquely, this District's water supplies (and those of individual islands within the District) are completely separate and independent, with no connection to the mainland. This and its reflection in the Project Objectives strongly supports combining options for frontages into a St Mary's whole island assessment. In addition, ERDF funding which is essential to financial viability, can only be secured into options which offer improved protection to the commercial premises, freshwater supplies, habitats and which, by doing so, offer a sustainable approach to assuring the (tourist) economy and continued viability of life on the islands.

3.5.7 St Agnes

Do nothing long-list option summary
During range of modelled events, the existing sea wall backing Porth Killier minimises direct overtopping. However it will be increasingly outflanked, leading to inundation of the Meadow & it's critical 'groundwater recharge' area. Continued wave action erosion of the glacial ram section to the immediate SE of the wall is likely within a relatively short timescale to result in the loss of the 'roadway' & the coastal path. The current rate of observed undercutting of the central section of the existing sea wall, of itself is not a significant threat to the wall (at least during the medium term benefit period). It is risks of outflanking by erosion and inundation pathways to either side (& risk of damage to rear of the wall) which is of concern.

Not managing or maintaining substantial dune frontages of Periglis & Porth Coose, making no prior or responsive provision will result in these natural capital assets degrading & their ecosystem service capacity being diminished. Truflow flood modelling just of overtopping is itself time static & partial and JBA's report acknowledges that it does not fully reflect how freshwater habitat and main water supply recharge area behind them will become increasingly vulnerable with escalating damage consequences to the Meadow, Pool, Lower Town, wells & other infrastructure receptors from flood water and saline inundation as a result of storm erosion and breaches of the dunes.

Manage & Maintain
Seek to slow localised scouring erosion of glacial ram to the SW of Porth Killier by 'dropping' 10m3 of medium size rock armour into the back of the existing 5m eroded breach section.
This would minimise undercutting of the wall and would potentially provide a reduction in erosion impacts on the most vulnerable section, at least under less extreme event conditions. However, the concern with this approach is the residual risk of the dropped stone actually exacerbating scouring erosion during the most extreme storm events. In addition, this would still leave the meadow vulnerable for overtopping through inundation and the pathway on the north side of Porth Killier.

Assume continuation of community capacity, voluntary & adhoc FCRM management & maintenance of dunes as aspect of wider landscape stewardship, extreme event & post event responses & emergency resources to address Dune overtopping, erosion & breach impacts. This is estimated at £4k p.a.

Invest to reduce risk
At Porth Killier, actions to address localised erosion & overtopping risk with proportionate local rock armour interventions -

- Reduce scouring of toe/foundation of 10m section of retaining sea wall by protecting it with 1.5m3 of rock armour per linear metre construction+ cost £8,725.
- Halt ram erosion & overtopping risk at a 5 metre section to immediate SE of sea wall (avoids loss of road) by installing localised 2.5m high Rock armour revetment, construction+ cost £39,820.
- Add 20m3 of rock armour to existing to raise height and address overtopping risk on NW side of Porth Killier construction+ cost of £12,500.

At Periglis & Porth Cooth

- Restore 500m of dunes, locally recharging 125m of it with imported granite 'crush'. Naturally & flexibly strengthen, raise and protect low sections with biomatting & by planting and establishing with varied palette of costal dune flora. Achieve a consistent profile 750mm above the current low points. Construction+ costs of £176,000. (+ extra 100m3 of crush)
- Repair Periglis Slipway (6m3 - £26,500) & enhance rock armour at quay & tie-in with beach entrance (£5,510). Construction+ costs of £33,010.
- Breach repair & tie-in stock & provisioning supply/resource & store/maintain (£3,000) for up to 25 years 75 tonnes of rock armour (£13,500) and 100 tonnes of crushed gravel in 1m3 big bags (£15,840), Reserve local availability of plant & capacity to responsively plug & repair dune breaches (x2) & localised rock armour measures to responsively address erosion, including along neighbouring Troytown frontage, utilising supplied and maintained stocks (£7,800). Construction+ costs of £40,140.

Do More

Repair/rebuild &/or extend by 30m the existing wall/full rock armour revetment on SE side and install full, tied in rock armour revetment along 30m vulnerable section in NW corner of bay. Construction+ cost estimate £1,320,325

Carry out dune works at Periglis & Porth Cooth but harden & fix with rock armour 'toe revetment' £575,000.

St Agnes Short-list Options Review

Specific risks & objectives	Options	Description	Cost estimate	Assessment
Island aims Reduce flood risk to the Meadow, Pool, Lower Town & infrastructure from overtopping of dunes & embankments Reduce flood risk and consequences arising from erosion and breaches to dunes and embankments Sustain the island's freshwater supplies by protecting wells and the key aquifer recharge area of the island's main rainwater 'catchment'. Sustain and enhance Natural Capital, the continued recovery of 'rat free' biodiversity and the cultural amenity and local economy value of the dunes, beaches, harbour, the Pool & the Meadow	Do Nothing **SoP 1:7**	Unchecked, outflanking of Porth Killier sea wall risks Meadow inundation & erosion of 'ram' potentially causing loss of informal 'roadway' & coastal path beyond a …. event. Cumulative damage to Periglis & Porth Coose dunes & 'tie ins' will increase overtopping & breach risk to properties, critical habitat & water supplies.		Does not reduce overtop or breach & erosion damages to property receptors, habitats, ecosystems, water supplies, amenities & tourism economy. It won't sustain community resilience although is compatible with natural change. It won't realise ERDF funding. **Estimated overtop & breach risk SoP 1:7**
	Manage & Maintain **SoP 1:20**	Assumed continued ad-hoc voluntary resilience measures & response by islanders, general maintenance of dunes by wildlife trust & post-breach event best-efforts to plug gaps. Together these are estimated at £3k p.a.	£52,445	Maintenance of dunes, including recent footpath re-routing, reduces rate of further deterioration of the dune's FCRM Natural Capital value. Islander's resilience & response efforts reduce scale of damages from breaches but are hampered by lack of appropriate materials. Reduces but does not stop deterioration or increasing future risk to receptors, water, community amenities & economy which remain vulnerable. Won't realise any available ERDF funding. **Estimated overtop & breach risk SoP 1:20**
	Do something 1 SoP 1:75	At Porth Killier Rock armour toe protection of existing sea wall. Ram erosion revetment. At Periglis & Porth Cooth Restopr 500m of dunes, repair slip/breakwater & rock armour at Quay.	£305,635 £8,725 £39,820 £257,090	
	Do Something 2 **SoP 1:150**	At Porth Killier address localised erosion & overtopping risk with proportionate localised rock armour interventions. Restore, recharge, naturally strengthen, raise & sustain 500m of Periglis & Porth Cooth dunes. Repair Periglis Slipway & enhance rock armour at quay & tie-in with beach entrance. Supply, store, maintain & licence reactive deployment of erosion & storm breach repair stock, plant & expertise to sensitively plug breach & tie-in damage, sustaining adaptive resilience & reducing flood damages.	£358,275	Proportionate approach addresses all three localised medium term issues at Porth Killier retaining a high degree of adaptive flexibility and responsiveness to change and/or localised impacts on coastal processes. Restoring Natural Capital of dunes, sustaining their tie-ins to rock frontages & small investments in adaptive resilience 'stock' & response arrangements (so that breach risks & resulting consequences can be locally addressed) - offers reduced overtop, breach & erosion damages to property receptors, habitats, ecosystems, water supplies, amenities & tourism economy. Supports & sustains community resilience. Compatible with SMP2 & natural change. It will enable realisation of ERDF funding. **Estimated overtop & breach risk SoP 1:150**

	Do More **SoP 1:150**	Repair the existing sea wall including replacement of damaged toe. Extend by installing full, tied-in rock armour revetment along 30m vulnerable sections to SE to protect roadway & also in NW corner of bay. 375m of dune restoration but with rock armour toe/revetment and without any of the dune repair stock and resilient response provisioning.	£1,330,000	Although in the immediate is potentially more effective as a means of flood & erosion protection, the impacts, future liabilities & limited outcomes/negative BCR all suggest this approach at Porth Killier isn't contextually appropriate, proportionate or feasible. In a similar sense, attempting to hard fix dune frontages by installing rock armour toe offers no significant advantage, isn't in keeping with SMP2 & carries with it a range of considerable environmental risks to beaches and dunes, in comparison to investing in a more flexible 'working with natural capital processes' approach that is softer, flexibly adaptive & restorative of the whole dune's strength & crest height, backed up with enhanced maintenance and immediate dune breach repair capacity. This harder, less adaptive approach is less effective at minimising low probability event, 2nd tide extreme storm damage impacts. **Estimated overtop & breach risk SoP 1:150**

3.5.8 Bryher long-list option summary

Do Nothing

No active management of dunes or efforts to sustain height and integrity prior, during or in aftermath of extreme storm events.

Manage & Maintain

Continuation of current local practices which have used a mix of inter-tidal and imported granite and other means to resist dune regression.

Invest to reduce risk

At Great Popplestone –offer recharged re-naturalising dune restoration of damaged sections £53,875.

50m3 reposition in situ of existing 'rock armour' £7800, 90m of dune restoration £27,450, Granite crush supplied for dune nourishment £22,000 placement supplement £2500.

At Stinking Porth reduce overtop & breach risk at 20m southern section with localised dune restoration £15,900. Dune restoration £6,100, 20m3 granite crush £8,800, supplied £1,000 plant supplement.

At Great Porth North – Dune nourishment and restoration of 80 linear metres £55,100.
80m of dune restoration £24,400 & granite crush recharge £29,400 & rock movement supplement of £1,300.
Replacement of 'informal' & dune compromising access routes not included. Will also require blocking off/limiting use or re-routing of vehicular tracks at rear of dunes that are compromising/damaging the dune and its mobility.

Great Porth, South of Great Carn restore 20m section of damaged dune with recharge (crush £7,000) £13,775.

Green Bay - £55,000 for 100m of 'dune' restoration and nourishment with 500cm3 per linear m2 to raise dune height by 250mm.

Bryher ongoing dune breach repair & tie-in stock & provisioning - £12,900.

Supply/resource & store/maintain (£2,000) for up to 25 years 50 tonnes of crushed gravel in 1m3 big bags (£8,000, Reserve local availability of plant & capacity to responsively plug & repair dune breaches (x1.5) utilising supplied and maintained stocks (£2,900).

Do More

Install rock armour 'toe revetment' into all the dune restorations

Kitchen Porth

Perception is that required vehicular access to low water quay and slip/launch area has compacted and lowered embankment. Potential to raise edge and across informal 'gravel roadway' to provide protective embankment between dune area & small cluster of vulnerable properties according to modelling.

Bryher Short-list Option Review

Options	Description	Cost estimate	Assessment
Do Nothing			
Manage & Maintain SoP 1:2 (for non-residential	Estimated responsive expenditure during & after overtop/breach events assumed similar to St Agnes at £3,000 p.a.	£53,445	Reactive post-event response to 'repair' damage to dunes and pump stagnating sea water inundation off pasture & pathways
Do Something 2	**Great Popplestone** – Recharge & restore 90m of dune inclusive of repositioning 50m3 of in-situ existing 'rock armour'. **Stinking Porth - Restore & nourish 20m** section to reduce overtop & breach risk. **Great Porth North** 80m linear of dune restoration and negotiated changes to access and vehicular routes to enable the dune to recover and recess. **Great Porth South of Great Carn** - 20m of damaged dune restoration with recharge **Green Bay -** 100m of 'dune' restored & nourishment with 500cm3 per linear metre to raise dune height by 250mm. **Bryher Adaptive Resilience** - dune breach repair stock, plant & reactive response capability **Kitchen Porth -** Raise front edge and across 75m of informal pathway by 500mm to provide protective embankment between dune area & vulnerable properties.	**£206,550** **£45,000**	supporting the natural rollback of the dunes as per the SMP and SMP2 review by repairing damage and minimise squeeze effects of hard interventions as well as avoiding storm damage being exacerbated by human erosion & access routes.
Do More	£575,000 - include rock armour 'toe revetment' into all restored dune works	£620,000	Substantially seek to continue holding the line by resisting roll-back (as has been attempted over the past 20 years)

3.5.9 St Martins short-list option summary

Options	Description	Cost estimate	Assessment
Do Nothing			Overtopping and breaches as well as significant storm erosion is to be expected especially via weak, low and damaged sections of the dunes. Without some form of protection or enhancement further dune damage and increasing vulnerability is likely from the effects of recreational use and beach access. Ultimately, the threat to visitor facilities and freshwater supplies will remain and will potentially increase due to dune damage, storm erosion and breaches with potentially far greater financial damage costs.
Manage & Maintain	Fence off the 25 % most damaged, weakest sections to give them the chance to recover	**£5,000** Fencing of front & rear of worst sections of dune totalling 200m x £25 per m	Fencing may enable a fully natural although gradual recovery, and it is unlikely to provide a uniform dune height and resilience. Of itself it will inevitably result in loss of some 'desire line' amenity, is unlikely to be well understood by visitors, and, footpath and access 'diversions' are likely to result in other neighbouring sections of the dune being damaged and stressed. It may potentially be self-defeating.
Do something 2	Sensitively restore with in-situ materials, supplemented with planting and transposing to protect the most damaged/compromised 25% of these dunes, reroute the important coastal path and engage with islanders and promote at visitors to realise and sustain the benefits.	**£61,200** - 200m of dune restoration	These frontages, while suffering damage from erosion are not generally losing beach material (probable net deposition). This option aims to work with that natural process, utilising deposits and sensitively restore the damaged sections with biodegradable geotex and planting. Some temporary fencing will be required as will engagement & communication with islanders & visitors as well as the AONB Committee to ensure understanding, support & participation for dune restoration and for the re-routing of sections of the coastal path to minimise damage while maximising amenity value.
Do More	restore and regenerate the damaged sections but also supplement locally by nourishing with granite crush to seek to deliver immediate increased consistency of dune height to minimise overtopping.	**£209,702** - costs of preferred plus, granite crush 200m3 £115,280 & plant supplement of £13,000	The 'more' in this instance is to replace engagement and participation with upfront investment in supplementing the damaged sections of the dunes by extra nourishing with granite crush. This offers a more uniform potentially higher dune in the short term. However its extra level of protection is likely to diminish over time due to further footfall damage and poor understanding of damage impacts.

3.6 Properties at risk by return period. Current (& prospective) SoPs - each Island

St Mary's Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05	42	39	Do Nothing 1:1
5	0.00	52	43	**Current Do Minimum 1:7**
10	0.00	54	44	
25	0.08	72	64	
50	0.15	73	67	Do something 1 1:75
100	0.22	81	78	**Do Something 2** & Do More 1:150
200	0.33	85	80	
200 CC 2050	0.45	110	98	
1000	0.40	99	86	

St Agnes Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05	0	1	
5	0.00	0	2	Do Nothing 1:7
10	0.08	1	2	
25	0.33	2	7	**Current Do Minimum 1:15**
50	0.35	2	7	DoSomething 1:75
100	0.37	2	7	**Do Something 2** & Do More 1:150
200	0.40	2	7	
200 CC 2050	0.50	3	8	
1000	0.45	2	7	

Bryher Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05	5	7	Do Nothing <1:1 **Current Do Minimum 1:1**
5	0.00	6	7	
10	0.05	6	8	
25	0.15	6	9	**Do Something 2** & Do More 1:45
50	0.25	6	9	
100	0.35	6	9	
200	0.40	7	9	
200 CC 2050	0.50	10	11	
1000	0.45	8	10	

St Martin's Return Period	Mean depth of flooding (minus threshold)	Residential properties at risk (250mm threshold)	Non-residential properties	Estimated SoPs
2	-0.05		1	
5	0.00		1	
10	0.05		1	Do Nothing 1:15 **Do Minimum 1:20**
25	0.15		3	
50	-0.01		3	
100	0		4	**Do Something 2 1:75** Do More 1:100
200	0.03		6	
200 CC 2050	0.05		7	
1000	0.04		7	

3.7 Optimism Bias - justification of rates for each island

St Mary's	30%	With exception of Hugh Town flood gates we have QS bill of quantities for all proposed PO measures + HRA, EIA, landowner/manager agreements & consents in place for end 2020 contract start.
St Agnes	40%	Extensive engagement & support for dune restoration & resilient stock elements provides relative cost confidence so 30%, while 60% for less detailed rock armour interventions at Porth Killier. Combined this equates to 40%, reflective of planned contract start mid-2021.
Bryher	60%	More limited engagement & post-survey assurance of quantified costs to date. 60% is reflective of this & end 2021 contract start
St Martin's	60%	Although works are relatively simple and don't need bulk materials or heavy plant, similar issue of limited engagement & post-survey assurance

St Agnes Optimism Bias – Do Something 2 option identifies £134,195 as cost estimate for works at Porth Killier to which a 60% OB is applied = £214,712 & £224,080 as cost estimate of dune restoration & resilient stock measures (have been subject of extensive engagement & consideration) 30% - £291,304. Total of £506,016 which averages out at 40%

Apportionment of overhead costs & optimism bias to enable fully-costed individual island-scale economic appraisal

This combined business case proposes implementing a coherent set of separately justified island-scale flood risk management schemes.

This involves the equitable apportioning of full range of costs, additional to estimated construction costs, for the do something options across each island as basis of separated economic appraisal & BCR calculations for each island.

The approach has been to identify the percentage distribution of construction+ costs of the preferred option and apply those same percentages to the overhead cost of the preferred and other do something options

In addition to apportionment of overhead costs the relevant rate of optimism bias (based upon current cost certainties) is applied for each island.

3.8 Apportionment of Costs (for each Island)

Whole life Costs after OBC	Construction	Overhead costs
Salary costs		35,552
Cost of Professional Advice (Project Management)		180,360
Site investigation and survey		42,000
Supervision (Cost Consultant Fees)		45,000
Sub-total		*302,912*
St Mary's Construction costs (62%)	986,079 (932,769 without hydro study in pre OBC costs of 34,885)	(187,805 apportioned overheads)
St Agnes Construction costs (19.6%)	358,275	(61,350 apportioned overheads)
Bryher Construction costs (15%)	251,550	(47,435 apportioned overheads)
St Martin's Construction costs (3.4%)	61,200	(10,752 apportioned overheads)
Sub total	*1,657,104*	
Optimism Bias		
OB St Mary's (30%)		352,165
OB St Agnes (40%)		167,850
OB Bryher (60%)		179,391
OB St Martin's (60%)		43,171
Sub total		
Contingency (10%)		166,000
Monitoring, evaluation & reporting		35,000
Sub total		*201,000*
St Mary's apportioned		124,620
St Agnes apportioned		39,396
Bryher apportioned		30,150
St Martin's apportioned		6,834
Future cost (maintenance) all on St Mary's		16,250

3.9 Full Cost Apportionment for Individual Island Economic Appraisal

St Mary's	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (62% of existing salary cost, maintain & 30% OB)	£91k	£38k	£33k	**£162k**
Do Something 1 (62% of FOH & 30% OB)	£745k	£188k	£280	**1,213k**
Do Something 2 (62% of FOHs & 30% OB)	£986k	£188k	£493	**£1,667k**
Do More (62% of FOH & 30% OB)	£2,350	£188k	£903	**£3,441k**

St Agnes	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (19.6% of salary cost, 40% OB)	£53k	£7k	£23k	**£83k**
Do Something 1 (19.6% of FOH & 40% OB)	£306k	£61k	£147k	**£514k**
Do Something 2 (19.6% of FOH & 40% OB)	£358k	£61k	208k	**£627k**
Do More (19.6% of FOH & 40% OB)	£1,330k	£61k	£596k	**£1,987k**

Bryher	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (15% of salary cost, & 60% OB)	£53k	£5k	£36k	**£94k**
Do Something 2 (15% FOH & 60% OB)	£252k	£78k	£179k	**£509k**
Do More(15% FOH & 60% OB)	£620k	£78k	£400k	**£1,098k**

St Martin's	Core Costs	Proportionate Fixed Overheads	Optimism Bias	Total for Appraisal
Do Minimum (3.4% of salary cost, & 60% OB)	£5k	£1k	£3k	**£9k**
Do Something 2 (3.4% FOH & 60% OB)	£61k	£18k	£43k	**£122k**
Do More (3.4% FOH & 60% OB)	£210k	£18k	£132k	**£360k**

3.10 Damage Avoidance Benefits

The national economic damage estimates are based on residential and non-residential property counts for each island, by return period modelled event (with existing defences), as defined in the JBA flood risk (overtop) modelling report, recalibrated for St Agnes and Bryher to reflect their significant additional risk from dune breaches. A 250mm threshold adjustment was universally applied & all non-residential property size was capped at 400m2 (only 25% of mainland averages) to reflect local circumstances.

Checked property receptor counts, fed into the 2019 MCM BCA Tool define the (modelling evidenced) baseline do-nothing PV flood damage estimates for each island.

The MCM BCA Tool has also been used to provide consistent assessment of the PV damages to property receptors, again based just on the NRD counts of the estimated reduced extents and depths, as a result of the different levels of investment in the measures of each shortlisted do-something option. Again these are provided at an individual island scale.

3.11 Benefit Period

The defined benefit period of 25 years reflects the relatively short and uncertain longevity of asset performance and depreciation in the medium to long-term of; enhancements to dunes; flood gates and barriers; and; enhanced community resilience stock arrangements (although residual benefits, especially from restoration of the dunes are very likely). It also reflects uncertainty about future coastal & climate risks as well as wider medium term economic sustainability and IoS investment dependencies.

A 25 year benefit period has been used and is proposed as most appropriate for the following reasons -

- It offers the most appropriate fit with SMP epochs and reviews and the need for a better understanding of changes in coastal processes and erosion risks.
- Climate change modelling and allowances don't (yet) include considerations beyond mean sea-level rise and this is of particular relevance in this context
- The vulnerability over short timescales of the lowland areas (that these measures seek to protect) to rapid climactic change (during C6th AD archipelago lost 50% of land in approximately 75 years.
- While some long-list measures initially considered had elements with longer lifespans, the shortlisted measures, those viewed as appropriate and feasible in such a sensitive and protected context, only have an estimated lifespan of 25 years.
- Economic sustainability & communities across the islands are heavily dependent in the medium-term upon other infrastructure investment externalities (e.g. the mainland transport links). These are beyond scope but add to the rationale of using a limited benefit period

3.12 Economic Appraisal

3.12.1 Estimating damages and damage avoidance benefits for each option (to property receptors)
Property counts by flood return period (& depths) are based on those identified in the JBA (overtop) flood modelling report, with recalibration to reflect additional dune breach risks and impacts on St Agnes & Bryher.

Example - Property counts for St Marys defended scenarios

AEP	Residential	Commercial	Critical infrastructure	Total
50%	42	32 (39)	1	75
20%	52	36 (43)	1	89
10%	54	37 (44)	1	92
5%	65	41	1	107
4%	72	43 (64)	1	116
3.33%	71	43	1	115
2%	73	44 (67)	1	118
1.33%	81	50	1	132
1%	81	51 (78)	1	133
0.5%	85	58 (80)	1	144
0.1%	99	63 (82)	1	163
1% UKCP09 2067	104	65	1	170

AEP	Residential	Commercial	Critical infrastructure	Total
0.5% UKCP09 2067	110	73	3	186
1% UKCP09 2067	110	88	4	202
0.5% UKCP09 2117	155	109	6	270
1% UKCP09 2117	167	117	6	290
0.1% UKCP09 2117	183	138	6	327
0.5% NPPF 2117	188	144	6	338

These provided inputs to the MCM Online BCA Tool 2019, which has been used to provide assured estimates of Present Value Damages for Do Nothing (baseline) & for each of the Do Something options.

Please note; all no-residential properties have reduced & capped size at 400m2 to reflect local scale.
Please note; a 250mm threshold was applied to all property receptors for all options & scenarios.

St Mary's Do Nothing (baseline) Damages

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	**42**	**-0.05**			**39**	**-0.05**	**400**
5	**52**	**0.00**			**43**	**0.00**	**400**
10	**54**	**0.00**			**44**	**0.00**	**400**
25	**72**	**0.08**			**64**	**0.08**	**400**
50	**73**	**0.15**			**67**	**0.15**	**400**
100	**81**	**0.22**			**78**	**0.22**	**400**
200	**85**	**0.33**			**80**	**0.33**	**400**
300	**85**	**0.35**			**82**	**0.35**	**400**

Table 2 - The return period of each flood that is analysed, and the land use data for the benefit area

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total Residential damages	NRPs at risk	Mean depth of flooding	Average m²	Damage/m²	Total Non-residential damages	Total damages (per return period)
2	42	-0.05	£1,128	£47,376	39	-0.05	400	£9	£133,692	£181,068
5	52	0	£1,128	£58,656	43	0	400	£42	£718,272	£776,928
10	54	0	£1,128	£60,912	44	0	400	£42	£734,976	£795,888
25	72	0.08	£7,196	£518,112	64	0.08	400	£42	£1,069,056	£1,587,168
50	73	0.15	£11,474	£837,602	67	0.15	400	£42	£1,119,168	£1,956,770
100	81	0.22	£19,362	£1,568,322	78	0.22	400	£42	£1,302,912	£2,871,234
200	85	0.33	£23,630	£2,008,550	80	0.33	400	£302	£9,663,040	£11,671,590
300	85	0.35	£23,630	£2,008,550	82	0.35	400	£302	£9,904,616	£11,913,166

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	**17.48**

Table 3 - Loss-probability calculation

Data from steps 1 and 2			Intermediate calculations				
Return Period (years)	Exceedance probability	Damages	Probability Interval	Mean damage (£)	Interval damages (£)	Cumulative damages (£)	Lifetime damages (i.e. Discounted) (£)
2	0.500	£181,068					
			0.300	£478,998	£143,699	£143,699	£2,512,083
5	0.200	£776,928					
			0.100	£786,408	£78,641	£222,340	£3,886,843
10	0.100	£795,888					
			0.060	£1,191,528	£71,492	£293,832	£5,136,626
25	0.040	£1,587,168					
			0.020	£1,771,969	£35,439	£329,271	£5,756,160
50	0.020	£1,956,770					
			0.010	£2,414,002	£24,140	£353,411	£6,178,164
100	0.010	£2,871,234					
			0.005	£7,271,412	£36,357	£389,768	£6,813,741
200	0.005	£11,671,590					
			0.002	£11,792,378	£19,654	£409,422	£7,157,322
300	0.003	£11,913,166					

TOTAL ANNUAL DAMAGES	**£409,422**
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	**£7,157,322**

St Mary's Do Minimum Damages

Please note; that JBA Truflow modelled event shapefiles visualises inundation through buildings at depths over 0.3m. This gives the inaccurate impression that all the buildings along Town Beach are flooded from the beach side, when in reality overtopped floodwater flows around them and the risk of flooding is predominantly from landward side accumulations.

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2		-0.05				-0.05	400
5		0.00			4	0.00	400
10	54	0.00			44	0.00	400
25	72	0.08			64	0.08	400
50	73	0.15			67	0.15	400
100	81	0.22			78	0.22	400
200	85	0.33			80	0.33	400
300	85	0.35			82	0.35	400

TOTAL ANNUAL DAMAGES	£240,240
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£4199,754

St Mary's Do Something 1 Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2		-0.05				-0.05	400
5		0.00				0.00	400
10		0.00				0.00	400
25		0.08				0.08	400
50		0.15				0.15	400
100	81	0.22			78	0.22	400
200	85	0.33			80	0.33	400
300	85	0.35			82	0.35	400

TOTAL ANNUAL DAMAGES	£70.367
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,230,125

St Mary's Do Something 2 Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2							400
5							400
10							400
25							400
50							400
100							400
200	85	0.33			80	0.33	400
300	85	0.35			82	0.35	400

TOTAL ANNUAL DAMAGES	£48,833
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£853,674

St Mary's Do More Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2							400
5							400
10							400
25							400
50							400
100							400
200	85	0.33			80	0.33	400
300	85	0.35			82	0.35	400

TOTAL ANNUAL DAMAGES	£48,833
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£853,674

St Agnes Do Nothing (baseline) Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	0	-0.05			1	-0.05	400
5	0	0.00			2	0.00	400
10	1	0.08			2	0.08	400
25	2	0.33			7	0.33	400
50	2	0.35			7	0.35	400
100	2	0.37			7	0.37	400
200	2	0.40			7	0.40	400
300	2	0.45			8	0.45	400

TOTAL ANNUAL DAMAGES	£70,063
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,224,810

St Agnes Manage & Maintain Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	0				0		
5	0				0		
10	0				0		
25	2	0.33			7	0.33	400
50	2	0.35			7	0.35	400
100	2	0.37			7	0.37	400
200	2	0.40			7	0.40	400
300	2	0.45			8	0.45	400

TOTAL ANNUAL DAMAGES	£59,619
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,042,231

St Agnes Do Something 1 Damages

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2		-0.05				-0.05	400
5		0.00				0.00	400
10		0.08				0.08	400
25		0.33				0.33	400
50		0.35				0.35	400
100	2	0.37			7	0.37	400
200	2	0.40			7	0.40	400
300	2	0.45			8	0.45	400

TOTAL ANNUAL DAMAGES	£10,516
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£183,842

St Agnes Do Something 2 Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	0				0		400
5	0				0		400
10	0				0		400
25	0				0		400
50	0				0		400
100	0				7		400
200	2	0.40			7	0.40	400
300	2	0.45			8	0.45	400

TOTAL ANNUAL DAMAGES	£4,698
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£82,120

St Agnes Do More Damages - JBA overtop + calibrated breach flood risk

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	0				0		400
5	0				0		400
10	0				0		400
25	0				0		400
50	0				0		400
100	0				7		400
200	2	0.40			7	0.40	400
300	2	0.45			8	0.45	400

TOTAL ANNUAL DAMAGES	£4,698
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£82,120

Bryher Do Nothing (baseline) Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	5	-0.05			7	-0.05	400
5	6	0.00			7	0.00	400
10	6	0.05			8	0.05	400
20	6	0.15			9	0.15	400
50	6	0.25			9	0.25	400
100	6	0.35			9	0.35	400
200	7	0.40			9	0.40	400
300	7	0.40			10	0.40	400

TOTAL ANNUAL DAMAGES	£89,814
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,570,078

Bryher No minimum

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2	3	-0.05			3	-0.05	400
5	4	0.00			4	0.00	400
10	6	0.05			8	0.05	400
20	6	0.15			9	0.15	400
50	6	0.25			9	0.25	400
100	6	0.35			9	0.35	400
200	7	0.40			9	0.40	400
300	7	0.40			10	0.40	400

TOTAL ANNUAL DAMAGES	£76,946
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£1,345,112

Bryher Preferred option Damages

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2					1	-0.05	400
5					1	0.00	400
10					2	0.05	400
20					2	0.10	400
50	3	0.10			5	0.10	400
100	3	0.15			7	0.15	400
200	5	0.25			9	0.25	400
300	7	0.35			10	0.35	400

TOTAL ANNUAL DAMAGES	£16, 282
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£284,628

Bryher Do More Damages

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2					1	-0.05	400
5					1	0.00	400
10					2	0.05	400
20					2	0.10	400
50	3	0.10			5	0.10	400
100	3	0.20			7	0.20	400
200	5	0.30			9	0.30	400
300	7	0.40			10	0.40	400

TOTAL ANNUAL DAMAGES	£16,530
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£288,974

St Martins Do Nothing (baseline) Damages

Scheme life	25
Discount rate	3.5%; 3%; 2.5%
Discount factor =	17.48

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2					1		400
5					1		400
10					1		400
25					3		400
50					3	-0.01	400
100					4	0	400
200					6	0.03	400
300					7	0.05	400

TOTAL ANNUAL DAMAGES	£8,284
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£144,811

St Martins Manage & Maintain Damages

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2					1		400
5					1		400
10					1	-0.02	400
25					2	-0.02	400
50					2	-0.01	400
100					3	0	400
200					5	0.03	400
300					5	0.04	400

TOTAL ANNUAL DAMAGES	£7,222
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£126,244

St Martins Do Something 2 Damages

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2							400
5							400
10							400
25					1	-0.02	400
50					1	-0.01	400
100					2	0	400
200					4	0.03	400
300					5	0.04	400

TOTAL ANNUAL DAMAGES	£731
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£12,786

St Martins Do More Damages

Return Period of the flood (years)	Residential properties at risk (No.)	Mean depth of flooding	Damage per residential property	Total damage	Non-Residential properties at risk	Mean depth of flooding	Average m²
2							400
5							400
10							400
25						-0.02	400
50					1	-0.01	400
100					2	0	400
200					4	0.03	400
300					5	0.04	400

TOTAL ANNUAL DAMAGES	£594
DISCOUNTED FUTURE ANNUAL AVERAGE DAMAGES	£10,389

3.12.2 Flood Damages Summary Table

National NRD economic damages	Do nothing baseline damages	Do Minimum	Do Something 1	Do Something 2	Do More
St Mary's	£7,157,322	£4,199,754	£1,230,125	£853,674	£853,674
St Agnes	£1,224,810	£1,042,231	£183,842	£82,120	£82,120
Bryher	£1,570,078	£1,345,112		£284,628	£288,974
St Martin's	£144,811	£126,244		£12,786	£134,422

3.12.3 Areas of Environmental Benefit

For each island this was calculated using GiA shapefile overlays and measurements of the areas of direct habitat enhancement as a result of dune restoration and also to 'hinterland' freshwater habitat which would benefit from reduced flood and saline inundation risk, where these were part of designated sites.

Island	Estimated area
St Mary's	20 ha
St Agnes	10 ha
Bryher	12
St Martin's	3.4

3.13 Individual Island Economic Appraisal & Option Ranking Tables

St Marys

Option	Costs to EA of total apportioned PV costs with 30% optimism bias applied)	Total apportioned PV costs & 30% optimism bias	Present Value damages	Present Value benefits	BCR	Raw PF score	Contribution	Adjusted PF & BCR
Do Nothing	0	0	£7,157,322	0	0	0	0	0
Do Minimum	£161,793	£161,793	£4,199,754	£2,957,568	18:1	102 %	0	102%
Do something 1	1,212,874	1,212,874	£1,230,125	£5,927,197	4.8:1	59%	0	59%
Preferred Option	£741,919	£1,666,919	£853,674	£6,303,648	3.6:1	47%	£925,000	100% 6.8:1
Do More	£3,440,549	£3,440,549	£853,674	£6,303,648	2:1	24%	0	24%

St Agnes

Option	Costs to EA of total apportioned PV costs with 40% optimism bias applied)	Total apportioned PV costs & 40% optimism bias	Present Value damages	Present Value benefits	BCR	Raw PF score	Contribution	Adjusted PF
Do Nothing	0	0	£1,224,810	0	0	0	0	0
Do Minimum	£116,633	£116,633	£1,042,231	£182,579	1.6:1	9%	0	9%
DS1	£513,779	£513,779	£183,842	£1,040,968	1:2	34%	0	34%
DS2	196,871	£626,871	£82,120	£1,142,690	1.8:1	34%	£430,000	102% 5.8:1
Do More	£1,987,286	£1,987,286	£82,120	£1,142,690	0.6:1	9%	0	9%

Bryher

Option	Costs to EA of total apportioned PV costs with 60% optimism bias applied	Total apportioned PV costs & 60% optimism bias	Present Value damages	Present Value benefits	BCR	Raw PF score	Contribution	Adjusted PF
Do nothing	**0**	**0**	**£1,570,078**	**0**	0	0	0	0
Do minimum	**£94,045**	**£94,045**	**£1,345,112**	**£224,966**	**2.4:1**	**13%**	**0**	**13%**
DS2	**£233,526**	**£508,526**	**£284,628**	**£1,285,450**	**2.5:1**	**51%**	**£275,00**	**105% 5.5:1**
Do More	**£1,098,046**	**£1,098,046**	**£288,974**	**£1,281,104**	**1.2:1**	**29%**	**0**	**29%**

St Martin's

Option		Total PV Costs to EA with 60% 0ptimism Bias	Total PV Costs with 60% optimism bias	Present Value damages	Present Value benefits	BCR	Raw PF score	Contribution	Adjusted PF & BCR
1	Do nothing	**0**	**0**	**144,811**	**0**	**0**	**0**	**0**	**0**
2	M&M	**9,208**	**9,208**	**126,244**	**18,567**	**2:1**	**11%**	**0**	**11%**
3	DS 2	**51,707**	**£121,957**	**12,786**	**132,025**	**1.1:1**	**46**	**70,250**	**103% 2.55:1**
4	Do More	**360,012**	**£360,012**	**10,389**	**134,422**	**0.4:1**	**15**	**0**	**15**

3.14 Summary of Most Cost Beneficial Options (across all 4 Islands)

Island	Current (Do-Minimum) SoP	Full PV Costs apportioned per island	Resulting (Preferred Option) SoP	PV Benefits each island	Apportioned Contributions (£1,700k ERDF)	Raw PF score	Adjusted PF	BCR (with PF)
St Mary's	14%	£1,667k	**0.66%**	£6,304k	**£925,000**	47%	100%	**6.8:1**
St Agnes	6.6%	£627k	**0.66%**	£1,143k	**£430,000**	34%	102%	**5.8:1**
Bryher	100%	£509k	**2.22%**	£1,285k	**£275,000**	51%	105%	**5.1:1**
St Martins	5%	£122k	**1.33%**	132k	**£70,250**	46%	103%	**2.5:1**

3.15 Selection Criteria & Choice

	Critical Success Factors & Objectives	Measurement Criteria	Priority (1-5)	Do nothing	M&M	DS1	DS2	Do More
1	Reduces medium term flood risk & damages from modelled overtopping of dunes & defences	PV Benefits based on JBA overtop flood risk modelling	5	5 (25)	4 (20)	3 (15)	1 (5)	2 (10)
2	Takes account of uncertain climate change vulnerabilities, offers adaptive resilience & reduces erosion and breach risks & damages	PV Benefits based on 'test' erosion & breach uplift scenario & climate change sensibility testing	4	5 (20)	4 (16)	3 (12)	1 (4)	2 (8)
3	Aligns with and delivers SMP policy objectives & fully compatible with relevant national and local plans	Rate the degree to which options align and deliver	3	4 (12)	3 (9)	2 (6)	1 (3)	5 (15)
4	Protect fresh water ecosystems & contribute to the conservation of the biodiversity & character of land & seascapes while enabling adaptive natural change.	Comparative area of reduced flood risk of options which are sensitive habitat & landscape of character Comparison of degree to which options work with natural process & change	3	5 (15)	4 (12)	2 (6)	1 (3)	3 (9)
5	Sustain the islands' scarce freshwater supplies by better protecting wells, vulnerable groundwater source recharge areas & wastewater treatment infrastructure in a manner compatible with future change to water services	Comparative reduced risk to vulnerable areas that recharge groundwater sources & benefit supply and wastewater treatment receptors	3	5 (15)	4 (12)	3 (9)	1 (3)	2 (6)
6	Help to sustain inter-island & mainland transport links, local community & visitor amenities & the tourism economy which has strong dependencies upon conservation, accessibility & the quality of coastal environments	Comparison of options in terms of reduced risks to transport, amenities and tourist economy receptors as well as landscape quality and access impacts, including during construction	2	5 (10)	4 (8)	3 (6)	1 (2)	2 (4)
7	Generate strong support from engaged communities & stakeholders (including visitors), who value flood coastal & climate resilience measures & are enabled to develop longer-term adaptive plans	The preference of CIoS representatives of communities & engaged stakeholders	3	5 (15)	4 (12)	2 (6)	1 (3)	3 (9)
8	Secure & realise) an available but time-limited remaining sum of approximately £2.4million of ERDF Flood Risk & Climate Change Adaptation (priority theme) EU Structural Fund Investments	Enables & is enabled by parallel submission of full ERDF bid which is & approved and followed by successful progression of a Funding Agreement	2	5 (10)	4 (8)	2 (4)	1 (2)	3 (6)
	Appraisal scores	**Lowest being best**		**122**	**97**	**64**	**25**	**65**

Scoring for each factor, prioritised 5-1 (5 being most important) is by ranking each option 1-5 (1 being best) then, for each factor multiply the priority score by the ranking (number in brackets) and then add them up to provide comparative score totals of the options. Clearly DS2 is preferable.

**please note that the Do Something option, as opposed to the Do Minimum and/or Do More on Bryer and St Martins are (nominally) identified as Do Something 2. The reason for this is simply easy of summary when combined into a single OBC*

3.16 Sensitivity analysis

	Raw Score	Contribution for 100% Score
As scenario 4	45%	1,601,963
Sensitivity 1 - Change in PV Whole Life Cost (25% increase)	16%	3,067,822
Sensitivity 2 - Change in OM2 - 50% of households in Very Significant (Before) risk may already be in Significant Risk band	44%	1,654,043
Sensitivity 3 - Change in OM3 - 50% of households in Medium Term loss (Before) may already be in Long Term loss	45%	1,601,963
Sensitivity 4 - Increase Duration of Benefits by 25%	38%	1,826,616
Sensitivity 5 - Reduce Duration of Benefits by 25%	44%	1,639,550

None of the sensitivity analysis criteria alter the preferred choice at an individual island scale or when combined

3.17 Summary of Proposed Measures (for each Island)

St Mary's – nourish, restore and protect damaged dunes, install flood gates and complement with bespoke localised 'set-back' measures to manage (residual) wave overtop volumes. Deliver an estimated 1:150 SoP by raising the low point crest/defence heights by 750mm (+250mm freeboard) on all the identified floodwater pathways.

St Agnes – nourish, restore and naturally strengthen damaged dunes, raising of all identified floodwater pathway low points and crest heights by minimum of 750mm (with 250mm freeboard), complemented by localised tie-in measures to achieve consistent height of defences 750mm above current minimum level. Ensure dunes are strengthened to enable slower and adapted recession & complement and assure this with community resilience (breach management) arrangements to assure estimated 1:150 SoP for benefit period inclusive of breach risk.

Bryher - raising identified floodwater pathway low point crest heights in dunes via nourishment and planting to achieve rise in minimum dune height by 500mm on western side and by 250mm to compromised sections of embankment on sheltered/protected eastern side. Complement by removal and reuse of previous 3rd party 'hold the line' rock armour measures to enable adaptive recession and recovery of dunes. Invest in community resilience arrangements to assure 1.45 SoP for 25 year benefit period, inclusive of breach risk.

St Martin's – restore & protect to enable the recovery of the natural strength of damaged sections of whole dunes, raising low point crest heights by 500mm. Move paths and engage to minimise future erosion damage to deliver and sustain estimated 1:75 SoP.

4. Commercial Case

4.1 Procurement Strategy

The Council of the Isles of Scilly is able to provide accountability, executive oversight and assurance of financial and contractual compliance. It will deliver the required planning & legal support and the management of tendering and contracting via its procurement function.

Procurement is central to project and risk management & effective delivery. As such the key contracts (identified below) are embedded in the time-lined Detailed Expenditure & Milestones by Quarters Delivery Spreadsheet and a separate/joint Procurement Plan are provide as appendix.

The latter identifies in detail how all procurement relevant to the delivery of this project will be in line with the Public Contracts Regulations 2015 (PCR 2015) and the ESIF-GN-1-001 Procurement Guidance.

The procurements to be undertaken within this project shall be based on the 6 stage methodology set out in "Public Procurement Guidance for Practitioners on the avoidance of the most common errors in projects funded by the European Structural and Investment Funds". The method followed will be modified to reflect subsequent relevant changes in published Public Contracts Regulations. The six stages being:

- Preparation and Planning
- Publication/Invitation to Bid
- Submission and the selection of bids
- Evaluation of tenders/bids
- Award of Contract
- Contract Implementation

A Project Director, taking a senior/management role within the Council, will be procured on a fixed term contractual employment basis. The services of an expert Project Director, with a proposed start date in the 3rd quarter of 2020/21, is considered the most effective, efficient and appropriate approach to ensuring development, delivery and effective contractual risk management. Their role will be central to responsibilities for the delivery of the procurement plan.

**this includes complementary ERDF-funded water scarcity & CC adaptive measures as well as related communications and monitoring include as a part of the ERDF funding proposal – IoS Climate Change Adaptation (water) Action Plan – but are additional to this flood & coastal risk management project.*

4.2 Key Contracts

The main prospective delivery contracts and estimated contract sums, which will be procured in prioritised order to minimise risk being:

6. Main Coastal Civil Engineering Works (NEC 3 option A) & Bulk Material Supply (£1,657k)
7. St Mary's Bespoke Demountable Barriers (£140k)
8. Porth Hellick Dune Restoration (£65k)
9. Off-island Dune Restoration contracts -
    - St Agnes dune restoration+ 500m (£394k)
    - Bryher dune restoration 360m (£204k)
    - St Martin's dune restoration 200m (£100k)
10. Off-island coastal resilience stock & plant storage, maintenance & deployment
    - St Agnes (£14k)
    - Bryher – (£8k)

The combined approach to management, development and delivery offers significant overhead and contractual risk efficiencies, alongside ERDF PF contribution in enabling realisation. Both are essential to achieving financial viability.

4.3 Efficiencies & Commercial Issues

While the main contract seeks to maximise efficiencies through economies of scale, in particular by inclusion of whole-project bulk material supplies, the scale and nature of the defined Off-Island Natural Dune Restoration elements offer the opportunity to realise localised economies and related cost and value efficiencies. This is

possible where local cross-sectoral consortia or enterprises are able to fairly compete for works contracts, utilising and demonstrating through price the economies of harnessing existing local resources and capacity.

The final element, at an estimated cost of less than 2.5% of the whole project, probably offers the best value in terms of damage avoidance benefits. It will involve the procurement of supply contracts for each of the off-islands for the provision of localised arrangement which store and maintain in situ material stocks relevant to providing responsive adaptive breach incident response and erosion repair as well as plant, 'licencing' and the assured capabilities to safely intervene and responsively plug repair such breaches, assist major incident recovery and support follow-up repairs to make good breaches in the dunes which arise over the next 25 years.

4.4 Risk Mitigation

Further development of costed and quantified specification of works and in-advance identification of supply sources of the bulk materials required will provide the earliest possible reduction in these cost uncertainties. Furthermore, the use of the NEC 3 option A form of contract for the larger-scale main civil engineering works, as well as the supply of bulk materials, means that the risk of works being completed (at the agreed price), once contracted, are largely borne by the contractor.

There is some relevant civil engineering works experience on the islands. It is anticipated and intended to attract interest in this main contract from both mainland contractors and perhaps larger local construction firms.

5. Financial Case

5.1 Financial Summary

Combined preferred option *Financial Summary*

	[1]Whole-life cash cost	[2]Total Project cost (approval)
Cost up to OBC[3] *(does not include required modelling & additional OBC costs via CIoS & contributors)*	156,420	61,420
Costs after OBC		
Salary costs	35,552	35,552
Cost of Professional Advice (Consultant Fees)	180,360	180,360
Site investigation and survey	42,000	42,000
Construction	1,657,104	1,657,104
Supervision (Cost Consultant Fees)	48,525	48,525
Monitoring, evaluation & reporting	35,000	35,000
Contingency	166,000	166,000
Risk Contingency (See s.12 of the Grant Memorandum)		
Risk or Optimism Bias[6]	742,577	742,577
Future cost (construction + maintenance)	(Cash)	
	12,500	N/a
Optimism Bias on future cost[7]	3,750	
Project total cost	3,079,788	2,968,538

5.2 Funding sources

The proposed project and the delivery of this business case is dependent upon securing two sources of financial investment – FCERM GiA and a sum of aligned EU Structural Investment Funds. This funding is available from the 2014/20 England ERDF Programme (for less developed regions) under the Priority Axis 5, Climate Change Adaptation Theme.

An initial first stage ERDF application was made in 2015. A second stage full bid, but for a much smaller programme of works than now proposed, was defined by the St Mary's (frontage) Study, was developed, submitted and approved in principle in 2016. However, it was not possible to progress it or finalise the agreed funding because IoS was the only District in England without any flood risk modelling and mapping (also, the necessary FCERM GiA grant application was not fully developed or submitted). This effectively put the funding and the project on hold. JBA risk modelling of flood risk has since been commissioned by the Environment Agency and completed.
In the meantime the change in exchange rate since the UK's EU exit referendum has made available an additional sum of ERDF funding, believed to be somewhere in the region of £1.4m.

A proposal to revive and extend the original project and seek to utilise the additional sum of ERDF secured support from Executive Officers & Members of the Council of the Isles of Scilly in May 2019. In response to an initial expanded project proposal, ERDF administrators MH&CLG invited preparation and submission of an extended full ERDF application. The revived ERDF proposal fully incorporates & mirrors the significantly larger programme of measures identified in this OBC. It also seeks funding for additional measures to help address water scarcity impacts on the local environment and economy and engagement with islanders to evolve a future Climate Change Adaptation Plan for adoption by the Council as (supplementary) policy and planning guidance.

The financial viability of this project is clearly dependent upon securing both FCERM GiA & ERDF investment.

If both sources of financial investment are committed and the scheme becomes financially viable for implementation, then the evidenced ERDF eligible expenditure can be claimed quarterly in arrears. It is understood that FCERM GiA grant claims can be made for work completed plus 3 months in advance within a financial year. Expenditure claim arrangements should limit the periods and sums during the project lifespan when additional funds will be required to bank-roll the project. During any such periods the Council of the Isles of Scilly will provide interim financing until claims can be made which meet these upfront costs through the overall Settlement Funding Assessment and the Council's General Reserves.

	%	Description	Total £k
Raw Partnership Funding score	44%	from (nominal) whole project PF calculator	
Funding:			
Contributions (list)		ERDF Funding	1,700,250
Other: (list)			
Local Levy			
Non GiA contributions			**1,700,250**
Adjusted Partnership Funding score	100%		
Grant in Aid			**1,356,162**
Project total cost (approval)			**3,056,412**

It is proposal to meet the estimated **£3,056,412** costs of delivery (October 2020 – February 2023) utilising £**1,356,162** of FCERM GiA grant & £1,700,250 of available, aligned but time-limited ERDF EU Structural Investment Funds.

5.3 Overall Affordability

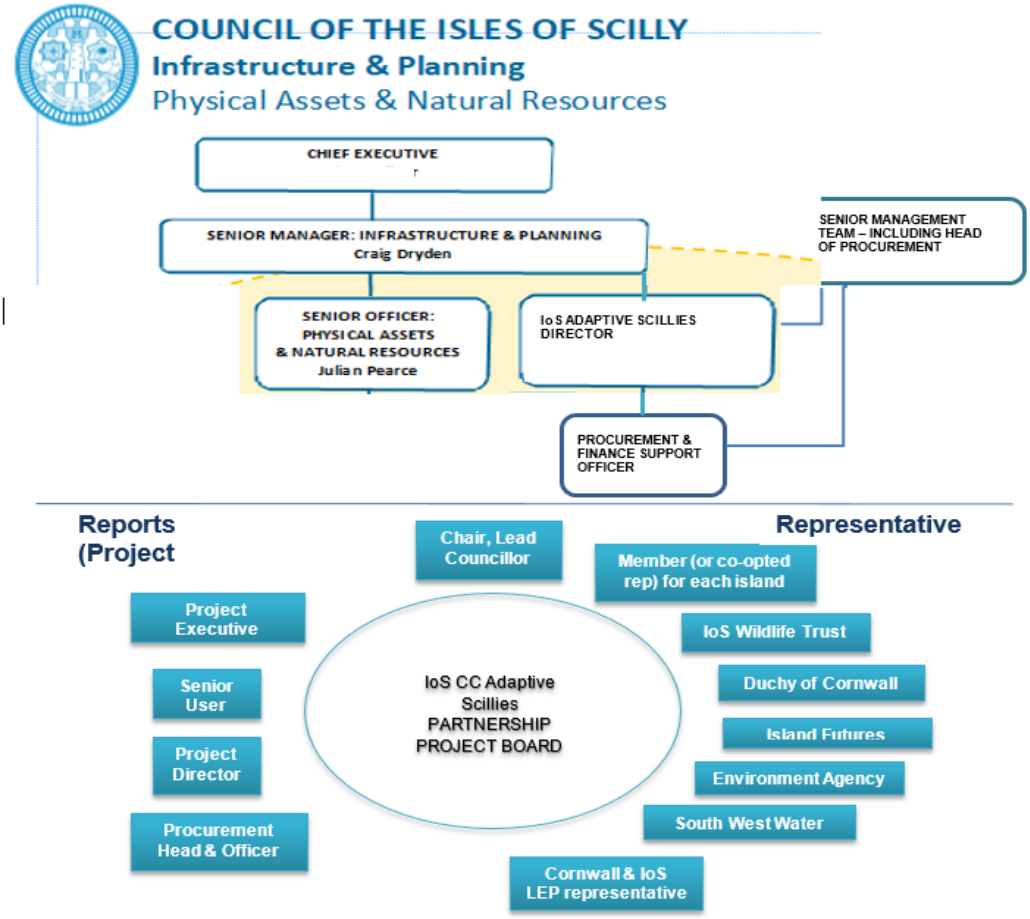
Annualised spend profile (£k)	Yr 0 2019	Yr 1 2020/21	Yr 2 2021/22	Yr 3 2022/23	Yr 4+	Total
Appraisal costs *(defrayed)*		61,420				
Existing staff costs		10,552	12,000	10,000	3,000	35,552
Construction & other costs		142,700	1,001,700	874,269	110,320	2,128,989
Optimism bias		49,000	348,249	300,000	45,320	742,577
Inflation			47,700	84,349	17,246	149,294
Project total cost		**263,672**	**1,409,649**	**1,268,618**	**175,886**	**3,056,412**
Less: Costs not eligible						
Less: Contributions of		**145,200**	**775,300**	**681,750**	**98,000**	**1,700,250**
Less: Local Levy being claimed						
Capital grant claim		**118,472**	**634,349**	**586,868**	**77,886**	**1,356,162**
Grant rate						44%

6. Management Case

6.1 Structure & Roles

Given the very limited size and capacity of the Council of the Isles of Scilly, resourcing and contracting the services of a suitable Project Director (who can provide the required expertise & leadership) has been identified as critical to effective delivery. This new appointee will work alongside the Council's LLFA lead officer (who will provide senior user responsibilities for the project) and the Council's lead procurement officer. They will report to the Head of Infrastructure (who will be the project executive), and to the Leader of Council (as project sponsor) and will liaise across the Council's senior management team to define and co-ordinate required legal, planning & financial management services.

A Partnership Project Board will be established to provide full executive accountabilities and oversight. The project delivery schedule identifies a series of gateway reviews during the development and delivery programme to ensure effective application of executive management responsibilities.



Benefit realisation is fully integrated into the development and delivery schedule and are reflected in the investment objectives. Benefits are cost-avoidance and non-financial and the primary ones can be realised and reported for each island once measures are completed. The delivery schedule timetables completion for all islands by March 2023. Monitoring and evaluation arrangements, which will be put in place prior to the delivery phases, will support and assure primary and wider benefit realisation.

6.2 Delivery Schedule

Events	Date DD/MM/YY
OBC & ERDF full bid approved	May 2020
FSoD sign-off & ERDF GFA signed	July 2020
Project Director appointed	August 2020
Full Project Start gateway review. Main works tendered	October 2020
Project Board established, tender evaluation & gateway review.	December 2020
Main civil engineering works contract let	January 2021
Civil Engineering preferred construction window 1	Feb – April 2021
Natural dune restoration research, consultation & specification report to Project Board & gateway review.	March 2021
Contract Old Town & Mermaid demountable barriers	January 2021
Follow-on St Marys dune restoration contracts let	May 2021
Natural dune restoration projects start, St Marys	July 2021
St Agnes dune contract let	Dec 2021
Civil Engineering preferred construction window 2	Sept – Dec 2021
Demountable barriers delivered	Dec 2021
Porth Hellick civil engineering & dune restoration complete & project board gateway review	Dec 2021
Civil Engineering preferred construction window 3	Feb- April 2022
Bryer & St Martin's dune contracts let	March 2022
Interim evaluation, coms plan & contract progress project board gateway review	May 2022
St Agnes Dune restoration + practically complete	June 2022
Civil Engineering preferred construction window 4	Sept – Dec 2022
Adaptive resilience stock arrangement & any remaining off island dune contracts let/put in place (MILESTONE, All contracts let)	Dec 2022
Civil engineering preferred construction window (reserved)	Feb – April 2023
All civil engineering works complete, gateway review	March 2023
Final supplies of adaptive resilience in situ stock to off islands. Closure of main civil engineering contract	March 2023
All dune restoration works practically completed & recorded, gateway review	March 2023

6.3 Delivery Plan, Assurance & Review

The proposed full project start has had to be delayed until the 3rd Quarter of 2020/21 (with some potential to accelerate if feasible and required)

Only relatively limited interim work is anticipated, in part to meet ERDF funding agreement requirements, and, to ensure that the required specification and inputs to the main design and build contract tender will be substantially complete in advance of the full project start. In parallel the Project Director role will need to be advertised, competitively selected and appointed by September 2020.

This offers the opportunity of a full Project Start-up Gateway Review by the Senior Management Team of the Council of the Isles of Scilly & a skeleton/shadow Project Board – supported by interim arrangements. This will focus proportionately on assessing the inputs and assuring progress of tendering and advertising.

Tender Evaluation & Contracting – tenders received will be treated with due diligence, they will be assessed for compliance, against the award and selection criteria. The results of this and subsequent tender assessments will be presented to, reviewed and assured by the Project Board. The minutes and the decisions of the Project Board will be recorded, minutes and retained through and beyond the lifetime of the project.

A project documentation retention schedule will be defined and delivered which will include the entirety of all the required procurement and employment processes. This will include the production of all the tender documentation in an electronic format with document revision numbers, the recording of evaluator's notes by using standard templates that are signed and scanned to the server, the use of electronic documents for identifying the preferred tender (evaluation matrices), copies of the contract notice and award notice, will be saved & stored.

6.4 Project Outcomes

Outcome Measures delivered by the project

Contributions to outcome measures	
Outcome 1 − Ratio of whole-life benefits to costs	
Present value benefits (£k) [Value taken from table 1]	£8,864,000
Present value costs (£k) [Value taken from table 1]	2,968,538
Benefit: cost ratio [Value taken from table 1]	3
Outcome 2 − Households at reduced risk [Values taken from the PF calculator]	
2a – Households moved to a lower risk category (number – nr)	94
2b – Households moved from very significant or significant risk to moderate or low risk (nr)	78
2c – Proportion of households in 2b that are in the 20% most deprived areas (nr)	0
Outcome 3 – Households with reduced risk of erosion [Values taken from the PF calculator]	
3a – Households with reduced risk of erosion (nr)	
3b – Proportion of those in 3 protected from loss within 20 years (nr)	
3c – Proportion of households in 3b that are in the 20% most deprived areas (nr)	
Outcome 4 – Water framework directive [Values for OM4a to 4c taken from the PF calculator]	
4a – Hectares of water-dependent habitat created or improved (ha)	45.4
4b – Hectares of intertidal habitat created (ha)	
4c – Kilometres of river protected (km)	
4d – Kilometres of WFD water body enhanced through FCRM	
4e – Kilometres of water body opened up to fish and /or eel passage through FCRM	
4f – Kilometres of river habitat enhanced (including SSSI) through FCRM	
4g – Hectares of habitat (including SSSI) enhanced through FCRM	45.4
4h – Hectares of habitat created through FCRM	

Appendix A: Partnership funding calculator

Attached as excel and pdf

Appendix B List of reports produced

- St Mary's Frontage Study – design plan drawings and quantified costs – Arcadis
- PF Calculator whole project, 250mm threshold, NRD receptors & 45.4ha OM4s

- Adaptive Scillies - full delivery expenditure quarterly timetabled spreadsheet April 20
- Adaptive Scillies Combined Project Procurement Plan