



## **11e7 Moricambe Bay**

### **(Technical report by Jacobs)**

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# Policy area: 11e7 Moricambe Bay

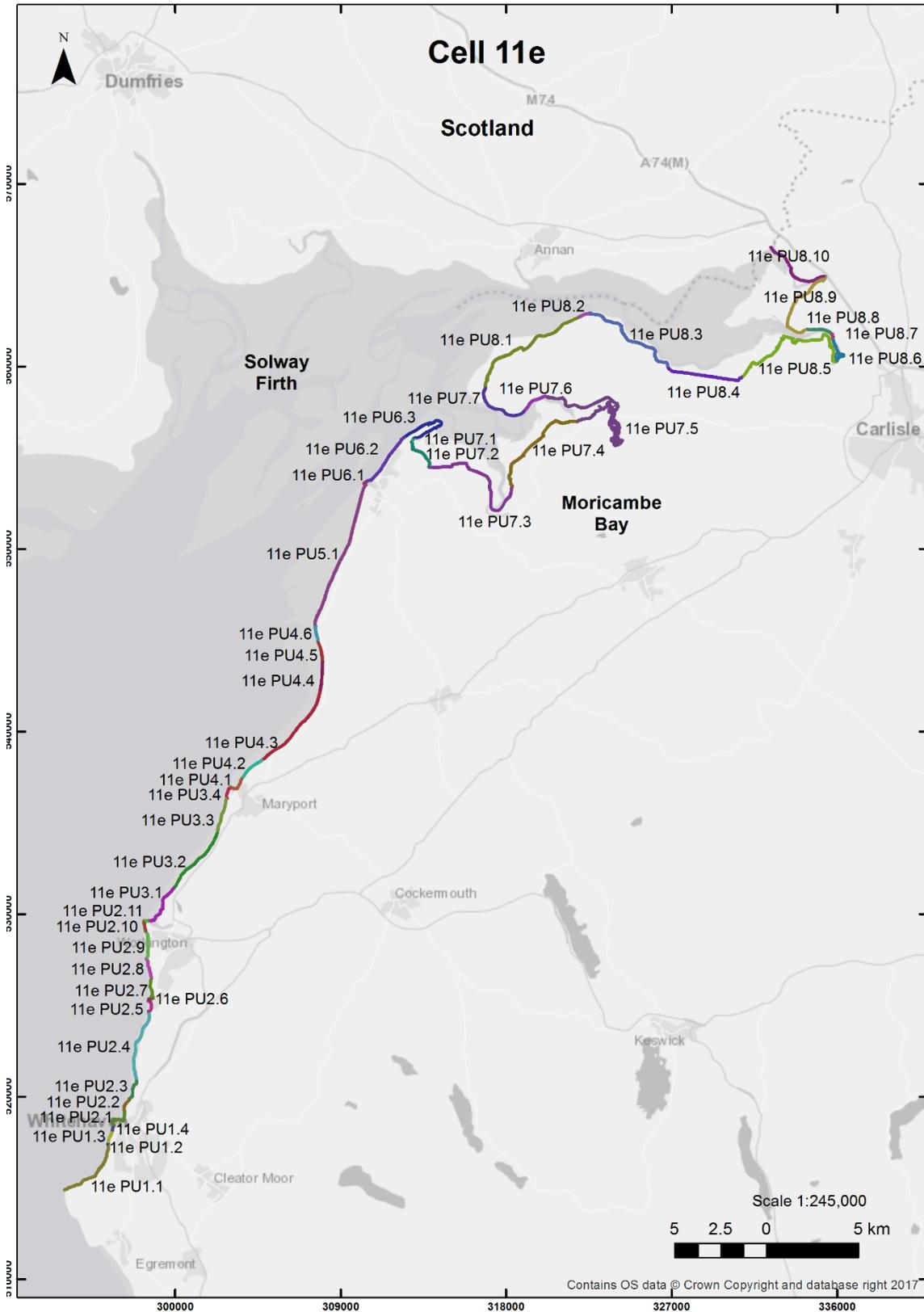


Figure 1 Sub Cell 11e St Bees Head to Scottish Border Location Plan of policy units. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

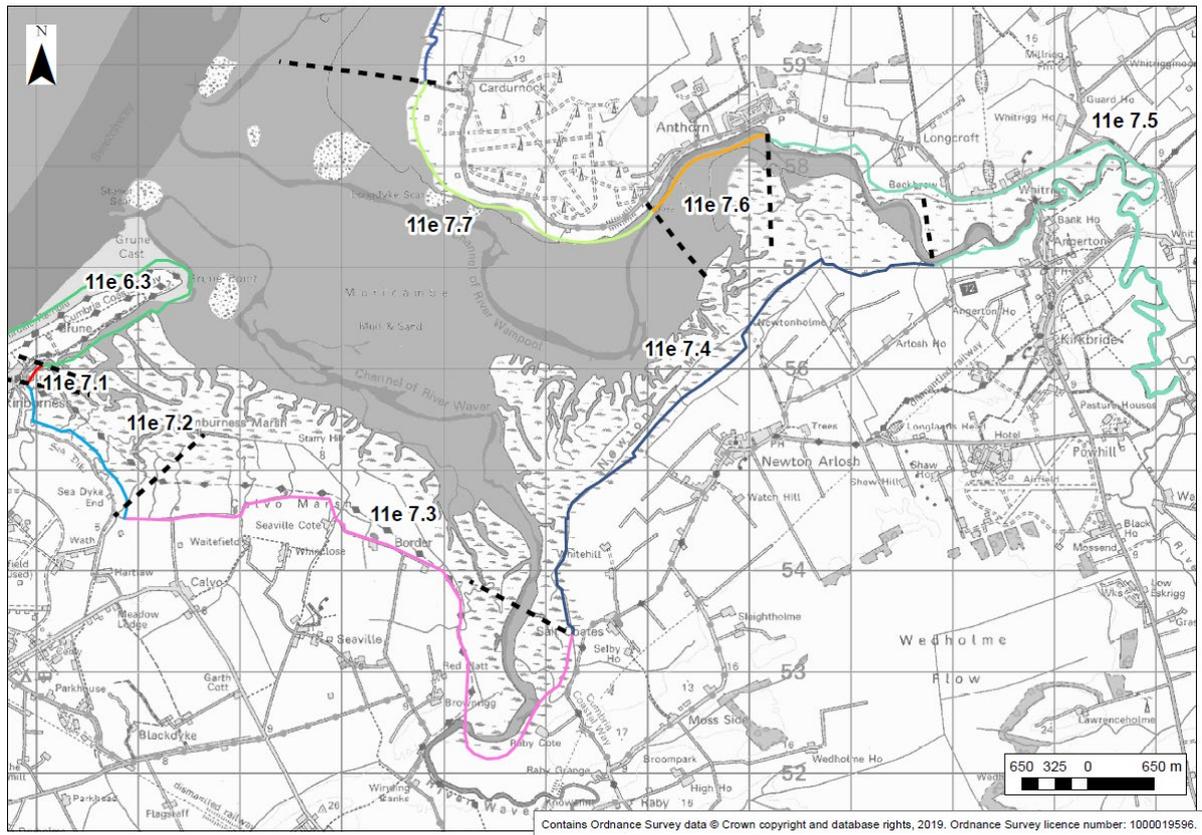


Figure 2 Location of Policy Area: 11e7: Moricambe Bay. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

# 1 Introduction

## 1.1 Location and site description

<b>Policy units:</b>	<p>11e7.1: Skinburness (east)</p> <p>11e7.2: Skinburness to Wath Farm</p> <p>11e7.3: Wath Farm to Saltcoates including Waver to Brownrigg</p> <p>11e7.4: Newton Marsh</p> <p>11e7.5: Newton Marsh to Anthorn including Wampool to NTL</p> <p>11e7.6: Anthorn</p> <p>11e7.7: Anthorn to Cardurnock</p>
<b>Responsibilities:</b>	<p>Allerdale Borough Council</p> <p>Cumbria County Council</p> <p>Private landowners</p>
<b>Location:</b>	<p>This policy area covers the frontage of Moricambe Bay, from the tip of natural sand and shingle spit – The Grune – in the south, to Cardurnock in the north. The shoreline is characterised by intertidal sand and mudflats, with marshes and reclaimed or improved former marshland behind.</p>
<b>Site overview:</b>	<p>Moricambe Bay is a natural tidal embayment, which sits within the wider estuarine system of Solway Firth. The River Waver and the River Wampool join the coast in the section, fragmenting the saltmarsh into three, Skinburness Marsh (south), Newton Marsh (central), Anthorn and Cardurnock Marsh (north). There is a short section of dunes on the eastern side of The Grune, but the remainder of the frontage is made up of saltmarsh.</p> <p>The Waver Channel follows the southern shoreline of the Bay flowing through the mud and sand foreshore, before connecting with the main channel of the Solway Firth. The northern shoreline of Moricambe Bay is more exposed and consequently is characterised by narrow areas of saltmarsh fronting the promontory between Cardurnock and Anthorn. The River Wampool meanders close to the northern shoreline at Anthorn and Cardurnock, before being deflected by Longdyke Scar and entering the main channel of the Solway Firth.</p> <p>Moricambe Bay and its extensive marsh systems act as a sediment sink within the larger Solway Firth system; there is also reworking and redistribution of these sediments within the bay itself. A negligible amount of fluvial sediment is supplied to the system due to the low flow of the Rivers Waver and Wampool (Halcrow, 2011). A key influence on patterns of erosion and accretion is the movement of tidal low water channels within the Bay. There are a number of scars, comprised of coarse less mobile sediments, which affect the movement of tidal channels within the Bay and consequently, the shaping of the Bay.</p> <p>The outer margins of the Bay are also influenced by movement of the main Solway Firth channel (also known as the Swatchway). Over the past century, this channel has moved landwards toward the southern shoreline, which has acted to propagate waves to the shoreline and increased exposure within Moricambe Bay (Halcrow, 2011).</p> <p>Earth embankments align much of the western and southern shorelines (the landward edges of Skinburness and Newton Marsh) to provide flood protection to the low lying agricultural hinterland. This flood risk area at the south west of Moricambe Bay is also at risk from flooding from the open coast frontage 11e6.2.</p>

There was previously a viaduct constructed across the Wampool Estuary, which constrained the course of this channel. Following its removal there was reorientation of the main Solway Firth channel and Wampool channel in Moricambe Bay (Bullen Consultants, 1998), with the Wampool channel moving back towards the centre of the bay.

There are several small settlements and isolated farmsteads within this policy area, or that have potential to be affected by future management of flood risk within this area: Skinburness, Silloth, Calvo, Seaville, Abbeytown, Newton Arlosh, Kirkbride, Angerton, Whitrigg, Anthorn and Cardurnock. These are connected by link roads which crisscross the reclaimed marsh areas and hinterland, including the B5302, which links to Skinburness along the southern shore, the B5307, which links Abbeytown and Angerton, along the central shore and the U2002, which links Angerton to Anthorn and Cardurnock along the north shore.

The coastal environment has significant environmental value and is designated as part of the larger estuarine system of the Solway Firth. Along the coast, the frontage is internationally designated as a Special Area of Conservation (SAC) (Solway Firth SAC) for its salt marshes and intertidal habitats, and as a Special Protection Area, SSSI and Ramsar site (Upper Solway Flats and Marshes) for its populations of breeding birds and wintering waders and wildfowl and supporting habitats. Inland, there are extensive areas of lowland raised bogs (mires), which are designated as South Solway Mosses SAC. These areas support unique communities of flora and fauna, with restoration works in progress to improve water management. All of the Solway Raised Mires are designated as Sites of Special Scientific Interest and some are National Nature Reserves. Moricambe Bay, up to the mean high water line, is a proposed Marine Conservation Zone (to be confirmed in 2019), which is proposed to protect smelt and nursery habitats for bass, pollack and some flatfish species.

Much of this frontage is designated as part of the Solway Coast Area of Outstanding Natural Beauty (AONB), which stretches from Rockcliffe to Maryport, for its landscape and historic and scientific interest. Parts of Moricambe Bay also falls within the buffer zone of the Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site in recognition of its significant historic importance and Outstanding Universal Value (OUV).

This is a popular area for walkers and bird enthusiasts and Skinburness, with a number of trails across the frontage, and Calvo Marshes are Registered Common Land under the Countryside Rights of Way (CRoW) Act 2000. Tourism is a key economic driver in this area and essential for the communities along the inner Solway coast.

## 1.2 Current SMP policy

The policy details for the whole policy area are shown in the table below, taken directly from the SMP2 (Halcrow, 2011); non priority units have been greyed out.

Table 1 Current SMP policy for policy area 11e7

**Overview:** *The long term plan for this area is for natural evolution of the coast where possible, allowing the sea to reclaim low lying areas, returning them to saltmarsh in the long term. Some Hold the line and Managed realignment may be permissible to manage flood risk to property and agricultural land, but this is unlikely to be economically justifiable and thus not funded. The policies will manage flood risk to the majority of property and built assets. However, a number of isolated properties, minor access roads and footpaths will become increasingly at risk of flooding. The proposed Managed realignment and large areas of No active intervention should compensate for any coastal squeeze in the defended sections.*

Location		Policy and Approach (from 2010)		
		0-20 years	20-50 years	50-100 years
11e7.1	Skinburness (east)	<b>Hold the line</b> – By maintaining the flood defences at Skinburness. Skinburness Marsh also provides natural defence.	<b>Hold the line</b> – By maintaining the flood defences at Skinburness. Skinburness Marsh also provides natural defence.	<b>Hold the line</b> – By maintaining the flood defences at Skinburness. Skinburness Marsh also provides natural defence.
11e7.2	Skinburness to Wath Farm	<b>Hold the line</b> – By reactive management, maintain flood embankment if required. Undertake a study to develop the approach to realignment and consider early implementation of where practicable.	<b>Managed realignment</b> – By constructing set back defences to allow space for marsh rollback & habitat creation opportunity.	<b>Hold the line</b> – By reactive management, maintain set back flood embankment if required. Skinburness Marsh also provides natural flood defence.
11e7.3	Wath Farm to Saltcoates including Waver to Brownrigg	<b>Managed realignment</b> – Saltmarsh will continue to provide natural flood defence. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution to saltmarsh. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution to saltmarsh. Allows measures to proactively adapt to future coastal changes.
11e7.4	Newton Marsh	<b>Managed realignment</b> – Saltmarsh provides a degree of natural flood defence. May be potential for local private Managed realignment of flood defences. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution to saltmarsh. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution to saltmarsh. Allows measures to proactively adapt to future coastal changes.
11e7.5	Newton Marsh to Anthorn including Wampool to NTL	<b>Managed realignment</b> – Saltmarsh will continue to provide natural flood defence. Undertake studies to assess viability of local flood risk management to Kirkbride and Angerton. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution to saltmarsh. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution to saltmarsh. Allows measures to proactively adapt to future coastal changes.
11e7.6	Anthorn	<b>Hold the line</b> – Monitor bank erosion and channel movement, and when assets at risk justify, construct a revetment in front of properties.	<b>Hold the line</b> – Monitor bank erosion and channel movement, and if assets at risk justify, construct a revetment.	<b>Hold the line</b> – By maintaining revetment and, continued monitoring extend defence line if required and justified.
11e7.7	Anthorn to Cardurnock	<b>Managed realignment</b> – Allow continued natural coastal evolution. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution. Reassess coastal risks to the Solway Mosses SAC. Allows measures to proactively adapt to future coastal changes.	<b>Managed realignment</b> – Allow continued natural coastal evolution. Reassess coastal risks to the Solway Mosses SAC. Allows measures to proactively adapt to future coastal changes.

## 2 Appraisal of non priority units

All seven policy units in this policy area have been defined as non priority units:

- 11e7.1 Skinburness (east)
- 11e7.2 Skinburness to Wath Farm
- 11e7.3 Wath Farm to Saltcoates
- 11e7.4 Newton Marsh
- 11e7.5 Newton Marsh to Anthorn
- 11e7.6 Anthorn
- 11e7.7 Anthorn to Cardurnock

A light touch review has been undertaken of current SMP recommendations, taking into account conclusions from option appraisals for the adjacent frontages, where appropriate.

### 2.1 11e7.1 Skinburness (east)

#### 2.1.1 11e7.1 – Existing approach to flood and coastal erosion risk management

This is a very short stretch of coast, which covers the landward side of Skinburness at the southern end of The Grune spit. The existing SMP2 policy along policy unit 11e7.1 is Hold the line from the short term. The primary justifications for this policy at SMP2 level were to manage flood risk to residential and commercial properties and amenities (mainly within Silloth and Skinburness). The possibility of setback defences was suggested, although it is unclear whether this referred to this unit or the adjacent unit. Potential visual impacts on the Hadrian's Wall WHS buffer zone (and on its Outstanding Universal Value) was recognised.

The primary risk is to Skinburness from flooding via Moricambe Bay. A low water tidal channel, a subsidiary of Skinburness Creek, which runs close the shoreline, through the marsh; this appears to be relatively stable but may be a conduit for elevated flows. The tidal limit is constrained by the Sea Dike Road embankment. The channel naturally constrains the width of fringing marsh which lies between this and The Grune spit. Beyond the channel there is an extensive width of marsh.

An earth embankment extends along the frontage, as far north as the last property; this does not appear to be tied into any other structure, although there may be slightly higher ground and humps in the road at its extents. At its southern end the embankment adjoins the Sea Dike. No further information is available relating to its design or current condition, although photographs suggests it is in fair condition. There is not likely to be any significant risk of wave action or wave overtopping, with the predominant risk during surge events when tidal levels are raised.



Figure 3 Skinburness East (11e7.1) illustrating the earth embankment and extensive marsh to seaward, within Moricambe Bay.

### 2.1.2 11e7.1 - Strategy considerations

Several properties and businesses lie within Environment Agency Flood Zone 1 and are potentially at risk during high tide and surge events. The link road to properties lies adjacent to the embankment, therefore could be cut off before properties themselves are affected. Risks are currently understood to be low, given the natural protection provided by the extensive marsh.

There is a potential flood route across the Grune at this location and via the adjacent unit (11e7.2). In the long term, there is also a dependence upon the plans for the open coast frontage (11e6.2).

This frontage lies within an important conservation area, recognised by its designation as an SPA, Ramsar, SSSI and SAC. The narrow band of saltmarsh which lies between The Grune and Skinburness village and the tidal channel is currently in favourable condition (last assessed 2010). The extensive marsh on the coastal side of the channel (Skinburness Marsh) is also in favourable condition (last assessed 2010). It is not one of the important marshes for its breeding birds but is used by wintering and feeding birds.

The area has high heritage and landscape value (Outstanding Universal Value), recognised by designations: Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site and Solway Coast AONB, with a scheduled monument (Skinburness milefortlet 9) located at the northern end of the village.

The area is also a popular destination for walkers and bird enthusiasts, and the proposed route of the England Coast Path runs along the road.

Under current conditions, it is unlikely that the embankment is overtopped on frequent occasions and based on photographs alone, it appears it is in fair condition, although there is uncertainty regarding tie in at the ends. In the future, the risk of flooding may increase as a result of rising sea levels and therefore the risks will need to be reappraised accordingly.

Due to the proximity of the channel to the embankment and properties and road behind, there is little opportunity for realignment of the embankment along this frontage, which reflects the Hold the line policy.

### 2.1.3 11e7.1 - Discussion

Given the potential flood risk to Skinburness, the current SMP2 policy remains reasonable. Since the SMP2 was adopted there have been no changes in environmental designations although this part of

the Firth may become designated as a marine conservation zone in 2019, which would lend more protection to the seabed species and habitats found at the site. Though this site is unlikely to be impacted by the SMP policy. The potential change in risk, due to sea level rise, needs to be monitored, to assess the need to improve the current defence.

Although not directly a coastal management issue, the Environment Agency are withdrawing from maintenance of drainage ditches and the running of the drainage pumps in this area. Currently a Water Management Committee is being established, anticipated within 5 years, before that the Environment Agency will continue to maintain.

### 2.1.4 11e7.1 - Strategic way forward

The preferred strategic approach is to continue to manage flooding risk from Moricambe Bay to Skinburness through maintaining flood embankments, Implementing the SMP policy of Hold the line through maintaining the flood defence embankment within existing footprints.

Future activities include:

- Regular inspections are recommended to assess the condition of the embankment and undertake maintenance and repairs as required. These are not currently undertaken as part of the North West Regional Monitoring Programme but may be undertaken by the Environment Agency.
- Asset maintenance, repairs and management within existing footprint.
- Continued monitoring of changes in the extent of marsh and intertidal areas, as part of the Northwest Regional Monitoring Programme, to identify any changes in observed trends and any possible increase in risk level.

Further details on actions and responsibilities are provided in the **Action Plan**.

## 2.2 11e7.2 Skinburness to Wath Farm

### 2.2.1 11e7.2 - Existing approach to flood and coastal erosion risk management

The existing SMP2 policy along policy unit 11e7.2 is Hold the line in the short term, Managed realignment for the medium term and Hold the line for the long term; as such a change in defence alignment is proposed, if 'practicable'.

The primary justifications for this policy at SMP2 level were to continue to manage flood risk to residential and commercial properties in Skinburness and Silloth, agricultural land and isolated properties and farmsteads within the flood plain. However, the SMP recognised opportunity for intertidal habitat creation (which may be required to replace or compensate potential long term coastal squeeze losses due to defences elsewhere) through creating setback defences.

The key risk to this area is from flooding. An earth flood embankment extends along this frontage: the Sea Dike, which is believed to date from the 14<sup>th</sup> Century, when it was constructed by the monks of Holm Cultram.

There are shared flood risks with adjacent frontages 11e6.2 and 11e7.1 and therefore is also a dependence upon the plans for these units and a need to consider costs and benefits of FCERM together.

### 2.2.2 11e7.2 - Strategy considerations

The Sea Dike embankment, together with the wide expanse of marsh within Moricambe Bay, currently minimises flood risk to an extensive low lying area, which extends to Skinburness and parts of Silloth. With the exception of Skinburness and Silloth, much of this area is undeveloped and mainly used for agriculture. It does include a number of smaller hamlets and farmsteads, together

with link roads. The C2052 runs alongside the Sea Dike embankment, in some parts it is protected by the embankment from high tide events but elsewhere the road lies on the seaward side of the bank crest.

This frontage lies within an important conservation area, recognised by its designation as an SPA, Ramsar, SSSI and SAC. The extensive marshlands on the coastal side of the embankment (Skinburness and Calvo Marshes) are currently in favourable condition (last assessed 2010). It is not one of the important marshes for breeding birds but is used by wintering and feeding birds.

The area has high heritage and landscape value (Outstanding Universal Value), recognised by designations: Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site and Solway Coast AONB. Skinburness and Calvo Marshes is also Registered Common Land and the proposed route of the England Coast Path runs along the landward edge of the bank.

There has been recent saltmarsh erosion predominately driven by channel migration and creek changes – recent data suggests that Calvo Creek is widening, resulting in erosion of the saltmarsh edge along the western shoreline of Moricambe Bay. This does not directly impact on the embankment as there is still an expanse of marsh seaward of the road, but is a risk that needs to be monitored.

### 2.2.3 11e7.2 - Discussion

The current SMP2 policy of Managed realignment in the medium term, with provision of a setback defence, is in accordance with the management principles of the AONB designation and the national and international environmental designations for the site. Since the SMP2 was adopted there have been no changes in environmental designations although this part of the Firth may become designated as a marine conservation zone in 2019, which would lend more protection to the seabed species and habitats found at the site; although this site is unlikely to be impacted by the SMP policy.

Realignment of the defence may impact on the frequency of high tide flooding of the road (C2052) is although parts of it are already seaward of the crest of the bank. The B5302 offers the alternative route. This could have consequences for locals who currently use the Sea Dike Road, with potential for slightly increased traffic on the B5302.

Given the designations along this shoreline, any change in defence alignment would require consent from Natural England.

### 2.2.4 11e7.2 - Strategic way forward

The preferred strategic approach is to implement the SMP policy to hold the line in short term by maintaining and refurbishing defences within current footprints. Monitoring changes to extents of marsh and intertidal areas to allow future assessment of the impacts of the existing defence on natural behaviour of the marsh and consider options for future realignment.

Future activities include:

- Continued monitoring of changes in the extent of marsh and intertidal areas, as part of the Northwest Regional Monitoring Programme, to identify any changes in observed trends and any increases in risk level as well as gathering data to inform future assessments of impacts of the existing defences on the natural development of the marsh.
- Detailed discussion between landowners, Environment Agency, Cumbria County Council (highways), Allerdale Borough Council, Solway Coast AONB, and Natural England to consider potential medium to long term relocation of the embankment to adapt to future sea level rise and the implications of this, including impacts of potentially closing the C2052.
- Monitoring of risk to historical assets and liaison with Historic England to enable sufficient time for recording and, where appropriate, collection of finds. Construction of new embankments as part of facilitating Managed realignment would require further discussion with Historic England to define routes which should minimise disturbance to historical assets

where possible or otherwise determine appropriate mitigation measures, such as the need for hand digging and recording of finds.

- There would also need to be an estuary wide feasibility study into Managed realignment opportunities, to include hydrodynamic modelling to determine effects on flood risk and geomorphology of estuary as well as the likely inundation of the sites and habitat creation.

Further details on actions and responsibilities are provided in the **Action Plan**.

## 2.3 11e7.3 Wath Farm to Salt Coates

### 2.3.1 11e7.3 - Existing approach to flood and coastal erosion risk management

The existing SMP2 policy along policy unit 11e7.3 is Managed realignment from the short term. The primary justifications for this policy at SMP2 level were that there are limited assets at risk and therefore insufficient economic justification for public funding of defences. Allowing rollback was also recognised as providing opportunities for future habitat creation to be included within the Environment Agency's Regional Habitat Creation Programme.

There are no formal flood defences; the wide expanse of marsh provides a natural flood defence along this stretch, with improved grassland abutting marsh at the coastal edge.

The coastal monitoring data show that at Skinburness Marsh there is evidence of active channel migration, particularly at Calvo Creek which is becoming wider (CH2M, 2017). The saltmarsh area has remained stable whilst the edge of the saltmarsh has slightly receded. (CH2M, 2017).

### 2.3.2 11e7.3 - Strategy considerations

The natural flood plain extends inland with several farmstead and mainly agricultural land at potential risk from flooding. There are various link roads, and a stretch of the B5307 and the Salt Coates Road are at risk of flooding and have flooded in the past; these link communities and farmsteads.

The area lies outside of the buffer zone of the Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site, but there are several listed buildings, associated with agricultural heritage, at potential flood risk. The frontage falls within the Solway Coast AONB and Skinburness and Calvo Marshes is Registered Common Land. The proposed route of the England Coast Path runs along the boundary between fields and marsh along the frontage and then follows the western bank of the River Waver. It crosses the river at the old railway embankment, following this before joining the road to Salt Coates.

This frontage lies within an important conservation area, recognised by its designation as an SPA, Ramsar, SSSI and SAC. The extensive marshlands on the west side of the River Waver (Skinburness and Calvo Marshes) are currently in favourable condition (last assessed 2010). It is not one of the important marshes for its breeding birds but is used by wintering and feeding birds. On the East Side of the River Waver, Newton Marsh – Raby Cote is also in favourable condition.

### 2.3.3 11e7.3 - Discussion

The current SMP2 policy of Managed realignment is in accordance with the management principles of the AONB designation and the national and international environmental designations for the site. Since the SMP2 was adopted there have been no changes in environmental designations although this part of the Firth may become designated as a marine conservation zone in 2019, which would lend more protection to the seabed species and habitats found at the site, although this site is unlikely to be impacted by the SMP policy.

There are potential opportunities to enable expansion of current saltmarsh, to potentially offset future issues of coastal squeeze, through agri-environment schemes to allow saltmarsh accretion and land level rise. This is also an objective of the AONB. Given the designations along this shoreline,

any change in management, which could involve introduction of ditches, changes to informal embankments where they exist and to drainage and a change in grazing patterns, would also require consent from Natural England.

For those properties that remain at flood risk, flood adaptation measures should be considered to adapt to future rising sea levels and reduce the impact of flooding and ensure safe exit during extreme events.

### 2.3.4 11e7.3 - Strategic way forward

There are no formal defences on the frontage, with the wide marsh giving natural protection. Environmental opportunities under the MR policy could allow potential for habitat enhancements here to mitigate impacts of defences elsewhere in the designated site. The preferred strategic approach is to allow area to function as naturally as possible and look for environmental opportunities to enhance site.

Future actions include:

- Monitoring of changes in the extent of marsh and intertidal areas, as part of the Northwest Regional Monitoring Programme, to identify any changes in observed trends and any possible increase in risk level. Note that in places no data have been collected since 2014. A recommendation would be for remote sensing to be undertaken where the marsh is narrowest, to appraise change in risk levels.
- Detailed discussion between landowners, Cumbria County Council (including highways), Allerdale Borough Council, Solway Coast AONB, and Natural England to consider potential for land management changes along the coastal fringe, with the view to creating more wetland areas while also seeking to manage risks to homes and infrastructure.
- Review risk to the B5307 and consider need for localised works to manage tidal flood risks, if required.
- Estuary wide feasibility studies into Managed realignment opportunities, to include hydrodynamic modelling to determine effects on flood risk and geomorphology of estuary as well as the likely inundation of the sites and habitat creation.

Further details on actions and responsibilities are provided in the **Action Plan**.

## 2.4 11e7.4 Newton Marsh

### 2.4.1 11e7.4 - Existing approach to flood and coastal erosion risk management

This unit covers the frontage from Salt Coates to Angerton House. The existing SMP2 policy along policy unit 11e7.4 is Managed realignment from the short term. The primary justifications for this policy at SMP2 level were that although several isolated properties could be at increasing flood risk in future, there was insufficient economic or environmental justification for the construction of new shoreline defences. Allowing rollback was also recognised as providing opportunities for future habitat creation to be included within the Environment Agency's Regional Habitat Creation Programme.

There are no formal flood defences; the wide expanse of marsh provides a natural flood defence along this stretch, with improved grassland abutting marsh at the coastal edge.

### 2.4.2 11e7.4 - Strategy considerations

The coastal strip is mainly undeveloped and its key use is as agricultural land. There are a number of isolated properties that lie within the flood plain, together with a link road and the stretch of B5307 which runs between Newton Arlosh and Angerton. This road has been flooded in the past, most recently during 2018 Storm Eleanor in January 2018, when it had to be closed. There is a small

sewage treatment works at Newton Arlosh, which also lies within the flood zone. Final effluent from the treatment works is discharged to unnamed tidal tributary of River Wampool.

This intertidal area is recognised for its environmental value by its designation as a SPA, Ramsar, SSSI and SAC. Whilst the hinterland falls within the SSSI buffer zone. The extensive intertidal marsh and sand flats of Newton Marsh are currently in favourable condition (2008). It was noted in the SSSI appraisal that there were areas of artificially drained saltmarsh pans and that remediation of these would further enhance unit.

The proposed route of the England Coast Path runs along the boundary between fields and marsh along the frontage. An alternative route is however also defined, recognising that the proposed route is at risk from flooding during high tide events.

The frontage also falls within the Solway Coast AONB.

### 2.4.3 11e7.4 - Discussion

There are potential opportunities to enable expansion of current saltmarsh, to potentially offset future issues of coastal squeeze, through agri-environment schemes to allow saltmarsh accretion and land level rise. This is also an objective of the AONB. Given the designations along this shoreline, any change in management, which could involve introduction of ditches, changes to informal embankments and a change in grazing patterns, would also require consent from Natural England.

As part of such schemes there may be opportunities to improve resilience of the B5307. Although there is alternative link between Newton Arlosh and Angerton, via Kirkbride, this is the only access to individual properties located along the road. Any such works should, however, look to minimise impacts on the natural flood plain.

For those properties that remain at flood risk, flood adaptation measures should be considered to reduce the impact of flooding and ensure safe exit during extreme events.

### 2.4.4 11e7.4 - Strategic way forward

No active intervention - there are no formal defences on the frontage, with the wide marsh giving natural protection. Environmental opportunities under the MR policy could allow potential for habitat enhancements here to mitigate impacts of defences elsewhere in the designated site.

Future activities include:

- Monitoring changes in the extent of marsh and intertidal areas, as part of the Northwest Regional Monitoring Programme, to identify any changes in observed trends and any possible increase in risk level. Note that in places no data have been collected since 2014. A recommendation would be for remote sensing to be undertaken where the marsh is narrowest, to appraise change in risk levels.
- Detailed discussion between landowners, Cumbria County Council (including highways), Allerdale Borough Council, Solway Coast AONB, and Natural England to consider potential for land management changes along the coastal fringe, with the view to creating more wetland areas, and to consider opportunities to improve resilience of the B5307 and manage flood risk to individual properties. The longer term viability of the B5307 and alternative options will also need to be determined.

Further details on actions and responsibilities are provided in the **Action Plan**.

## 2.5 11e7.5 Newton Marsh to Anthorn

### 2.5.1 11e 7.5 - Existing approach to flood and coastal erosion risk management

This unit covers the frontage from Angerton House, on the south bank of the River Wampool to Anthorn on the north bank; Anthorn village itself is covered by unit 11e7.6. The existing SMP2 policy is Managed realignment from the short term. The primary justifications for this policy at SMP2 level

were that there are limited assets at risk, with properties and amenities mainly located within Angerton and Kirkbride and outside of the flood zone. Allowing rollback was also recognised as providing opportunities for future habitat creation to be included within the Environment Agency's Regional Habitat Creation Programme.

There are no formal flood defences; the wide expanse of marsh provides a natural flood defence along this stretch, with improved grassland abutting marsh at the coastal edge and rising land behind.

## 2.5.2 11e7.5 - Strategy considerations

The majority of properties lie above the flood risk zone, but there remain a number at potential risk of flooding. The coastal road runs along the back of the marsh between Angerton and Whitrigg and is known to flood, resulting in road closures. This is a key link road between villages and communities on the Cardurnock Peninsula and there are no viable alternative routes. A United Utilities (UU) pressured mains pipe runs beneath the road, from Angerton to Bowness, around the periphery of the Cardurnock Peninsula. There is an outfall from Anthorn WwTW to the Wampool Estuary that is understood to have become damaged where it crosses the marsh. There are also areas of agricultural land that at flood risk, with the primary use being pasture land, including the marshes.

Most of the intertidal area within this unit is designated as part of Solway Firth Special Area of Conservation (SAC) and Upper Solway Flats and Marshes Special Protection Area (SPA), SSSI and Ramsar site. Both Whitrigg Marsh and the adjacent Longcroft Marsh are currently in favourable condition (last assessed in 2010): they are not one of the more important marshes for breeding birds but do support wintering bird populations. Further west, is Anthorn Marsh; this is also currently in favourable condition, although concerns were raised at the time of assessment (2013) regarding coastal access and the risk of stock being pushed around on this narrow marsh which would have a detrimental effect on grazing levels on various parts of the marsh.

Although much of the area lies outside of the buffer zone of the Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site, there is a Scheduled Monument, Kirkbride Roman Fort, 370 m south east of Whitrigg Bridge, which is included within the World Heritage Site. The frontage also falls within the Solway Coast AONB.

The proposed route of the England Coast Path runs along the boundary between fields and marsh along the frontage until it crosses the River Wampool at Whitrigg Bridge. It then runs along the boundary between fields and marsh along the frontage between Beckbrow and Anthorn, although an alternative route is also defined, recognising that the proposed route is at risk from flooding during high tide events.

Fluctuating elevations on the mud and sand banks occur due to erosion and subsequent deposition of fine material in this dynamic environment. The River Wampool has migrated across the sand flats, tending to widen and shallow, and has led to the development of sand bars in the estuary. There is limited data available from the Northwest Regional Monitoring Programme for much of the frontage, due to the limited assets at risk. The recent data available for Anthorn Marsh suggest that although narrow, the marsh is relatively stable and there is no evidence of marked recession of the saltmarsh front (CH2M, 2017); however, more data would be useful in order to confirm this. Previous analysis reports have reported that at Anthorn and Cardurnock, the shoreline has retreated over the past century due to erosion by fluvial and marine action as the River Wampool has migrated landward, leading to the creation of eroded saltmarsh terraces (CEUK, 2015). This northern shoreline is also more exposed to wave attack than some parts of the bay.

## 2.5.3 11e7.5 - Discussion

Along Whitrigg Marsh and Longcroft Marsh there are potential opportunities to enable expansion of current saltmarsh, through changes in land management and agri-environment schemes, and thereby potentially offset future issues of coastal habitat losses elsewhere. This is also an objective

of the AONB. Given the designations along this shoreline, any change in management, which could involve introduction of ditches, changes to informal embankments and a change in grazing patterns, would also require consent from Natural England. As part of such schemes there may be opportunities to improve resilience of the coastal road; this sits at the back of the natural flood plain, so any works should not have a significant impact on the functioning of the natural flood plain. Again, consents would be required from Natural England.

For those properties that remain at flood risk, flood adaptation measures should be considered to reduce the impact of flooding and ensure safe exit during extreme events.

#### 2.5.4 11e7.5 - Strategic way forward

Managed realignment through natural defence management - consider opportunities to allow natural expansion of the saltmarsh alongside increasing the flood resilience of the road in future.

Future activities include:

- Monitoring of changes in the extent of marsh and intertidal areas, as part of the Northwest Regional Monitoring Programme, to identify any changes in observed trends and any possible increase in risk level. Currently there is limited data available for this frontage. A recommendation would be for remote sensing to be undertaken where the marsh is narrowest, to appraise change in risk levels.
- Detailed discussion between landowners, Cumbria County Council (including highways), Allerdale Borough Council, Solway Coast AONB, and Natural England to consider potential for land management changes along the coastal fringe, with the view to creating more wetland areas while also seeking to manage risks to homes and infrastructure.

Further details on actions and responsibilities are provided in the **Action Plan**.

## 2.6 11e7.6 Anthorn

### 2.6.1 11e7.6 - Existing approach to flood and coastal erosion risk management

The existing SMP2 policy along policy unit 11e7.6 is Hold the line from the short term. The primary justifications for this policy at SMP2 level were to maintain the integrity of Anthorn as a coastal settlement. The potential impacts on international conservation designations and Hadrian's Wall WHS buffer zone (and on its Outstanding Universal Value) were recognised.

There are no defences along this stretch and properties and the road lies close to the shoreline, fronted by a narrow strip of fringing marsh (see Figure 5 and Figure 6).



Figure 4 Anthorn (West) showing the proximity of the road and properties to the shoreline.



Figure 5 Anthorn (East). 2012 aerial image courtesy of the North West Regional Monitoring Programme.

## 2.6.2 11e7.6 - Strategy considerations

Anthorn itself consists of two parts: the old village dating back to the 13<sup>th</sup> century, to the west of Anthorn Bridge, and the newer village to the east, which was built to home naval personnel from the nearby naval air station in the 1950s. Most of the new village lies above the Environment Agency Flood Risk Zone, but there is risk to some properties within the old village.

The U2002 runs between these two parts and is the only link road around the Cardurnock Peninsula. The section of road at Anthorn lies within the Environment Agency Flood Risk Zone and has flooded in the past, during high tide events. A United Utilities (UU) pressured mains pipe runs beneath the road, from Angerton to Bowness, around the periphery of the Cardurnock Peninsula. The proposed route of the England Coast Path also follows the coastal road along this length.

The area has a significant environmental value, recognised in its international and national conservation designations (SPA, Ramsar, SAC, SSSI). Anthorn Marsh is currently in favourable condition, although concerns were raised at the time of assessment (2013) regarding coastal access

and the risk of stock being pushed around on this narrow marsh which would have a detrimental effect on grazing levels on various parts of the marsh.

This coastline has high historical value (Outstanding Universal Value), recognised by its designation as part of the Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site buffer zone. There are also listed properties within the old part of Anthorn. As well as being a potential risk from flooding and erosion, their location means that there would be a high risk of damage should the road need to be relocated. The frontage also falls within the Solway Coast AONB.

### 2.6.3 11e7.6 - Discussion

The SMP policy is for Hold the line along this frontage from the short term. Currently, there are no defences along the section and the SMP proposed that in the short term channel movement and any resultant bank erosion should be monitored. If a need for defences were then determined, a revetment should be constructed in front of properties. However, as this is a relatively low energy environment it is considered that rather than introducing a new rock revetment it may be possible to use or trial the use of more environmentally friendly green solutions to estuary edge protection techniques first.

Although there has been reported erosion of the marsh in the past, due to movement of the channel, recent data (although limited) suggests the marsh is currently stable. Therefore, at the present time, the level of risk does not appear to have increased since the SMP.

Should risks increase in the future, there may be justification for a new defence to be constructed. Given the proximity of the road and properties to the shoreline, there is little opportunity for setback, but it is likely that construction along the back of the narrow marsh (but seaward of the road) would be recommended to limit impacts on the natural flood plain. As well as erosion control defences could also involve construction of a low flood wall or earth embankment to manage flood risk to the road. Walls generally require less maintenance but are potentially more unsightly in such a rural setting compared to an embankment, and can be more expensive. Embankments require a large footprint, which may be a limiting factor in places along this frontage, and require more regular inspection and maintenance.

The direct and indirect habitat impacts of new defences would require assessment through a HRA under the Habitats and Species Conservation Regulations (2017) and may require a CRoW assessment (with regard to the SSSI). The impacts of this option on the WFD objectives of the relevant water bodies would also require assessment (to include consideration of hydromorphological constraints), particularly as this would directly affect natural functioning of the estuary. Potential impacts on the recommended Solway Firth Marine Conservation Zone would also have to be considered.

The decision regarding a wall or embankment may be informed by the objectives of the AONB. Construction would require careful consideration of the heritage landscape and the potential for buried archaeology to be discovered.

### 2.6.4 11e7.6 - Strategic way forward

Hold the line through natural defence management - there are no formal defences present but the SMP policy allowed for the potential need to introduce defences if the narrow marsh protecting the road and adjacent properties were eroded. If the erosion risk changes, enhancement of the marsh through "Green" low cost shoreline stabilisation techniques should be considered first.

Future activities include:

- Continued monitoring of changes in the extent of marsh and intertidal areas, as part of the Northwest Regional Monitoring Programme, to identify any changes in observed trends and any increases in risk level. Currently there is limited data available for this frontage. A recommendation would be for remote sensing to be undertaken where the marsh is narrowest, to appraise change in risk levels.

- Should monitoring determine an increase in risk levels, options would need to be developed involving detailed discussion between landowners, Cumbria County Council (including highways), Allerdale Borough Council, Solway Coast AONB, Natural England and Historic England to appraise the best approach including consideration of Green Solutions to estuary edge stabilisation.

Further details on actions and responsibilities are provided in the **Action Plan**.

## 2.7 11e7.7 Anthorn to Cardurnock

### 2.7.1 11e7.7 - Existing approach to flood and coastal erosion risk management

The existing SMP2 policy along policy unit 11e7.7 is for Managed realignment from the short term. The primary justifications for this policy at SMP2 level were that there are limited assets at risk and also opportunities for future habitat creation to be included within the Environment Agency's Regional Habitat Creation Programme. It was, however, recognised that the policy may need to change in future if Solway Mosses SAC is threatened by coastal flooding.

There are no formal flood defences present along this coast, but earth embankments are present and for much of this stretch the road is on slightly raised ground.

### 2.7.2 11e7.7 - Strategy considerations

The unit mainly includes the Anthorn Radio Station, which occupies the site of a former Royal Naval air station (also known as RAF Anthorn, RNAS Anthorn and HMS Nuthatch). In 1961 the site was chosen to become a NATO VLF (Very Low Frequency) transmitting site for communicating with submarines. The site also includes a LF transmitter and since 2007 Britain's national time signal transmissions have been transmitted from here. The site is currently operated by Babcock International.

Between Anthorn and Cardurnock, the road moves slightly inland and is located on raised land, with a grassed bank in front and fringing marsh beyond that. There is currently low risk to this section of road. There is another slight dip in the road mid way between Anthorn and Cardurnock where the road may become flooded on occasion.

The area has significant environmental value, recognised in its international and national conservation designations (SPA, Ramsar, SAC, SSSI). Cardurnock Marsh is currently in favourable condition, although concerns were raised at the time of assessment (2014) regarding coastal access and the risk of stock being pushed around on this narrow marsh which would have a detrimental effect on grazing levels on various parts of the marsh. Inshore of the Anthorn Radio Station lies South Solway Mosses, which are designated a SAC and SSSI (Bowness Common SSSI).

The hinterland has a high heritage value: designated as part of Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site buffer zone (considered of Outstanding Universal Value) and includes the scheduled monuments of Cardurnock Milefortlet and Cardurnock Tower, which formed part of the Roman frontier defences along the Cumbrian Coast. There is also high potential for buried archaeology, including remains of other milefortlets and intervening stone watchtowers. Their location means that there would be a high risk of damage should the road need to be relocated. The frontage also falls within the Solway Coast AONB.

Recent data indicates that Cardurnock Marsh is relatively stable owing to energy dissipation across the wide foreshore and sand flats. Minor change occurs where small channels have migrated across the marsh (CH2M, 2017). Flood risk is mostly constrained by the coastal road (U2002) and there is no significant risk to the NATO site at present.



Figure 6 Cardurnock Peninsular, showing the Anthorn Radio Station and the proximity of the coastal road to the shoreline (Aerial photograph from 2015, courtesy of the Northwest Regional Monitoring Programme).

### 2.7.3 11e7.7 - Discussion

Currently there is a low risk to this frontage from either flooding or erosion, with only short sections of the coastal road (U2002) at flood risk within this policy unit. Given the proximity of the road and strategically important Anthorn Radio Station, to the coast, there is limited opportunity for any habitat creation or for realignment of the road along the frontage between Anthorn and where the coastal road turn inland to Cardurnock.

Further west there may be more potential opportunities to enable expansion of current saltmarsh, through a change in land management, and thereby potentially offset future issues of coastal squeeze, through agri-environment schemes.

Since the SMP2 was adopted there have been no changes in environmental designations although this part of the Firth may become designated as a marine conservation zone in 2019, which would lend more protection to the seabed species and habitats found at the site. Though this site is unlikely to be impacted by the SMP policy.

Although there is no justification for a change in SMP2 policy at this time; risks to the coastal road should be monitored.

### 2.7.4 11e7.7 - Strategic way forward

Managed realignment - there are no formal flood defences present along this coast, but earth embankments are present and for much of this stretch the road is on slightly raised ground. - consider opportunities to allow natural expansion of the saltmarsh alongside increasing the flood resilience of the road in future.

Future activities include:

- Continued monitoring of changes in the extent of marsh and intertidal areas, as part of the Northwest Regional Monitoring Programme, to identify any changes in observed trends and any possible increase in risk level. Currently there is limited data available for this frontage. A recommendation would be for remote sensing to be undertaken where the marsh is narrowest, to appraise change in risk levels.
- Detailed discussion between landowners, Cumbria County Council (including highways), Allerdale Borough Council, Solway Coast AONB, and Natural England to consider potential for land management changes along the coastal fringe, with the view to creating more

wetland areas while also seeking to manage risks to homes and infrastructure. Risk to the U2002 will need to be considered as part of this.

Further details on actions and responsibilities are provided in the **Action Plan**.

### 3 Summary of proposed strategy: 11e7

**Preferred strategic approach:** Environmental enhancement – allow the area to continue to function as naturally as possible and look for environmental opportunities for enhancements, whilst maintaining or improving resilience to core communities and infrastructure through localised "Green" low cost shoreline stabilisation if necessary.

		Next 10 years	Beyond 10 years
11e 7.1	Skinburness (east)	Continue to manage flooding risk from Moricambe Bay to Skinburness through maintaining flood embankments within existing footprints.	
11e 7.2	Skinburness to Wath Farm	Hold the line in short term by maintaining and refurbishing defences within current footprints. Monitor changes to extents of marsh and intertidal areas to allow future assessment of the impacts of the existing defence on natural behaviour of the marsh and consider options for future realignment.	Continue to manage flood risk from Moricambe Bay to Silloth and Skinburness through maintaining existing or set-back flood embankments.
11e 7.3	Wath Farm to Saltcoates	Allow area to function as naturally as possible and look for environmental opportunities to enhance designated sites.	
11e 7.4	Newton Marsh	Allow area to function as naturally as possible and look for environmental opportunities to enhance designated sites.	Managed realignment through natural defence management - consider opportunities to allow natural expansion of the saltmarsh alongside increasing the flood resilience of the B5307 road in future.
11e 7.5	Newton Marsh to Anthorn including Wampool to NTL	Allow area to function as naturally as possible and look for environmental opportunities to enhance designated sites.	Managed realignment through natural defence management - consider opportunities to allow natural expansion of the saltmarsh alongside increasing the flood resilience of the B5307 road in future.
11e 7.6	Anthorn	Monitor changes to flood and erosion risk to coastal road, UU assets and properties in Anthorn. The SMP policy allows for the potential need to introduce defences if the narrow marsh protecting the road and adjacent properties erodes. Consider enhancement of the marsh through "Green" low cost shoreline stabilisation techniques.	Continue to monitor changes to flood and erosion risk to coastal road, UU assets and properties in Anthorn. If erosion risk increases, low cost environmentally friendly channel erosion protection measures should be considered before resorting to a revetment and low flood wall or earth embankment.
11e 7.7	Anthorn to Cardurnock	Managed realignment - consider opportunities to allow natural expansion of the saltmarsh alongside increasing the flood resilience of the road in future.	Continue to monitor flood and erosion risk to coastal road and UU assets. Consider opportunities to allow natural expansion of the saltmarsh alongside increasing the flood resilience of the road in future.

### Key actions and activities (next 10 years):



- Monitor condition of defences
- Monitor marsh, intertidal change and channel movement
- Monitoring of highway condition and safe operation



- Patch and repair degradation/damage of defence assets if required



- Studies to consider long term viability of the B5307 and alternative options



- Liaison between stakeholders to develop options in case erosion risk to Anthorn increases, including consideration of Green Solutions to estuary edge stabilisation.



- Detailed discussion between stakeholders to consider potential for land management changes along the coastal fringe, with the view to creating more wetland areas while also seeking to manage risks to homes and infrastructure.

Further details on actions and responsibilities are provided in the **Action Plan**.

## 4 References

Coastal Engineering UK Ltd (CEUK) (2015). Allerdale and Carlisle Annual Local Monitoring Report 2014.

CH2M (2017). Allerdale and Carlisle Analytical Report, 2016. Prepared for Allerdale Borough Council and Carlisle City Council, as part of the North West Regional Monitoring Programme. December 2017.

Halcrow (2011). North West England and North Wales Shoreline Management Plan SMP2. North West & North Wales Coastal Group. Main report and appendices.