Economics Report

Jersey Shoreline Management Plan

Government of Jersey

60580871

July 2019

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
00	March 2019	Draft (WIP)	21/03/19	Tara-Leigh McVey (pp. Jason Drummond)	Regional Director
01	April 2019	Updated Draft in response to Government of Jersey comments	24/04/2019	Tara-Leigh McVey	Regional Director
02	May 2019	Further updates in response to comments from Greg Boyd	07/05/2019	Tara-Leigh McVey (pp. Jason Drummond)	Regional Director
03	May 2019	Further updates in response to Government of Jersey Comments	23/05/2019	Tara-Leigh McVey	Regional Director
04	June 2019	Further updates in response to Government of Jersey Comments	11/06/19	Tara-Leigh McVey	Regional Director
05	July 2019	Minor amendments	4/7/19	Tara-Leigh McVey	Regional Director

Distribution List

Issue	Association / Company Name
Updated Draft	Government of Jersey (Jamie Mason and Fiona Glover)

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1. Introduction

1.1 Background

AECOM has been commissioned to produce a Shoreline Management Plan (SMP) for the Government of Jersey. The SMP will facilitate the development of policies for managing flood risk and erosion over the next 100 years. As part of the SMP, AECOM has undertaken an economic appraisal to review the economic viability of policies and potential delivery schemes within the SMP.

The first stage of the economic appraisal was to determine the potential flood damages with Present Management. The first sections (sections 1 to 4) of this report outline the methodology used to do this and present the results. The second stage of the appraisal has been to determine the benefits of the preferred policies and establish the economic case for investment. The review has been undertaken Island-wide, as well as for each Coastal Management Area (CMA) and each Coastal Management Unit (CMU), as the management intent is set at CMU level. The CMUs have previously been defined as part of the policy development process, with consistent themes within each which helps to facilitate and rationalise policy identification and appraisal. The division of the Island into CMAs and CMUs is presented in Figure 1-1.

For the present day there are 277 residential properties at risk from a 1 in 200 year (0.5% AEP) flood event. There are also 183 non-residential properties at risk of flooding from the same return period event. Due to rising still water levels, in 100 years' time there are around 1500 residential properties and 1300 non-residential properties are expected to be at risk from a 1 in 200 year (0.5% AEP) event[1].

The damage values used in the assessment are based on guidance created for England in the Multi-Coloured Manual (MCM). To reflect the difference between these typical damage values used in assessments in England and the typical value of land and property in Jersey, a 24% uplift factor has been applied to each category in both the damages assessment and the economic appraisal. This is based on the location adjustment construction costs for Jersey, published by the Building Cost Information Service (BCIS) (2015).

1.2 Damage Assessment

As discussed above, the first sections of this report outline the property (residential and non-residential) and indirect flood damages with the current defences in place. This scenario represents the Present Management, where the minimum action taken will be to maintain the existing structures, but without raising / improving to mitigate sea level rise and climate change or the construction of any new sea defences. This scenario does not acknowledge the presence of de-facto defences[2]. Developing this scenario is an essential part of the appraisal because it provides the baseline from which the preferred management options can be compared against to demonstrate the economic benefits of policies which result in an improved standard of protection or mitigate the effects of climate change.

With this approach, the existing defences would be maintained and repaired, with remedial and additional works carried out where necessary. However, adaptation to sea level rise or other climate change responses would not be addressed. Under this scenario the existing defences along the coastline will be maintained until the end of their residual life. Flood risk would increase significantly over time due to rising still water levels, resulting in increased risk to properties behind the defences in the future.

No damage assessment of a hypothetical undefended scenario ('Do Nothing' – a hypothetical walkaway where the existing structures would not be maintained and left to collapse) has been included, as it is the intention of Government of Jersey to continue to maintain the existing structures across the Island as a minimum. This approach also aligns with the updated Treasury Green Book (2018), which recommends that using a baseline of Present Management provides a more effective basis for intervention than 'Do Nothing'.

[1] A floor threshold value of 0.15m has been applied to residential and non-residential properties, reflecting where properties are raised above street level.

[2] De-facto defences are buildings or other features which act to reduce flood risk without that being their primary function.

A further qualitative assessment has been undertaken for impacts which cannot be quantified, such as critical infrastructure, access and egress from the Island and potential reputational risks to the Jersey finance sector.

1.3 Business Disruption Assessment

In addition to the traditional damage assessment (based on direct physical damage or losses to property and infrastructure), a high level Gross Value Added (GVA) assessment methodology has been applied to more fully reflect the economic impacts of flooding by valuing business disruption over time as a response to flood risk, determining the wider economic benefits of Flood and Coastal Erosion Risk Management (FCERM) from the with Present Management Scenario.

The method for calculating GVA is outlined in 'Flood and Coastal Erosion Risk Management and the Local Economy TOOLKIT (2014). AECOM has developed a bespoke LEVI (Local Economic Valuation of Impacts) Tool which adopts the GVA toolkit methodologies. The LEVI tool uses average GVA figures per full-time employee for each business sector for (Statistics Jersey, 2018) to estimate the GVA value of business disruption.

1.4 Economic appraisal

The economic appraisal in this study supports the policy evaluation process in line with the HM Treasury Green Book. Although Jersey is outside of the United Kingdom and funding for coastal defences comes from the Government of Jersey, the economic appraisal methodology adopted is consistent with the Environment Agency's FCERM Appraisal Guidance (FCERM-AG, 2010) as it represents industry accepted best practice. The FCERM-AG is due to be reviewed by the Environment Agency in line with the emerging FCERM strategy (expected to be published in 2020).

After establishing the damages with Present Management, the benefits of the potential policy options for each CMU have been established. Benefits are based on the direct damages avoided (reduced flooding to property, people, assets and infrastructure) and a number of indirect damages avoided (e.g. health and wellbeing impacts of flooding). In addition, the preferred policy option costs have been established.

In this report, the costs and benefits are compared to determine the benefit cost ratios (BCRs). Costs associated with the options include design, construction and maintenance of the option over its design life. This economic comparison is known as cost benefit analysis (CBA) and provides a rational and systematic framework for assessing the advantages and disadvantages of the defence measures suggested as part of the preferred policy options.

The CBA has been undertaken using the framework of the FCERM-AG (2010). FCERM-AG represents the latest standard of benefit-cost analysis for all flood and coastal risk projects in England. In this assessment only FCERM eligible damages (and potential benefits) have been included, although a separate Business Disruption Assessment has also been undertaken alongside the damage assessment.

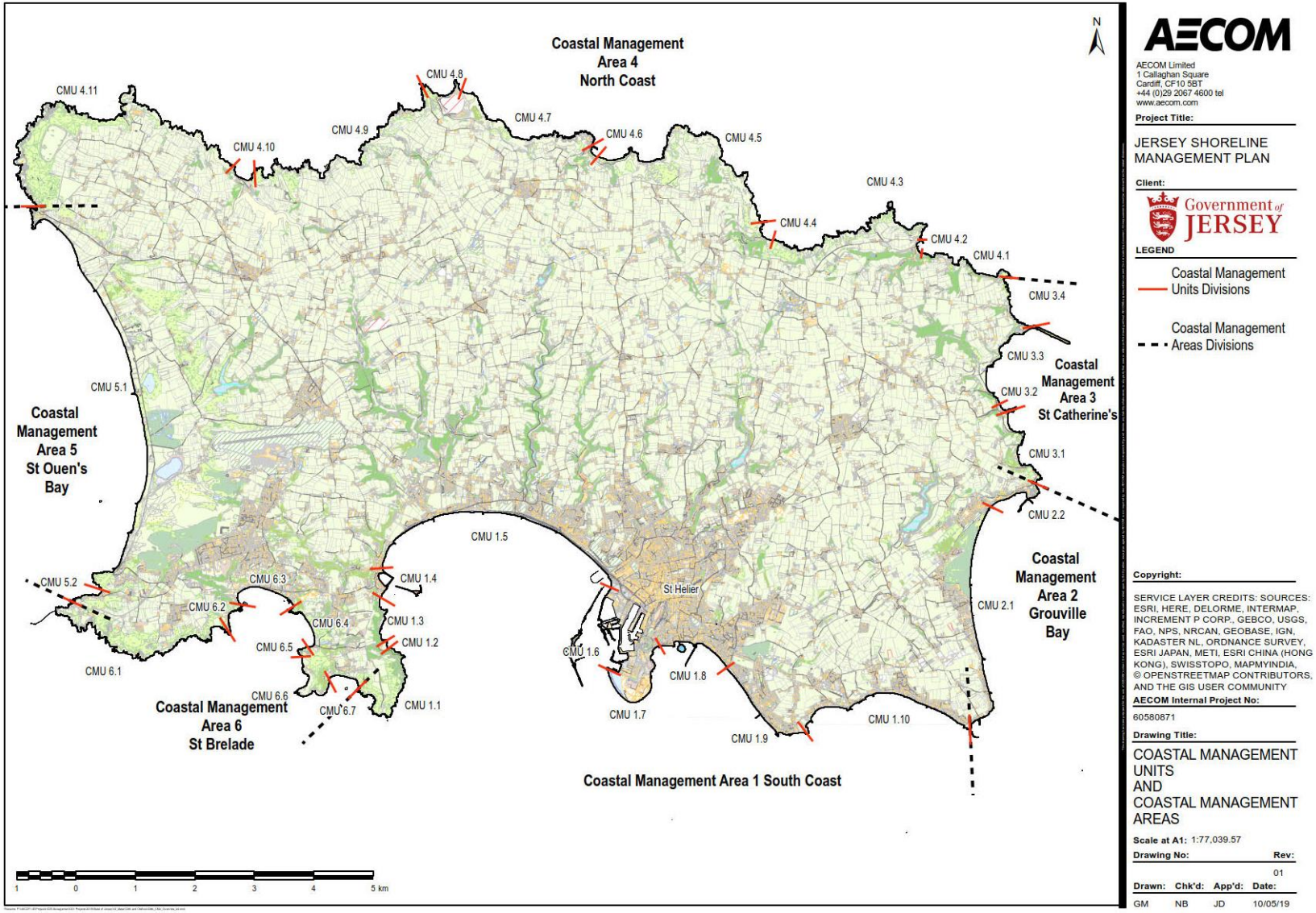

Figure 1-1: Jersey Coastline (Coastal Management Areas and Coastal Management Units)

2. Methodology

2.1 Supporting hydraulic modelling

To determine the possible flood depths arising from wave overtopping and tidal inundation as a result of extreme Still Water Levels (SWL), an analysis of the flood modelling has been carried out.

The analysis of tidal inundation been undertaken for present day and the future, by considering climate change to include the assessment of rising still water levels for the next 100 years. This analysis assumes all of the current coastal defences are in place.

The following simulations were carried out for four different years over the next 100 years; 1:1 year (100% AEP), 1:5 year (20% AEP), 1:75 year (1.33% AEP) and 1:200 year (0.5% AEP). The years simulated were 2020, 2040, 2070 and 2120. The time periods between these years are known as epochs:

- Epoch 1 (Present Day): 2020 to 2040
- Epoch 2 (Medium Term): 2040 to 2070
- Epoch 3 (Long Term): 2070 to 2120

Wave overtopping simulations were carried out for the coastal defences for the same return period events, though only for 2020 and 2040. In order to understand the predicted impact of flooding from both overtopping and SWL flood risk after 2040, the overtopping flood extents for 2040 were combined with the tidal flood extents for 2070 and 2120. Refer to the Hydraulic Modelling Report for more details of these models.

The maximum depth grids from the flood model results were rendered in GIS to facilitate the inspection of flood depths for assets within the study area.

2.2 Identifying flood depths and properties at risk

An address point dataset supplied by Government of Jersey was used to identify the properties at risk. The database includes the property address, post code, property type (e.g. detached residential, semi-detached residential, factory, office, shop etc.) and property coordinates for all assets on the Island.

Flood depths for each modelled extreme event were assigned to each property using GIS by obtaining the depth of flooding intercepting with the building outlines.

2.2.1 Data filtering

The database contains a number of properties and assets which cannot be included in a damages assessment. Once the flood depths for each property had been assigned, the database was checked to remove duplicate address points. For example, where single locations had multiple residencies or uses, these were reduced to only include one property point.

The property point database used for the assessment does not include any information pertaining to the floor level of each property, and as detailed in the MCM (2018) only ground floor properties should be included in the assessment. In the absence of this data, flats have been excluded from the assessment.

Approximately 300 assets with no classification description ('Awaiting classification' and 'Pending Internal Investigation') were excluded from the analysis out of a total 7000 records. A number of other classifications were also excluded as they have negligible susceptibility to flooding as per the guidance in the MCM Technical Note (2016)[3], such as bus shelters, postal boxes, property shells and unused land.

[3] Chatterton, J.B. (2016) National Receptor Dataset: Property codes with prefix "9". Version 1, May 2016 © Flood Hazard Research Centre, Middlesex University

2.2.2 Property thresholds

For residential properties, a threshold value of 0.15m was applied; this threshold level was estimated based on visual inspection of the properties, which shows that many of the properties are raised above street level. A threshold value of 0.15m has also been applied for non-residential properties, and considered to be a representative average value, according to guidance in the MCM (2018) and google street view property inspections. The impacts of varying the threshold level assumption has been sensitivity tested as part of the assessment (see Section 8.1).

2.3 Residential flood damages

Depth-damage data was obtained from the latest version of the Multi-Coloured Manual (MCM, 2018). The value of flood damage was based on the residential property type (detached, semi-detached, terrace, flat) and the depth of flooding for each flood scenario. For residential properties which did not include a classification for property type, the value of flood damage was based on the 'Residential Sector Average'.

Damage values for 'Short duration, salt water, major flooding' were adopted and were then adjusted by a factor of 1.056 to allow for emergency costs (as recommended in the MCM, 2018). The direct flood damages values for different depths are summarised in Table 2-1.

2.4 Non-residential flood damages

Non-residential flood damages were also obtained from the MCM (2018). The property damages are based on the non-residential property type, the footprint area (m^2) and the depth of flooding for each of the modelled return periods. The footprint area (m^2) was not supplied in the property point database; therefore, indicative floor sizes for each non-residential property type were derived from the MCM (2018) for each non-residential property.

Damage values for 'Short duration, salt water, major flooding' were used. The direct flood damages values for different depths are summarised in Table 2-2.

Table 2-1: Flood damages for residential properties adopted from the MCM (2018). Values adjusted to account for emergency uplift and latest available CPI (January 2019)

Short Duration, salt water, major flood. Adopted from MCM (2018) (£)																
MCM Code	Property Type / Age / Social Grade	Component	Depth (m)													
			0	0.05	0.1	0.2	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3
0	Residential Sector Average	Total Damage	1161	7654	12381	20997	25565	30947	33648	36898	39996	43525	46541	49365	55780	58728
11	Detached	Total Damage	1055	10068	16851	29121	35883	42873	47096	51904	56852	62330	66818	70681	79314	83726
12	Semi-detached	Total Damage	1413	7094	11413	19322	23555	28446	30803	33916	36846	40258	43379	46483	52712	55679
13	Terrace	Total Damage	1226	6572	10387	17744	21540	26217	28271	30929	33334	36090	38438	40809	46525	48911
15	Flat	Total Damage	824	6867	11202	19166	23298	28533	30826	33216	35260	37595	39461	40911	45784	47741

Table 2-2: Flood damages for non-residential properties from the MCM (2018). Values adjusted to account for latest available CPI (January 2018)

Short Duration, warning, salt water, no cellar. MCM (2018) (£)														
MCM Code	Property Type	Depth (m)												
		0	0.25	0.5	0.75	1	1.25	1.5	1.75	2	2.25	2.5	2.75	3
2	Retail	47	272	433	596	752	870	980	1079	1228	1316	1380	1410	1451
3	Offices	56	287	454	581	705	781	867	973	1107	1200	1268	1300	1344
4	Warehouses	19	302	526	686	834	948	1040	1133	1180	1199	1230	1239	1268
6	Public buildings	28	166	239	303	370	418	477	542	624	695	733	748	768
8	Industry	10	63	100	129	162	188	215	243	283	309	334	353	374
51	Leisure	200	540	658	755	856	930	1022	1119	1243	1342	1411	1444	1482
521	Playing Field	1	3	5	7	8	9	9	10	13	14	14	15	16
523	Sports Centre	23	133	180	222	268	296	356	418	493	554	580	592	605
525	Sports Stadium	5	31	50	65	82	92	105	116	136	145	152	157	160
526	Marina	11	34	47	67	86	98	110	124	146	168	185	198	216
910	Car Park	2	9	13	16	20	24	30	39	52	85	98	104	117
960	Substation	14	995	1333	1665	2616	3258	4204	4544	5861	5887	5911	5927	5937

2.5 Write off and capping damages

2.5.1 Property write off

It is stated in FCERM-AG that properties should be assumed written-off once flooded by an event of 1 in 3 year return period (33% AEP) or less, as the property would no longer be habitable or functional. Once written off the present day value of the property is taken as an economic damage but it can no longer accrue flood damages after that point.

The numerical model simulations undertaken for the study included a 1:1 year event (100% AEP). However, the majority of the damages for a 1:1 year event are due to wave overtopping flooding, which has a large amount of uncertainty associated with it. To reduce this uncertainty in the damages, the 1:20 year event (5% AEP) has been used in the assessment to determine property write off. Property write off becomes more relevant in the future as sea level rise increases the frequency of flooding across the Island.

In addition to write off from flooding, in the coastal environment property write off can also occur as a result of erosion or property loss due to collapse of supporting land or defences in front of a building. On the Island there are a small number of properties located in close proximity to the shoreline which would potentially be at risk of structural failure should the land in front of it be lost.

The risk of erosion has been incorporated into the damage assessment by considering the properties across the Island which are within a 30m buffer of the shoreline, following the guidance in the Coastal Erosion and Beach Analysis Technical Note. In total, 12 properties are in close proximity to the coastline, and are considered to be at risk from erosion/structural failure across the 100 year appraisal period if the land in front of the properties does continue to erode. To provide an estimate of the potential damage to these properties should erosion occur, they have been written off from an economic appraisal perspective in the epoch in which the structural failure would occur.

2.5.2 Property capping

The MCM (2018) also states that total present value flood damages for a property over the duration of the appraisal period must not exceed the property market value. The cumulative damages were monitored for each property and once they exceeded the property value the flood damages were capped so the property did not accrue any more damages.

2.5.3 Property values

The value of each property was required to incorporate write off and capping within the economic assessment. For residential properties, median house sale prices for the Island were obtained from the States of Jersey Viability Assessment for Review of Developer Contributions Report (May 2017). Values were used for each residential property type (detached, semi, terrace, flat), and the median value across all property types was used as the residential sector average for property points with no property type classification.

The commercial property values were valued on the rateable value for their business type (provided by the valuation office). Average values for retail, workshops, industry, warehouses and offices between £35/m^2 and £156/m^2 were estimated and then multiplied by the indicative floor space to estimate the rentable value of the business. In accordance with FCERM-AG, the rentable values were then divided by the business yield (6%) to provide an estimate of the market value for flood damage and capping purposes.

2.6 Discount rate

Discounting is a technique used to compare benefits (and costs) that occur at different points in time over the appraisal period (i.e. the next 100 years). Standard discount rates were used to convert all cash damages to 'present values' (PV). This enables the whole life damages, benefits and costs of the options to be compared and also leads to a realistic assessment of the cost implications in today's terms. According to the Treasury Green Book, different discount rates have been used for loss of life and all other damages, which are given in Table 2-3 (HM Treasury Green Book, 2003). The impacts of varying the discount rate to a reduced rate as suggested in the Treasury Green book for long term appraisals, has been sensitivity tested as part of the assessment (see Section 8.2).

Table 2-3: Discount Rates

	0-30 years	31-75 years	76-125 years
Loss of Life	1.5%	1.29%	1.07%
All other Damages	3.5	3%	2.5%

The annual average (non-discounted, cash) damages were discounted over the appraisal period to calculate the discounted whole life PV damages (Section 3.2).

2.7 Indirect flood damages

In addition to the direct flood damages to residential and non-residential properties, indirect flood losses were considered. Indirect flood losses reflect deviations from the economic theory that suggests in a perfectly competitive world, all sales or production would simply transfer to a competitor with no financial loss to the Island as a whole. In reality, deviations from the competitive model exist and trade cannot simply be transferred, leading to indirect flood damages. Indirect flood damages are included within the Present Value (PV) Total Damages. The areas of indirect flood damages that have been included in the assessment are discussed further below.

2.7.1 Intangible damages / benefits

Intangible damages associated with flooding to cover aspects potential health impacts (e.g. mental health), loss of personal items, disruption to the community etc. were included in the assessment at a rate of £238 per residential property (MCM, 2018). Intangible health damages / benefits are not applicable to non-residential properties.

2.7.2 Damages to vehicles

Flood damage to vehicles was considered at a rate of £3,500 per vehicle (MCM, 2018; 2013 value uplifted to present day using CPI). For the with Present Management scenario this damage was applied to 50% of residential properties at risk of flooding because it represents a scenario where it is assumed people would move their vehicles where there has been a high flood risk. Vehicle damages were not applied to non-residential properties.

2.7.3 Evacuation / temporary accommodation

Damages associated with the costs of evacuation / temporary accommodation after flood events have been included. These are based on evacuation costs provided in the MCM (2018) which estimate temporary accommodation and alternative accommodation costs for each residential property at £842 and £3533 respectively. It is assumed that 50% of the residential properties affected by flooding will require temporary accommodation, and 50% will require alternative accommodation. Evacuation damages are not applicable to non-residential properties.

2.7.4 Traffic disruption

Flooding is predicted to impact La Neuve Route, La Route de la Haule and Victoria Avenue from St Aubin's Harbour to St Helier and La Route de la Liberation. Flooding can affect roads by leading to traffic disruption and increased journey durations. Traffic disruption depends on the duration of a road closure, length of diversion and volume of traffic. Under the damages assessment with Present Management, flooding would affect three roads on the Island and require significant diversions, leading to traffic disruption.

To estimate the damages generated through traffic disruption to these three roads, the Diversion-Value Method (Method 2) of the MCM (2018) was adopted. This assumes that vehicles will be diverted onto neighbouring roads, increasing the distance they travel but their speed will remain unaffected.

The average speed was assumed to be 30mph, according to typical speed limits across the Island, and the diversion distance was determined using a GIS inspection of the road networks. Jersey traffic count data for 2017 obtained by Automatic Traffic Counters (ATCs) was used to determine the average number of vehicles passing through the road in any given hour. Finally, the average number of hours of disruption due to flooding was assumed to be 12 for each road in a flood event.

2.7.5 Road damages

Flooding can damage the integrity of a road surface which will need to be repaired to ensure the safety of vehicle users. Road reconstruction costs following flooding have been obtained from the MCM (2018); £15/m^2 for a quiet road and £50/m^2 for a busier road (busier roads typically require a thicker surface layer and road works may need to occur at night or off-peak and thus incurring overtime costs).

The areas of flooding on La Neuve Route, La Route de la Haule, Victoria Avenue and La Route de la Liberation (busy major roads) were obtained from a GIS inspection for the range of return period events and time epochs. The average annual damage per year associated with road reconstruction costs associated with flooding is estimated to be £632k by the year 100.

2.7.6 Loss of life

The indirect damages associated with potential loss of life from a flood event have been estimated by following the Defra Flood and Coastal Defence appraisal guidance; Social Appraisal, Supplementary Notice to Operating Authorities – Assessing and Valuing the Risk to Life from Flooding for the Use in Appraisal of Risk Management Measures (2008).

By utilising this guidance and following the 'Risks to people' method, the loss of life (£) per magnitude of flood event was estimated. This calculation was based upon a number of variables for the appraisal area that included the flood hazard rating (variables include the depth and flow of water, and the debris factor), the area vulnerability rating (variables include a flood warning system, speed of flood onset and the nature of the area), and the people vulnerability rating (age of population, health of population). The loss of life (£) for each magnitude of flood event was then factored by the probability of the flood event occurring to determine an annual damage per year associated with loss of life.

The annual damage per year associated with a loss of life for the present day (year 0) has been used for each year in the appraisal period. This reflects the likelihood that the level of awareness of flooding (no matter the flood risk) will remain constant throughout the 100 years. The annual damage per year associated with a loss of life is estimated to be approximately £1,518k.

3. Damage Assessment

The damage assessment was carried out for a 100 year appraisal period from present day to 2120. As previously stated, this damage assessment assumes the current defences are in place and will continue to be maintained over the appraisal period. The damages have been established for different spatial extents; Island-wide, for each Coastal Management Area (CMA) and each Coastal Management Unit (CMU).

3.1 Properties at risk

The number of properties expected to be at risk from flooding Island-wide for a range of return period events under the Present Management scenario is presented in Table 3-1 below.

Table 3-1: Total number of properties at risk under the Present Management scenario Island-wide, assuming a property threshold of 0.15m for both residential and non-residential properties.

Year	Return period event	Residential properties at risk	Non-Residential properties	Total properties at risk of flooding
2020	1:1	40	12	52
	1:20	161	73	234
	1:75	217	121	335
	1:200	277	183	460
2040	1:1	55	18	73
	1:20	188	108	296
	1:75	263	165	428
	1:200	334	279	613
2070	1:1	55	19	74
	1:20	193	176	369
	1:75	815	402	1217
	1:200	888	522	1410
2120	1:1	664	316	980
	1:20	952	764	1716
	1:75	1376	1013	2389
	1:200	1507	1315	2822

3.2 Damages

The damages with Present Management for the 100 year appraisal period both Island-wide and for each CMA are presented below in Table 3-2, and the damages for each CMU are presented in Table 3-2 to Table 3-8. The cash damages are the undiscounted damages (presented in today's cash terms) whereas the Present Value (PV) damages are those which include discounting through time (see Section 2.6). The PV damages are those which will be adopted in the benefit cost ratio.

For the whole Island in the 100 year appraisal period, the damages with Present Management undiscounted cash damages are approximately £2.7 billion. In discounted present value terms this equates to approximately £475 million.

Table 3-2: Damages with Present Management; Island-wide and for each CMA 1-6

Spatial Extent	With Present Management Cash Damages (£k)	With Present Management PV Damages (£k)
Island-wide	**2,707,125**	**475,746**
CMA1: South Coast	2,623,064	464,107
CMA2: Grouville	47,131	6,767
CMA3: St Catherine's	9,699	987
CMA4: North Coast	20,441	2,261
CMA5: St Ouen's Bay	4,586	1,125
CMA6: St Brelade	2,204	500

Table 3-3: Damages with Present Management; CMA1 South Coast

Spatial Extent	With Present Management Cash Damages (£k)	With Present Management PV Damages (£k)
CMA1: South Coast	**2,623,064**	**464,107**
CMU1.1	0	0
CMU1.2	0	0
CMU1.3	0	0
CMU1.4	76,541	13,457
CMU1.5	126,356	23,716
CMU1.6	1,071,833	143,766
CMU1.7	2,641	756
CMU1.8	1,322,750	275,868
CMU1.9	3,905	750
CMU1.10	19.038	5,793

Table 3-4: Damages with Present Management; CMA2 Grouville Bay

Spatial Extent	With Present Management Cash Damages (£k)	With Present Management PV Damages (£k)
CMA2: Grouville	**47,131**	**6,671**
CMU2.1	22,281	2,425
CMU2.2	24,850	4,246

Table 3-5: Damages with Present Management; CMA3 St Catherine's

Spatial Extent	With Present Management Cash Damages (£k)	With Present Management PV Damages (£k)
CMA3: St Catherine's	**32,179**	**7,689**
CMU3.1	6,331	330
CMU3.2	533	396
CMU3.3	2,835	261
CMU3.4	0	0

Table 3-6: Damages with Present Management; CMA4 North Coast

Spatial Extent	With Present Management Cash Damages (£k)	With Present Management PV Damages (£k)
CMA4: North Coast	**20,441**	**2,261**
CMU4.1	0	0
CMU4.2	17,498	1,785
CMU4.3	0	0
CMU4.4	337	168
CMU4.5	1096	57
CMU4.6	1,510	250
CMU4.7	0	0
CMU4.8	0	0
CMU4.9	0	0
CMU4.10	0	0
CMU4.11	0	0

Table 3-7: Damages with Present Management; CMA5 St Ouen's Bay

Spatial Extent	With Present Management Cash Damages (£k)	With Present Management PV Damages (£k)
CMA5: St Ouen's	**4,586**	**1,125**
CMU5.1	4,586	1,125
CMU5.2	0	0

Table 3-8: Damages with Present Management; CMA6 St Brelade

Spatial Extent	With Present Management Cash Damages (£k)	With Present Management PV Damages (£k)
CMA6: St Brelade	**2,204**	**500**
CMU6.1	0	0
CMU6.2	0	0
CMU6.3	1,089	282
CMU6.4	19	2
CMU6.5	0	0
CMU6.6	0	0
CMU6.7	1,096	216

3.3 Qualitative Assessment

Some of the impacts of flooding cannot be quantified as part of the damage assessment, though they can be qualitatively assessed to provide a full understanding of the risk to all assets across the Island.

3.3.1 Access and Egress at the Port of St Helier

The Port of St Helier provides a key access point for the Island, linking Jersey to the UK and continental Europe for travel, imports and exports. In a flood event, damage to the Port has the potential to reduce its operational viability, impacting on the economic well-being of the Island.

Almost 360,000 people travel through the Port in any one year, with 98.6% of all goods, including fuel and food supplies, arriving there. An assessment of the flood risk shows that a 1:200 return period event in 2070 could reduce or hinder access to the Port. In this scenario, the reduced access could impact energy and food security, preventing goods being transported to the Island. All hydrocarbons used for heating, energy generation and as transport fuels arrive through the Port and the majority of Jersey's food is imported through the UK by major and private retailers, and crop and livestock production on the Island is reliant on imports of fertilizers.

Furthermore, reduced access to the port could prevent residents returning or leaving and has the potential to impact the visitor economy, presenting a risk to the reputation of Jersey as a tourist destination.

3.3.2 Infrastructure at La Collette

At La Collette, there are several critical infrastructure installations including the Power Station and Energy Recovery Facility, operated by Jersey Electricity and Government of Jersey respectively. There are also hazardous installations which handle a range of substances, including an LPG storage facility operated by the Jersey Gas Company, and a fuel storage depot operated by La Collette Terminal Ltd.

An assessment of the flood risk to La Collette for a 1:200 return period event concludes that the entirety of the critical infrastructure considered is outside of the flood risk area; therefore there would be no residual damage to any of these assets.

3.3.3 Electricity Supply

There are three subsea interconnectors located off of the north, east and south east coasts which provide an electricity supply to Jersey and Guernsey from the Channel Islands Electricity Grid (CIEG) cable link to France, in addition to the on-Island generators. These cables provide Jersey with greater energy security, through the potential to import 290 MW of electricity with better reliability.

These subsea interconnectors are located along the seabed, with a 2km wide protection zone along the full length of the cables. Two of the subsea interconnectors (Normandie 1 and 2) connect to Archirondel Electricity substation, which is critical infrastructure for the supply of energy to all of Jersey and Guernsey. Archirondel substation is located within an area at risk of flooding from overtopping, which could impact the energy security of Jersey.

The third interconnector (Normandie 3) connects at Gorey, in an area not at risk of flooding. There is limited erosion predicted where the cables connect onshore at Archirondel and Gorey, therefore there is not likely to be scour damage by erosion.

3.3.4 Potential Reputational Risk to Jersey Finance Sector

Jersey has a well-established reputation for international financial services. Future economic investment for the Island will be dependent on the resilience of the finance sector to changing climate conditions as confidence in the resilience of the services provided in Jersey is vital to Jersey's future competitiveness

The majority of key assets for the financial sector are located within St Helier (CMU1.6), and St Helier Harbour is crucial to the development of the economy on the Island. The flood modelling has identified several properties which provide financial services to be at risk of flooding from a 1:200 return period event in the present day and in 2120 (where specific financial businesses are at risk of flooding, the value of the damages have been assessed as part of the GVA assessment).

These flood scenarios can generate concerns from potential investors, substantiating a reputation risk to the Jersey finance sector, which could encourage reduced investment to Jersey and increased investment to competitors. For example, flooding caused by Hurricane Ivan to Grand Cayman Island in 2004 resulted in widespread damage to infrastructure, and is perceived to be one of the reasons why Jersey received an influx of investment in the financial sector (TCPA, 2015)[4]. Competitors to Jersey for offshore financial services are already taking effective action on climate resilience, which has seen them maintain their positions in the ranking of off-shore states. Both Gibraltar and the British Virgin Islands (BVI) have established policies which identify future risks from climate change, and potential adaptation measures. Similarly, Guernsey has published flood risk assessment studies which demonstrate their commitment to managing flood risk and coastal erosion over the next 100 years, and the Isle of Man has developed a national strategy on sea defences, flooding and coastal erosion.

3.3.5 Tourism and Recreation

Jersey has a significant visitor economy, a proportion of which relies on the value of coastal tourism and recreation. Flooding and coastal erosion at coastal recreation locations on the Island has the potential to reduce their value in terms of access to leisure activities, reducing the number of visitors.

In 2017, 727,000 visitors spent £250 million in the local economy, with 82% of the total spend attributed to holidaymakers; as such, damage to coastal tourism could have a large economic impact. Gross Value Added (GVA) to the economy in hospitality is estimated to be 60% of visitor expenditure. As an estimation of the value of coastal tourism, it is assumed that 10% of this GVA can be attributed to visiting coastal sites, and should half of these visitors choose to travel to another destination, if these sites had reduced access, approximately £7.5 million annual losses from the visitor economy would result.

Portelet Beach, a popular recreation beach located between Portelet and Noirmont Common on the south coast, is predicted to be impacted by coastal erosion over the next 100 years. According to the Coastal Erosion and Beach Analysis Technical Note, the beach is at risk of erosion, at a rate of 0.3m per year. As such, it is predicted that from year 50 the beach will have been eroded or it quality diminished. This will lead to a loss of amenity and recreational value, however there are alternative beaches close by (such as Ouasine Bay) which could accommodate visitors from Portelet Beach.

[4] TCPA (2015) Future-proofing Jersey: Building Resilience for the 21st Century. Available from: https://www.gov.je/sitecollectiondocuments/government%20and%20administration/r%20tcpa%20future%20proofing%20jersey%20phase%201%20report%20final%2023.06.2015.pdf [Accessed 19 March 2019]

4. Business Disruption Assessment

In order to provide a holistic valuation of potential flood damage, a business disruption assessment has been completed using the Gross Value Added (GVA) assessment methodology, outlined in the Frontier Economics Toolkit (2014)[5]. This provides a supplementary assessment of the value of business disruption over time as a response to flood risk, adding to the assessment for direct physical damage to infrastructure detailed in Section 3.

This assessment provides a valuation of the wider economic impacts of flooding which are not measured in the MCM methodology, in the form of 'Dynamic Impacts'. The economic impacts assessed within the damage assessment, including the damages to properties, relate specifically to impacts in the short term - termed 'First Round Impacts'.

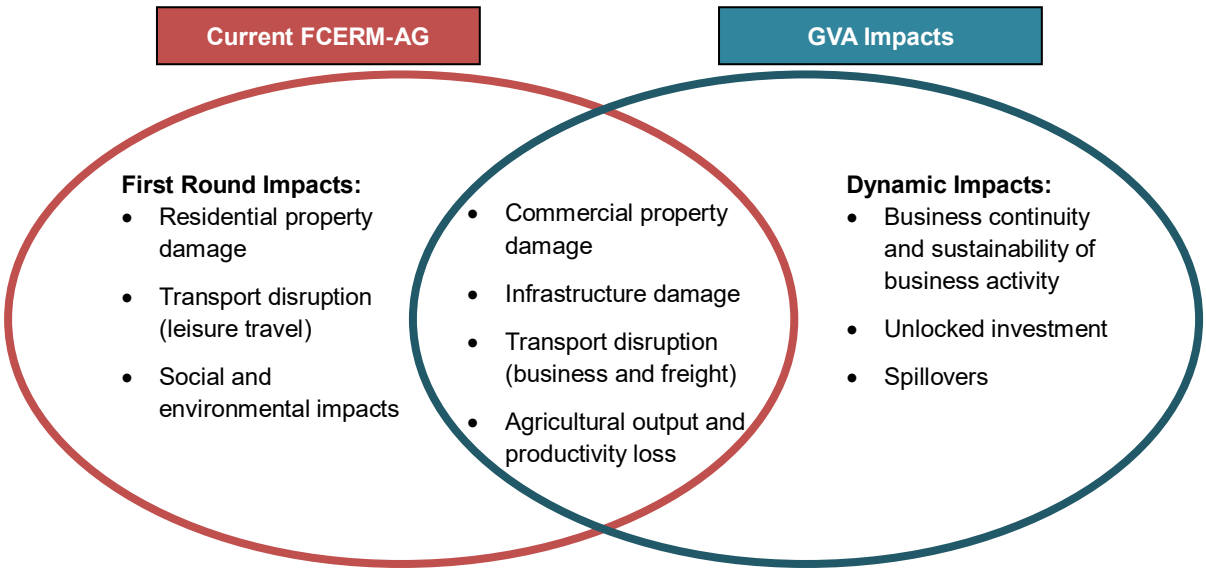

Figure 4-1: Overlap of current direct damage 'first round' impacts and additional 'dynamic' impacts on the economy.

Dynamic impacts reflect the outcomes for a local economy over time as businesses respond to changes in flood risk. Strategic flood risk management intervention is likely to:

- Support business continuity and sustainability of business activity in an area;
- 'Unlock' investments that might otherwise have been constrained or unattractive given the flood risk; and,
- Lead to 'spill over' impacts which reflect interdependencies or other intangible impacts on economic activity.

By evaluating the potential contribution to the local economy of investing in flood risk management measures it helps build an understanding of their potential impacts on the local economy. This would be expected to support a business case for improving the standard of protection of the coastal defences.

4.1 Dynamic Impacts Assessment

The contribution to the economy is quantified where possible and measured as Gross Value Added (GVA). The primary focus is on valuation of the potential disruption to existing businesses, and associated impacts on the local economy. As the methodology for assessing business disruption and its application are evolving, it is likely that the approach, data and assumptions will need to be reviewed and updated over time as a richer evidence base comes to light.

[5]Frontier Economics (2014) *Flood and Coastal Erosion Risk Management and the Local Economy TOOLKIT.* Available from: http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2662_full_toolkit.sflb.ashx [Accessed 3 January 2019].

A proportionate level assessment of business disruption was applied in this study using the AECOM's LEVI (Local Economic Valuation of Impacts) Tool. The Tool which adopts the Frontier Economics toolkit methodology, to has been used to estimate the wider impacts on economic activity by explicitly considering businesses' likely responses to flood risk. The assessment has drawn upon a range of available data including:

- Frontier Economics toolkit (2014) and annexes;
- Average GVA per full time employee and the approximate number of full time employees per business within each business sectors in Jersey (Statistics Jersey GVA and GDP report 2017);
- Property point data for commercial properties in Jersey which are at risk of flooding;

Typically, an assessment of business disruption using the GVA assessment methodology is undertaken using a 10 year appraisal period, as this period represents the likely duration over which direct impacts can be reasonably attributed or linked to specific interventions. Beyond that the envelope of uncertainty grows significantly and other factors may become more influential in determining the futures experienced; therefore a 10 year appraisal period has been adopted in this study.

The assessment is based on an average annual figure for the period which is then presented as a discounted (Present Value) total for the whole period. The base year of appraisal used was 2018 with a discount rate of 3.5%.

The dynamic impacts assessment focusses on quantitative estimations of disruption to existing businesses, including valuation of potential losses from flood risk detrimentally impacting on business continuity and operation, based on GVA loss per business for the length of disruption.

4.1.1 Business Responses to Flood Risk

The assessment is based on businesses which are predicted to flood from a 1:5 (20% AEP), 1:75 (1.33% AEP) or 1:200 (0.5% AEP) year flood event in the Present Day. It is assumed that each business will have sufficient measures already in place to prevent business disruption from a 1:1 (100% AEP) flood event,

The damages for each business predicted to flood from a given flood event were estimated using the length of disruption, GVA per FTE per week that would be lost, and the number of FTEs.

The length of disruption is based on the business response to flooding; in the absence of coastal defences, evidence suggests that disruption to business activity could last many weeks. Based on a review of available evidence, we assume that without the intervention, a business could be disrupted for around 16-24 weeks because of flooding. The length of business disruption was assumed to be 20 weeks if businesses stay and do nothing, and 10 weeks if they stay and adapt (applying average standard values from the Toolkit).

Businesses operate in the context of uncertainty about when, how, what scale, how long and how often they may experience flooding. They have to make business decisions to manage the risks they face. In response to flood risk, businesses respond in one of four ways:

- Stay and do nothing
- Stay and adapt
- Move
- Shut down

Without detailed data to underpin an assessment of potential business behaviours (with respect to flood risk), two scenarios have been used in the valuation of impacts:

1. All businesses will 'Stay and Do Nothing', assuming a length of disruption of 20 weeks for a single flood event; and
2. Likely business response which includes an estimate of the proportion of the businesses implementing a 'Stay and adapt' response and the remaining implementing a 'Stay and Do Nothing' response. The estimated proportions are based on business size and sector as per the Toolkit. This assumes a length of disruption of 20 weeks for 'Stay and Do Nothing' responses, and 10 weeks for 'Stay and Adapt' responses.

4.2 Dynamic Impacts

The analysis shows a potential dynamic impact cost to the local economy of £93M over the next 10 years in a Present Management scenario (present value (PV). However this estimate is based on a probabilistic assessment and this figure is the accumulation of potential annual average damages over the 10 year period. In reality, it is not likely that the annual level of damage would be consistent; rather, large one-off damage events may occur infrequently, with long periods of little or no damage in between.

Table 4-1 presents the estimated dynamic impacts in PV terms and Cash Annual Average Damage (AAD)[6] based on the two scenarios where all businesses will 'Stay and Do Nothing', and the likely business response which includes a proportion of businesses adopting 'Stay and Do Nothing' and a proportion adopting 'Stay and Adapt'. Implementing new coastal defence structures to a 1:200 year standard of protection would prevent all disruption to business; therefore the benefits presented in Table 4-1 are equal to the total dynamic impacts with Present Management.

Table 4-1 also shows the potential GVA damage to the economy for each return period event; should a low frequency, high impact event occur such as a 1:200 year flood, the estimated damage could be £110M if all businesses were to stay and do nothing.

This GVA total is additional to the first round impacts associated with commercial property, infrastructure and transport damage avoided, which is included in the damages assessment in the previous section. The assessment demonstrates there would be significant local value from implementing new defence structures, in terms of preventing GVA loss from business disruption, providing a more comprehensive evidence base in addition to the damage assessment for the potential delivery of schemes.

Table 4-1 Summary of Estimated Dynamic Impacts arising from Business Disruption

Scenario	With Present Management Scenario Cash Damage Dynamic Impacts (£k)			With Present Management Scenario Total Dynamic Impacts (£k)	
	1:20yr event	1:75yr event	1:200yr event	Cash AAD	PV (2020-2030)
All businesses 'Stay and Do Nothing' (20 weeks business disruption)	40,436	68,480	110,422	10,909	93,425
Likely business response, reflecting a proportion of businesses 'Stay and Do Nothing' and a proportion 'Stay and Adapt' (20 weeks and 10 weeks business disruption respectively)	20,288	34,379	55,350	5,475	46,889

[6] Cash Annual Average Damage is the theoretical average cash damage that would be caused each year by flooding over the 10 year period that the GVA damages have been assessed for. It does not mean that damage will occur in every year, in some years there may be minimal damages and in some years major damages may occur.

5. Option Costs

Cost estimates for the potential policy options have been developed for each CMU. Whole life costs for the options consider the preferred defence measures for each CMU, in terms of the capital costs to build new structures at the required standard of protection (based on the length and height required) and the maintenance costs to sustain the performance and operation of the existing defences and new structures over the appraisal period.

To be consistent with the damages assessment, the costs have been discounted by applying the same discount rate through time to provide PV costs.

5.1 Policy Options

Through the policy option appraisal, potential policy options have been identified for each CMU. These policy options represent the management intent for managing coastal flooding and erosion risk along the coastline for the next 100 years, across the three epochs.

In each CMU, a preferred policy option has been identified and a preferred defence measure has been selected in the costing process. The combination of these measures across the coastline will form the preferred options. Evidence from this report, alongside stakeholder engagement, will support the selection of the preferred policy option and preferred defence measures.

5.1.1 No Active Intervention

Where there is no flooding or erosion risk, and therefore no potential damages, the preferred policy option for each CMU will be No Active Intervention (NAI) if there are no existing defences; therefore there will be no associated costs calculated for NAI.

5.1.2 Maintain the Defence Line

Where there are pre-existing defence and no increased risk of flooding or coastal erosion, the preferred policy option will be Maintain the Defence Line (MTDL), as it is the intention of Government of Jersey to continue to maintain the existing structures across the Island as a minimum.

The costs for the CMUs with this policy will only include the scheduled maintenance costs (Section 5.4).

5.1.3 Adaptive Management and Advance the Line

Where there is a risk of flooding or erosion and damages have been identified, the Improve options will be Adaptive Management (AM) or Advance the Line (AD).

For these options, it has been assumed that either a new structure is put in place or the service life of the existing defences / coastal structures will be maintained and height increased through to the end of the appraisal period, for a 1:200yr Standard of Protection (SoP) for 2120. This has been identified as the preferred SoP, to provide consistent flood protection across the island.

In the CMUs where flood risk from wave overtopping is the only source of flood risk in epoch 1 (present day), the costs of implementing a community awareness scheme as an initial form of adaptive management has been calculated within the capital construction costs. These schemes would seek to reduce the damages associated with flooding, without implementing new structures at the defence line in the present day, by raising awareness of the risks of flooding within the community including improve signage and promoting property level resilience measures to prevent loss of life and damages to vehicles.

5.2 Capital construction costs

The cost estimates for capital construction works were undertaken using the best available information from a variety of sources. In the first instance, values have been estimated from rates provided in the Civil Engineering Price Book SPONS (2018), and the Environment Agency guidance 'Delivering benefits through evidence, cost estimation for coastal protection – summary of evidence. Report SC080039/R7' (2015).

For the majority of defence measures considered, the cost of the structure varies with the height and the standard of protection being delivered. The required height of the structures was attained by undertaking a GIS analysis of the existing coastal defences / structures to obtain their elevation, and comparing this elevation to the modelled flood depths to obtain the elevations required to achieve the desired standards of protection.

To provide an estimation of the costs for designing the coastal defences and supervising sites during implementation, uplift factors have been included of 10% and 5% respectively for each defence.

A suitable allowance for preliminaries and contractor overhead/profit has been included in the cost estimates, and the 24% uplift factor has been applied, based on the location adjustment construction costs for Jersey.

Capital construction costs also include costs for the Community Awareness scheme which is proposed in CMUs where flood risk from wave overtopping is the only source of flood risk in epoch 1. This includes the cost of providing flood warning signage to be updated every five years, and hosting public awareness consultations twice per year in each CMU where this is proposed to provide an in depth understanding of the flood risk to the local community. This may result in residents choosing to implement property level resilience measures, however this is not included in the costs or as part of the benefits assessment.

Table 5-1 presents a summary of estimated capital construction unit costs (cash) for a range of defence measures which will be implemented as part of the preferred policies, including allowances for design, site supervision and the location adjustment for Jersey. Unless stated otherwise, all costs are provided per one metre length and height of defence. Given the level of this study these costs are based on high level estimation and intended for budgeting and investment planning purposes. It should be recognised that costs will vary locally, and will depend on a range of factors. Further cost refinement will occur during subsequent stages of appraisal and design of schemes.

Table 5-1: Capital construction costs

Defence Measure	Typical Cash Cost / m length
Setback floodwall	£5,000
Recurve wall	£5,000
Embankment	£2,800
New seawall (vertical or sloping) (universal height)	£15,800
Crest raising	£4,400
Sheet piling with concrete capping – in front of existing defence	£16,000
Community awareness scheme (Signage and two public awareness consultations)	£11,150

5.2.1 Optimism Bias

In line with FCERM-AG, an optimism bias of 60% has been applied to the capital construction costs for each defence measure. Optimism bias;

"is included to account for the tendency for appraisers to be overly optimistic in the assessment of project costs, timescales and benefits in comparison to the final values. This 'optimism' is a result of uncertainty in the final design detail and implementation as a result of high level approach required at this stage. To counter this, the HM Treasury issued guidance in the form of a percentage to increase the present value costs depending on the uncertainty surrounding the estimates. This guidance has been adopted within the FCERM-AG."

FCERM-AG recommends typically adopting an optimism bias value of 60% for estimating strategy costs, such as this.

5.3 Maintenance costs

In addition to the capital costs, maintenance costs also contribute to the whole life option cost estimates. Maintenance costs refer to the costs for periodic or annual maintenance works that are required to maintain the structural integrity of the new or existing defences.

Maintenance costs have been estimated using the Growth, Housing and Environment Sea Defence maintenance rates, provided by Government of Jersey. An optimism bias allowance of 60% has also been applied to the maintenance costs, aligning with the allowance applied to the capital costs. Table 5-2 presents the maintenance costs in cash value of the existing coastal defences and those which will be implemented as part of the preferred policies. Unless stated otherwise, all costs are provided per one metre length and height of defence.

Table 5-2: Maintenance costs

Defence Measure	Cash Cost / m length
Granite wall repairs	£1,035
Concrete wall repairs	£690
Masonry wall repairs (vertical)	£1,150
Masonry wall repairs (sloping)	£895
Piling repairs (universal height)	£930

5.4 Whole life costs

In each CMU the capital and maintenance costs were combined through time to produce option costs across the 100 year appraisal period. This process was carried out after identifying the preferred defence measure for each CMU, according to the policy options.

When determining the maintenance costs through time, it was necessary to make a number of assumptions relating to the timing and frequency of maintenance. It is assumed that 20% of the defences will undergo maintenance every 10 years, and that after new defences have been put in place, no maintenance will be required for 20 years. After this point, the preceding maintenance schedule will continue.

The matrices shown below in Table 5-3 to Table 5-8 present the whole life costs for the Present Management Scenario, which is limited to scheduled maintenance, and the preferred defences measures identified through the preferred policy option for each CMU. The whole life costs have been estimated for the full appraisal period of 100 years, and all new structures are assumed to be built to a 1:200 year standard of protection for 2120.

In each of the tables, a cost of 0 alongside a note of ‘NAI’ for the No Active Intervention policy option denotes that there are no existing defences in place and therefore no assets to maintain.

Table 5-3: Cash and PV whole life costs; 2120 SoP, 100 year appraisal period for CMA1 South Coast

CMU	With Present Management		Preferred Policy Option	
	Cash Value	PV	Cash Value	PV
CMU1.1	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU1.2	£414k	£142k	£414k	£142k
	Scheduled Maintenance		Scheduled Maintenance	
CMU1.3	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU1.4	£2,898k	£995k	£14,465k	£7,419k
	Scheduled Maintenance		Community Awareness, setback flood wall & sheet piling	
CMU1.5	£20,286k	£6,967k	£36,433k	£15,528k
	Scheduled Maintenance		Community Awareness, recurve wall & sheet piling	
CMU1.6	£10,488k	£3,602k	£10,762k	£3,746k
	Scheduled Maintenance		Setback floodwall	
CMU1.7	£8,280k	£2,844	£8,280k	£2,844
	Scheduled Maintenance		Scheduled Maintenance	
CMU1.8	£6,210k	£2,133k	£11,143k	£6,636k
	Scheduled Maintenance		Crest raising	
CMU1.9	£7,866k	£2,702k	£13,950k	£5,398k
	Scheduled Maintenance		Community Awareness & crest raising	
CMU1.10	£8,694k	£2,986k	£14,090k	£5,536k
	Scheduled Maintenance		Community Awareness & crest raising	

Table 5-4: Cash and PV whole life costs; 2120 SoP, 100 year appraisal period for CMA2 Grouville Bay

CMU	With Present Management		Preferred Policy Option	
	Cash Value	PV	Cash Value	PV
CMU2.1	£16,560k	£5,687k	£21,754k	£7,760
	Scheduled Maintenance		Community Awareness & crest raising	
CMU2.2	£414k	£142k	£5,638k	£2,679k
	Scheduled Maintenance		New seawall	

Table 5-5: Cash and PV whole life costs; 2120 SoP, 100 year appraisal period for CMA3St Catherine's

CMU	With Present Management		Preferred Policy Option	
	Cash Value	PV	Cash Value	PV
CMU3.1	£2,277k	£782k	£2,277k	£782k
	Scheduled Maintenance		Scheduled Maintenance	
CMU3.2	£621k	£213k	£1,710k	£1,223k
	Scheduled Maintenance		New seawall & crest raising	
CMU3.3	£2,961k	£924k	£2,961k	£924k
	Scheduled Maintenance		Scheduled Maintenance	
CMU3.4	£994k	£341k	£994k	£341k
	Scheduled Maintenance		Scheduled Maintenance	

Table 5-6: Cash and PV whole life costs; 2120 SoP, 100 year appraisal period for CMA4 North Coast

CMU	With Present Management		Preferred Policy Option	
	Cash Value	PV	Cash Value	PV
CMU4.1	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU4.2	£1,201k	£412	£1,201k	£412
	Scheduled Maintenance		Scheduled Maintenance	
CMU4.3	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU4.4	£1,366k	£469k	£1,366k	£469k
	Scheduled Maintenance		Scheduled Maintenance	
CMU4.5	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU4.6	£518k	£178k	£518k	£178k
	Scheduled Maintenance		Scheduled Maintenance	
CMU4.7	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU4.8	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU4.9	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU4.10	£1,408k	£483k	£1,408k	£483k
	Scheduled Maintenance		Scheduled Maintenance	
CMU4.11	£0k	£0k	£0k	£0k
	NAI		NAI	

Table 5-7: Cash and PV whole life costs; 2120 SoP, 100 year appraisal period for CMA5 St Ouen's

CMU	With Present Management		Preferred Policy Option	
	Cash Value	PV	Cash Value	PV
CMU5.1	£24,426k	£8,389k	£24,426k	£8,389k
	Scheduled Maintenance		Scheduled Maintenance	
CMU5.2	£497k	£171k	£497k	£171k
	Scheduled Maintenance		Scheduled Maintenance	

Table 5-8: Cash and PV whole life costs; 2120 SoP, 100 year appraisal period for CMA6 St Brelade's

CMU	With Present Management		Preferred Policy Option	
	Cash Value	PV	Cash Value	PV
CMU6.1	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU6.2	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU6.3	£4,016k	£1,379k	£7,392k	£3,737k
	Scheduled Maintenance		Community Awareness & crest raising	
CMU6.4	£2,774k	£953k	£2,774k	£953k
	Scheduled Maintenance		Scheduled Maintenance	
CMU6.5	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU6.6	£0k	£0k	£0k	£0k
	NAI		NAI	
CMU6.7	£0k	£0k	£0k	£0k
	NAI		NAI	

6. Option Benefits

The benefits of the potential options have been calculated for each of the CMUs where the management intent is to improve the defences, through the preferred policy options Adaptive Management or Advance the Line. CMUs where there are no improvement works planned, and only scheduled maintenance will take place, are not included in the benefits assessment.

6.1 Standards of protection and scheme duration

There are a number of flood cells across the Island, which has influenced the division of the CMAs into CMUs. As such it is necessary for the scheme in each CMU to provide a consistent Standard of Protection (SoP). If one area of each CMU had a lower standard of protection it would compromise the effectiveness of the remainder of the area and the overall standard would be reduced.

The option benefits have therefore been established for a range of standards of protection. The SoP provided is irrespective of which of the defence measures are selected as the preferred approach in each CMU. By establishing the option benefits for different standards of protection it also enables the economic appraisal to align with the decision rules outlined in FCERM-AG.

The existing onset of flooding on the Island is approximately 1:1 year (100% AEP). Although the preferred SoP has already been identified as a 1:200 year SoP, the benefits have also been calculated for a 1:75 year SoP to allow for a comparison of the potential benefits.

The benefits for the Standards of Protection have been established to present the economic and funding viability for a range of choices:

- 1:75 year SoP (100 years)
- 1:200 year SoP (100 years)

6.2 Benefit calculations

The economic benefits of the improve options are determined by calculating the difference between the baseline damages with Present Management and the residual damages. The scenario with Present Management represents the policy options NAI and MTDL.

For the Improve options (Adaptive Management and Advance the Line), the benefits of raising the defences to a 1:75 year SoP equate to the damages with Present Management for a 1:200 year return period event. The benefits of raising the defences to a 1:200 SoP equate to the same value of all of the flood damages up to the 1:200 year return period event, as that is the highest modelled flood event.

In the CMUs where flood risk from wave overtopping is the only source of flood risk in epoch 1 (Present Day), the potential of implementing the community awareness scheme as a form of adaptive management has also been considered in the benefits calculation. The benefits of this approach are based on the assumptions that there would be no damages to residential or non-residential properties for a 1:1 year return period event, and no loss of life or vehicle damages over the appraisal period. The benefits of implementing a community awareness scheme in these areas will equate to the property damages with Present Management for 1:20, 1:75 and 1:200 year return period events, and the associated indirect damages.

To be consistent with the option costs, the benefits have been discounted by applying the same discount rate through time to provide PV costs

6.3 Benefits of policy options to improve the Standard of Protection

The economic benefits of the various standards of protection for each CMU where the management intent is to improve the defences, through the preferred policy options adaptive management or advance the line are presented in the following tables; Table 6-1 to Table 6-4. In each of the tables, a cost of 0 alongside a note of NA denotes that Community Awareness is not a viable improve option for that CMU, as flood risk is being driven by rising Still Water Levels.

Table 6-1: PV benefits (£k) over the SMP duration of 100 years; CMA1 South Coast

CMU	PV Benefits (£k)				
	Community Awareness (epoch 1)	Improve – 75yr SoP (epoch 1)	Improve – 200yr SoP (epoch 1)	Preferred Policy Option	
CMU1.4	769	12,248	13,457	Community Awareness and Improve 200yr (epoch 1)	13,457
CMU1.5	6,378	17,597	23,716	Community Awareness and Improve 200yr (epoch 1)[7]	21,559
CMU1.6	0 (NA)	130,395	143,766	Improve 200yr SoP (epoch 2)	116,196
CMU1.8	0 (NA)	253,607	275,868	Improve 200yr SoP (epoch 1)	275,868
CMU1.9	0	682	750	Community Awareness (epoch 1), Improve 200yr (epoch 2)	719
CMU1.10	2,631	4,970	5,793	Community Awareness (epoch 1), Improve 200yr (epoch 2)	4,524

Table 6-2: PV benefits (£k) over the SMP duration of 100 years; CMA2 Grouville Bay

CMU	PV Benefits (£k)				
	Community Awareness (epoch 1)	Improve – 75yr SoP (epoch 1)	Improve – 200yr SoP (epoch 1)	Preferred Policy Option	
CMU2.1	177	1,735	2,425	Community Awareness (epoch 1), Improve 200yr (epoch 2)	2,336
CMU2.2	0 (NA)	3,915	4,246	Improve 200yr (epoch 2)	3,517

Table 6-3: PV benefits (£k) over the SMP duration of 100 years; CMA3 St Catherine's

CMU	PV Benefits (£k)				
	Community Awareness (epoch 1)	Improve – 75yr SoP (epoch 1)	Improve – 200yr SoP (epoch 1)	Preferred Policy Option	
CMU3.2	0 (NA)	40	396	Improve 200yr SoP (epoch 1)	396

Table 6-4: PV benefits (£k) over the SMP duration of 100 years; CMA6 St Brelade

CMU	PV Benefits (£k)				
	Community Awareness (epoch 1)	Improve – 75yr SoP (epoch 1)	Improve – 200yr SoP (epoch 1)	Preferred Policy Option	
CMU6.3	52	182	282	Community Awareness (epoch 1), Improve 200yr (epoch 2)	207

[7] The benefits for the preferred policy option for CMU 1.5 comprise the benefits from the Community Awareness scheme to be implemented at epoch 1,and the benefits from a planned flood alleviation scheme from First Tower to West Park in epoch 1 (not the entirety of St Aubin's Bay. The benefits represent constructing new defences to a 1:200 year standard of protection across the entirety of St Aubin's Bay in epoch 2.

7. Benefit Cost Ratios

Table 7-1 provides the Benefit Cost Ratios (BCRs) for the preferred policy options, for the 100 year appraisal period. The BCRs have been calculated using the PV benefits provided in Table 6-1 to Table 6-4 and the PV whole life costs in Table 5-3 to Table 5-8. The BCRs have only been provided for each CMU where the management intent is to improve the defences, through the preferred policy options Adaptive Management or Advance the Line.

Table 7-1: Benefit Cost Ratios for the Preferred Policy Option

CMU	Preferred Policy Option	PV Benefit (£k)	PV Cost (£k)	Benefit Cost Ratio	Comments
CMU1.4	Community Awareness and Improve 200 yr (epoch 1)	13,457	7,419	1.81	The preferred policy option is assumed to be economically viable as the BCR is greater than 1.
CMU1.5	Community Awareness and Improve 200yr (epoch 1)	21,559	15,528	1.39	The preferred policy option is assumed to be economically viable as the BCR is greater than 1.
CMU1.6	Improve 200yr (epoch 2)	116,195	3,746	31.02	The benefits here make up the second largest proportion of benefits across the Island, including St Helier, hence the BCR is so large.
CMU1.8	Improve 200yr SoP (epoch 1)	275,868	6,636	41.57	The benefits here make up the largest proportion of benefits across the Island, hence the BCR is so large.
CMU1.9	Community Awareness (epoch 1) Improve 200yr (epoch 2)	719	5,398	0.13	The benefits here are low as there are few properties at risk from flooding in one area along the frontage. However it is assumed that the proposed defences would be built along the full length of the frontage, hence the BCR is less than 1.
CMU1.10	Community Awareness (epoch 1) Improve 200yr (epoch 2)	4,524	5,536	0.82	The benefits here are low as there are few properties at risk from flooding in one area along the frontage. However it is assumed that the proposed defences would be built along the full length of the frontage, hence the BCR is less than 1.
CMU2.1	Community Awareness (epoch 1) Improve 200yr (epoch 2)	2,336	7,760	0.30	The benefits here are low as there are few properties at risk from flooding in one area along the frontage. However it is assumed that the proposed defences would be built along the full length of the frontage, hence the BCR is less than 1.
CMU2.2	Improve 200yr (epoch 2)	3,517	2,679	1.31	The preferred policy option is assumed to be economically viable as the BCR is greater than 1.
CMU3.2	Improve 200yr SoP (epoch 1)	396	1,223	0.32	The BCR here is less than 1, as the damages to Archirondel substation and the electricity supply it provides have been assessed qualitatively. The preferred policy option has therefore been selected for this CMU to provide flood protection to Archirondel

CMU	Preferred Policy Option	PV Benefit (£k)	PV Cost (£k)	Benefit Cost Ratio	Comments
					substation, which is critical infrastructure for the supply of electricity across Jersey.
CMU6.3	Community Awareness (epoch 1) Improve 200yr (epoch 2)	207	3,737	0.06	The benefits here are low as there are few properties at risk from flooding in one area along the frontage. However it is assumed that the proposed defences would be built along the full length of the frontage, hence the BCR is less than 1.

There are units (CMUs 1.9, 1.10, 2.3, 3.2 and 6.3) where the BCR is shown to be less than 1. In these areas there are very few assets at risk although the flood risk spans the length of the frontages, and in this assessment the cost of the full length of defences has been included. It should also be noted that the economic benefits of maintaining the existing defences have not been captured due to the With Present Management baseline. Should the existing defence benefits be included it is likely that the economic justification would be much stronger and most likely improve the BCR to greater than unity. The BCRs as presented however show the areas of greatest priority for improvement.

8. Sensitivity testing

8.1 Property thresholds

A key uncertainty in the valuation of the damages with Present Management and the benefits of the Do Something options is the values that have been assumed for the property threshold, based on a visual inspection and average values in the MCM (2018). Residential and non-residential property threshold levels have been assumed to be 0.15m.This threshold level has been sensitivity tested with alternative thresholds of 0.05m and 0.1m.

Table 8-1 presents the changes to the total PV damages with Present Management with varying values of threshold for the residential and non-residential properties. The sensitivity test has been undertaken Island-wide in order to obtain the maximum potential differences. As can be seen, reducing the threshold to 0.05m increases the damages with Present Management by approximately 10-15%, as does reducing the threshold to 0.1m. It is expected that the percentage change in the damages with Present Management would be similar to the resultant change in option benefits.

Table 8-1: Sensitivity test of residential and non-residential threshold levels in relation to the total PV damages (£k) for the 100 year appraisal period, Island-wide

Scenario	Duration	Property Threshold Level		
		0.05m	0.1m	0.15m (original)
With Present Management	100yrs	645,153	555,103	483,304

8.2 Discount Rate

Discount rates have been used to convert cash damages and benefits to PV damages across the whole life of the SMP, as detailed in Section 2.6. According to the Treasury Green Book, discount rates create uncertainty in the valuation of long term appraisals such as this. The discount rates used have been sensitivity tested against a reduced rate, which also declines over time.

Table 8-2 presents the changes to the total PV damages with Present Management with the reduced discount rate given in the Treasury Green Book. The sensitivity test has been undertaken Island-wide to show the maximum potential differences in the damages. As can be seen, using a reduced discount rate increases the damages by approximately 5%.

Table 8-2: Sensitivity test of Discount rates in relation to the total PV damages (£k) for the 100 year appraisal period, Island-wide

Scenario	Duration	Discount Rate	
		Reduced Rate[8]	Standard Rate (original)
With Present Management	100yrs	504,330	483,304

[8] Reduced discount rates for Loss of Life are 1% (0-30 years), 0.86% (31-75 years) and 0.71% (76-125 years). For all other damages, the reduced discount rates are 3% (0-30 years), 2.57% (31-75 years) and 2.14% (76-125 years).

9. Summary

The economic appraisal shows the benefits of delivering the defence measures outlined to deliver the preferred policy options within the SMP, over the full appraisal 100 year appraisal period in comparison to the costs of implementing new defence measures and maintaining the existing defences.

The damage assessment estimated that under the With Present Management Scenario, there would be approximately £2.7 billion cash value and £475 million of present value damage over the next 100 years – including direct damages to residential and non-residential properties, and indirect damages detailed in Section 2.7.

The total estimated benefit for the CMUs where the preferred policy options are to improve the defences through Adaptive Management or Advance the Line is approximately £438 million; although the damages across the island are greater than the benefits, the additional benefit of reducing GVA losses from business disruption is not included in this value, though it should be considered as additional benefit from implementing this SMP. The business disruption assessment has considered the potential GVA loss due to flooding of businesses on the island, which estimates that a single 1:200 year flood event could cause damages up to £110 million if the businesses are not able to adapt to the flood risk, and an estimated total potential GVA damage of £93 million (PV) over the next 10 years.

Table 9-1 presents the total costs, benefits and BCRs for all CMUs in both cash and PV terms; although there are some CMUs where the BCR is less than 1 (see Table 7-1) the overall BCR suggests the scheme will be economically viable considering all damages across the island together.

Table 9-1: Total Costs and Benefits for CMUs with the preferred policy option to improve the defences

Value	Epoch 1 (2020-2040) (£k)		Epoch 2 (2040-2070) (£k)		Epoch 3 (2070-2120) (£k)		Full Appraisal Period (100 years) (£k)	
	Cash Value	PV	Cash Value	PV	Cash Value	PV	Cash Value	PV
Benefits	113,879	88,878	328,896	131,187	2,174,301	218,083	2,617,076	438,778
Costs	36,589	32,195	84,425	37,762	76,900	9,232	197,914	79,190
BCR (Cash)	3.11		3.90		28.27		13.22	
BCR (PV)	2.76		3.47		23.62		5.54	

The total costs for maintenance and capital construction across the island are presented in Table 9-2. This includes the costs for all CMUs – with the capital costs for implementing new defences, and maintenance costs maintaining new and existing defences. This provides an understanding of the whole life costs of the management intent for the whole SMP, island-wide.

Table 9-2: Island-wide Capital and Maintenance Costs

Scenario	Epoch 1 (2020-2040) (£k)		Epoch 2 (2040-2070) (£k)		Epoch 3 (2070-2120) (£k)		Full Appraisal Period (100 years) (£k)	
	Cash Value	PV	Cash Value	PV	Cash Value	PV	Cash Value	PV
Preferred Policy Capital Costs	9,899	9,332	57,473	28,791	926	103	68,298	38,226
Preferred Policy Maintenance Costs	26,689	22,863	26,952	8,971	75,975	9,129	129,616	40,963
Total SMP implementation costs	36,588	32,195	84,425	37,762	76,901	9,232	197,914	79,189

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