11e5 Dubmill Point to Silloth

(Technical report by Jacobs)

Policy area: 11e5 Dubmill Point to Silloth

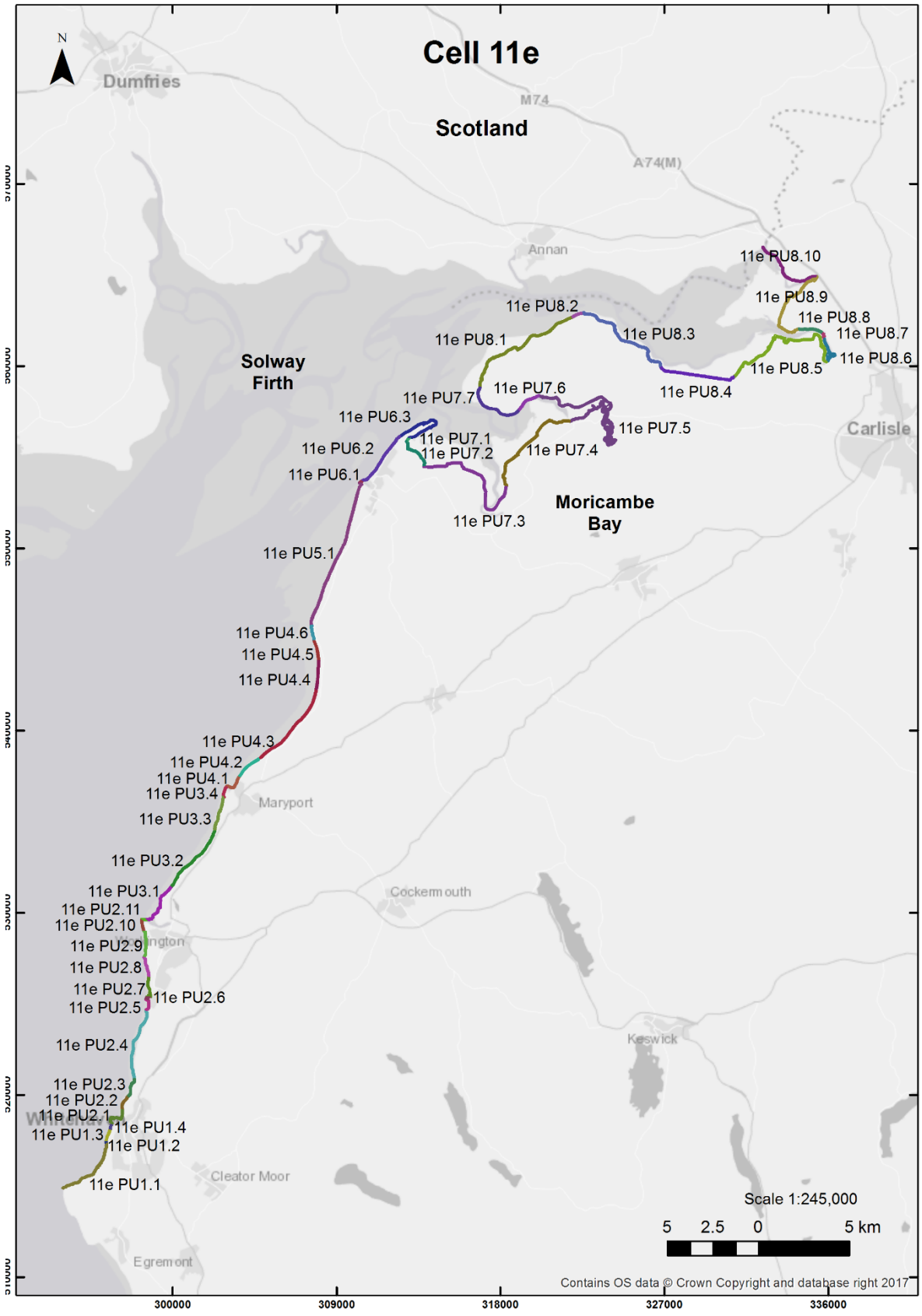

Figure 1 Sub Cell 11e St Bees Head to Scottish Border Location Plan of policy units. Baseline mapping © Ordnance Survey: licence number 100026791.

1 Introduction

1.1 Location and site description

Policy units:	**11e5.1 Dubmill Point to Silloth (priority unit)**
Responsibilities:	Allerdale Borough Council Cumbria County Council United Utilities
Location:	This unit lies between the defended headland of Dubmill Point and Silloth Harbour to the north.
Site overview:	The shoreline is mainly low lying, characterised by a wide mud, sand and shingle foreshore, fronting low lying till cliffs and two belts of dunes; at Mawbray and at Silloth. The lower wide sandy foreshore is interspersed by numerous scars, including Dubmill Scar, Catherinehole Scar, Lowhagstock Scar, Lee Scar, Beck Scar and Stinking Crag. These scars are locally important for wave dissipation and influence shoreline retreat. The behaviour of this shoreline is strongly influenced by the Solway Firth, as the frontage lies at the estuary's lower reaches. Over the long term, the foreshore has eroded across the entire frontage due to the shoreward movement of the Solway Firth eastern channel (Swatchway), which has caused narrowing of the intertidal sand area and increased shoreline exposure to tidal energy. The Swatchway currently lies closer to the shoreline towards the north of the frontage. There is a northward drift of sediment, but the southern arm of Silloth Harbour intercepts this movement, which helps stabilise the beach along this section. Most of the coastline is undefended, apart from defences at Dubmill Point and some local cliff protection defences constructed in 2013 to protect the public highway between Mowbray and Beckfoot. The hinterland is largely undeveloped, with Beckfoot the only settlement along the coastal edge and Mawbray located a little further inland. The B5300 runs adjacent to the coast but lies closest to the shoreline along the Beckfoot frontage and at Dubmill Point, where it is at risk from erosion. The area is known for its natural beauty, as recognised by being part of the Solway Coastal AONB, easily accessed through multiple Public Rights of Way including the proposed route of the English Coast Path (not yet adopted). The area is included with the international designated sites of the Upper Solway Flats and Marshes SPA and Ramsar, and Solway Firth SAC. Silloth Dunes and Mawbray Bank are designated as a SSSI, which extends for the whole length of the frontage, whilst the adjacent foreshore is designated as Upper Solway Flats and Marshes SSSI. The area has an important history and falls within the Frontiers of the Roman Empire Buffer Zone and Hadrian's Wall World Heritage Site, recognising important sites of Roman origin along this coastline, including a number of towers which are strung out along the coastline and which formed part of the Roman frontier defences along the Cumbrian coast and Beckfoot Roman Fort; these are designated as Scheduled Monuments.

For comment

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).

Table 1 Current SMP policy for policy area 11e5

Overview: *Along this section of coast the long term vision is to maintain a naturally functioning system & conserve the environmental status of this area. There is insufficient economic justification for any significant interventions with coastal defences along this section. This plan allows for adaptation where there are assets at risk and will result in a naturally functioning, and sustainable coast line, maintaining the current natural habitats into the long term, but will result in the loss of a strip of agricultural land and increasing risks to the B5300 coast road at Beckfoot. The implementation of the policy will need to manage residual risks to isolated properties and assets.*

Location		Policy and Approach (from 2010)		
		0-20 years	20-50 years	50-100 years
11e5.1	Dubmill to Silloth	**Managed realignment** – Allow continued natural coastal evolution with localised limited intervention to manage risk to assets whilst adaptation is considered. Risk should be monitored and the case for local set back flood defences, individual property defences or resilience to be considered in medium term.	**Managed realignment** – Allow continued natural coastal evolution, with continuing adaptation measures.	**Managed realignment** – Allow continued natural coastal evolution, with continuing adaptation measures.

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2 Appraisal of priority units

There is only one unit covered by this policy area:

- 11e5.1 Dubmill to Silloth

2.1 Existing approach to flood and coastal erosion risk management

2.1.1 Justification of current SMP policy

Section 1.2 sets out the SMP policies for this priority unit. The primary justifications for the policies at the SMP level were:

- Social: Only limited assets at risk, at Beckfoot. Case for local flood defences or individual property defences or resilience to be considered in medium term.
- Environmental: Will contribute to maintaining conditions of internationally and nationally designated sites but allows limited intervention at Beckfoot Cemetery to allow recording or adaptation.
- Economic: No justification for intervention but allows for private funding of defences if required.

2.1.2 Current defences

There are only two stretches of defences along this unit:

- A short stretch of armour stone wall at Dubmill Point, which is replaced by a gabion mattress and basket wall moving northwards (the northern end of defences that commence in the adjacent unit 11e4.6)
- A rock retaining wall and apron south of Beckfoot (constructed in 2013, since the SMP).

The rest of the shoreline is currently undefended, with the dunes providing protection to the hinterland. Figure 1 shows the policy unit boundaries, together with a summary of defence lengths between Dubmill Point and Silloth.

Table 2 provides a summary of the condition and estimate residual life for the defence structures, whilst the following text provides further detail regarding current condition and recent management, based upon information taken from the most recent asset inspection report (CH2M, 2017a) and previous inspection reports by Coastal Engineering UK and Capita Symonds (reported in CH2M, 2017a).

Table 2 Existing defence condition and estimated residual life

Unit	Location	EA Asset Ref	Defence Type	Condition	Residual Life (years)
11e5.1	Dubmill Point	011KE90460301C03	Rock armour and gabion wall	Very Poor or Failed	0-5
11e5.1	South of Beckfoot (Castle Corner)		Rock armour highway wall	Good	10-20

For comment

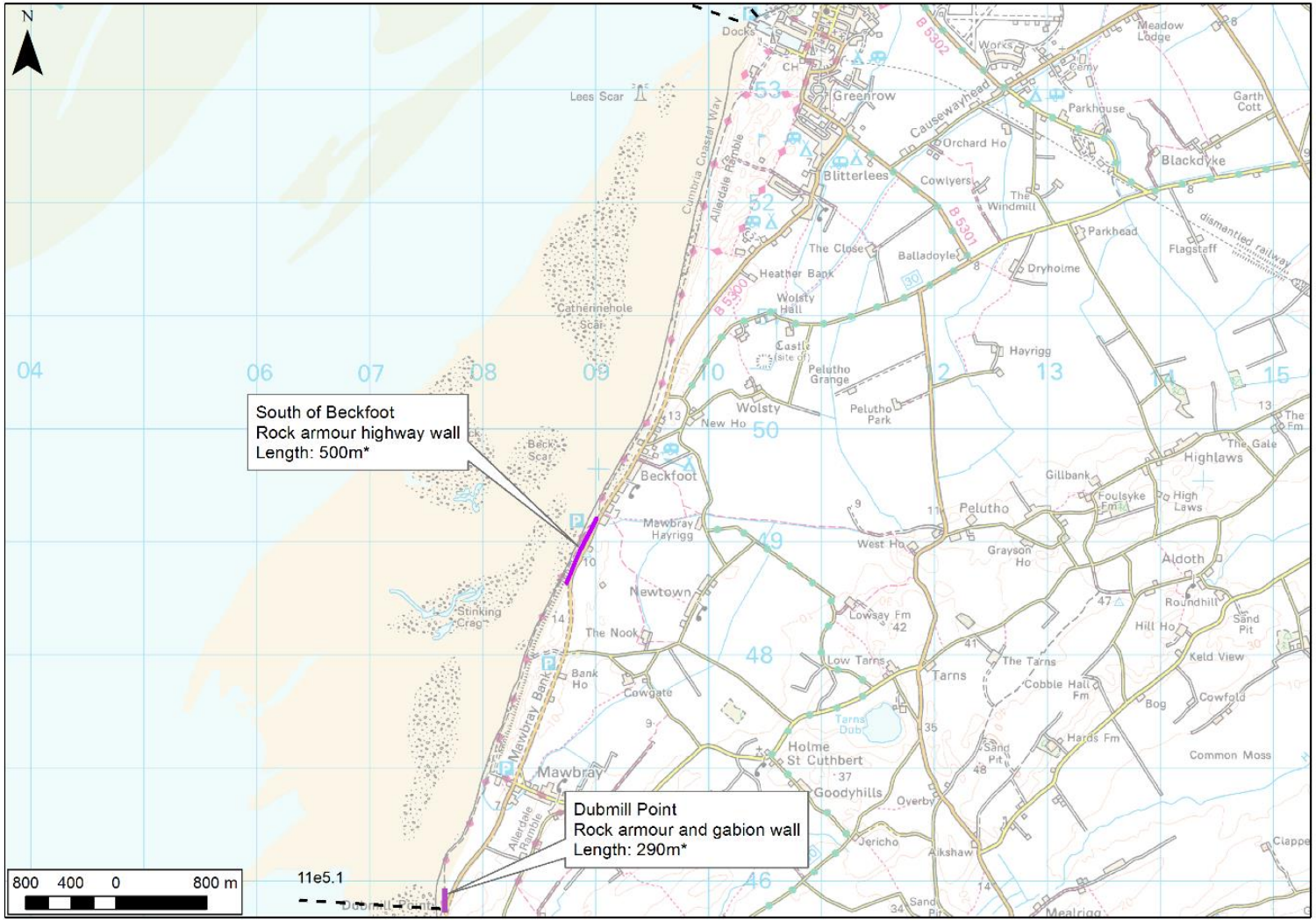


Figure 2 Policy unit boundaries and summary of defence lengths between Dubmill Point and Silloth. Baseline mapping © Ordnance Survey: licence number 100026791.

Dubmill Point: rock armour and gabion wall (290 m) – Cumbria County Council

The defences comprise an armour stone wall built to a similar profile as the concrete stepped wall to the south with the stones having been grouted and overlain with concrete. To the north this is replaced by a gabion mattress and basket wall which merges into the natural dune frontage (Coastal Engineering UK, 2013). These were constructed to protect the public highway, but at the time of the first inspection (Capita Symonds, 2010) the bottom row of gabions was already noted to be in very poor condition. By 2014, the gabions to the north were recorded as "damaged beyond repair", with "significant erosion of the dunes and undercutting at the northern terminal end" (Coastal Engineering, 2014). The most recent inspection (CH2M, 2017a) notes that there has been no change in either the rock armour, which remains intact, or the gabions, which are now largely ineffective in preventing overtopping and erosion of the low cliffs behind. Further routine inspection by Cumbria County Council in April 2018 (Figure 5, Figure 6) identified that there has been recent movement of this structure.

Figure 3 Dubmill Point: armour stone wall. Photograph taken during CH2M (2017a) asset inspection.

Figure 4 Gabion baskets at Dubmill Point – there is evidence of erosion along the backshore, suggesting the effectiveness of this defences has diminished over time.

Figure 5 Dubmill Point: armour stone wall front elevation. Photograph taken during CCC Inspection (Apr 2018).

Figure 6 Dubmill Point: armour stone wall crest – movement of wall. Photograph taken during CCC Inspection (Apr 2018)

South of Beckfoot: Rock armour wall (500 m) – Cumbria County Council

Figure 7 Rock amour wall south of Beckfoot. Terminal erosion is evident. Photograph taken during CH2M (2017a) asset inspection.

The rock retaining wall and apron were constructed in 2013 to protect the public highway (Figure 7, Figure 8). The crest of the structure decreases towards the north, where the defences are replaced by dunes.

The structure was overtopped in winter 2013 and 2014, which caused damage to the cliffs and dunes (Coastal Engineering UK, 2014). There has also been some terminal erosion (Figure 7). The latest survey (CH2M, 2017) identified that there had been erosion at the northern end of the defence, where the rock wall is lower and that the rock apron had become exposed due to lower beach levels. Along the car park area, geotextile had been removed, exposing the base of the car park.

These defences are only intended to be a temporary measure with a condition of planning consent being that they are removed within 5 years of construction (2018).

Figure 8 Oblique aerial photograph (2015) showing defences protecting a short stretch of the B5300 at Beckfoot. © Northwest Regional Monitoring Programme.

2.1.3 Shoreline change

Dubmill Point to Beckfoot (Mawbray dunes): No monitoring data is currently collected as part of the North West Regional Monitoring Programme. Here there is a wide belt of sand dunes and from oblique aerials they appear well vegetated and stable (Figure 9).

Figure 9 Mawbray dunes and beach 2015 ©Northwest Regional Monitoring Programme.

For Comment

NCERM predictions of future shoreline retreat along this frontage (under No active intervention) are as follows:

By year 20:	4 to 8 m
By year 50:	10 to 20 m
By year 100:	20 to 40 m

It is assumed that these are higher than for the rest of this unit as they take account of observed changes along the exposed frontage of Dubmill Point to the south. There is no monitoring data available for this frontage, so current rates of change are unknown. The estimates presented by NCERM should, however, take account of the episodic erosion that may be expected during storm events.

Beckfoot village:

Figure 10 Beckfoot Village and beach 2015 © North West Regional Monitoring Programme

Along Beckfoot village frontage (Figure 10), most of the observed changes in beach level relate to cross shore sediment redistribution; much of the sediment is held on the foreshore in bars, which migrate on and offshore on a seasonal basis: a similar process occurs further north and is illustrated in Figure 12. This cross shore movement of sediment can result in changes in upper and mid beach levels by up to 2 m (CH2M, 2017b). Smaller changes are observed across the lower foreshore. There has been erosion along the southern part of Beckfoot frontage of up to 14 m since 2004, with most of this erosion the result of 2013 and 2014 winter storms. Elsewhere, erosion during this period was in the region of 5 m. There has been no advancement of the dune face since and the toe of the dunes remains in a similar position to that recorded in spring 2014. The beach levels at the toe of the dunes have fluctuated over time and currently levels are higher than previously recorded (data set covers period 2012 to 2017). During the 2015 and 2016 winter storms there was erosion of the car park area, to the north of the defences and along the southern part of Beckfoot village. However, aerial images (Google Earth) suggest that the backshore position was previously at similar location in 2003, but that there was subsequent accretion and development of low dunes resulting in an advancement of the shoreline by around 12 m between 2003 and 2008. This may indicate a cyclical trend of accretion and retreat along this shoreline, but further monitoring will be required to confirm this.

Recent data suggests retreat rates here tend to be low, but storms can cause over 10 m erosion along the low lying fringing dunes.

To the north of Beckfoot Village there has been net accretion since monitoring under the North West Regional Monitoring Programme started in 2012, but over this period the position of the dunes has fluctuated, so overall the dunes can be considered fairly stable.

NCERM predictions of future shoreline retreat along this frontage (under No active intervention) are as follows:

For comment

By year 20:	0 to 1.3 m
By year 50:	1.7 to 3.3 m
By year 100:	3.4 to 6.6 m

These values are based on observed historical change which indicates little net change over long timescale. There is also some evidence that changes are cyclical along this frontage. However, there is a risk that several metres of erosion may locally occur during a single storm, as observed during 2013 to 2014 and 2015 to 2016.

Beckfoot to Silloth Harbour (Silloth dunes):

Figure 11 Silloth Dunes 2015 ©Sefton MBC: North West Regional Monitoring Programme

Between the northern limit of Beckfoot village frontage to where there is a wider expanse of dunes no monitoring data is currently collected as part of the North West Regional Monitoring Programme. Along Silloth dunes, there was retreat of the fringing dune as a result of the 2013 and 2014 storms, but much of the backshore has experienced little change since. Some erosion occurred during the 2015 and 2016, but erosion was less than 5 m. As to the south, the beach levels at the toe of the dunes are volatile and levels can fluctuate by up to a metre over the period of a year, as sediment is moved alongshore and pushed up the beach as a series of bars. This process is illustrated in Figure 12. So, although the dunes along this section of frontage are fairly stable, a few metres of retreat are possible during winter conditions, when high energy events occur that cause the majority of change. Adjacent to Silloth Harbour entrance, the beach profile data indicate that current beach and upper foreshore levels are high but the lower beach is low relative to earlier surveys, creating a steep beach profile.

There are no NCERM rates for this frontage. As for the section to the south, there has been fluctuations in the position of the dunes, with little net trend evident, making predicting future shoreline change difficult. However, observations indicate that several metres of erosion may occur during storms, which needs to be taken into account when considering future risk.

Additional analysis of shoreline change has also been undertaken as part of Capita's B5300 Coastal Defence Appraisal (Capita, 2015). This used aerial photography covering the period 2006 to 2011 (a period of 5 years) to map the position of cliff and dune lines, together with historical Ordnance Survey maps from Epoch 2 (1891 to 1912). Table 3 shows the calculated change based on these data sets, relevant to this frontage. The results indicate that most of the shoreline is experiencing little change or slight accretion. The only area identified to be at risk of erosion is South of Castle Corner, where the temporary defences are holding the shoreline artificially in advance of its natural position

For comment

Table 3 Historical erosion rates calculated as part of the 2015 Capita study (only part of Table 3-5 is shown here) (Capita, 2015). Negative values indicate erosion, positive values indicate accretion.

Table 3-5: Historic erosion rates

Location	Total Historic Change (m)	Historic Rate (m/yr)
North of Dubmill Point	+25.2 to +82.4	+0.23 to +0.75
South of Mawbray	+61.1 to +79.9	+0.56 to +0.73
Mawbray Centre	+48.4	+0.44
North of Mawbray	+30.9 to +35.5	+0.28 to +0.32
South of Castle Corner	-33.9 to -44.8	-0.31 to -0.41
North of Castle Corner	+3.9 to +19.0	+0.04 to +0.17
South of Beckfoot	+55.7 to +59.0	+0.51 to +0.54
Beckfoot Centre	+61.8	+0.56
North of Beckfoot	+33.0 to +45.4	+0.30 to +0.41

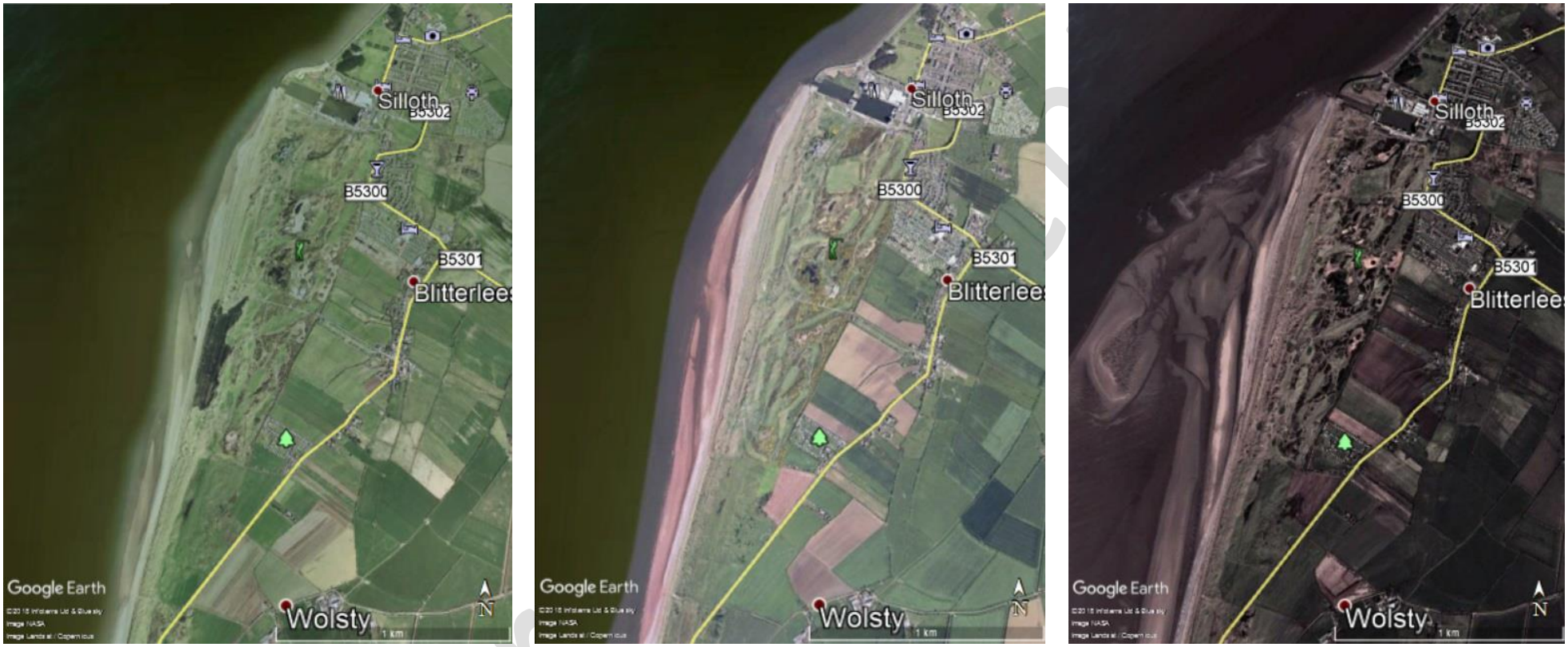
Using these data, Capita (2015) also calculated potential future shoreline change, for the same three time periods as used by the SMP and NCERM. A band of anticipated change is provided, with the upper limit provided to take account of a possible increase in erosion rate that may occur as a result of sea level rise. The results relevant to this frontage are shown in Table 3. The predictions presented here assume that current trends continue and do not take account of the observed fluctuations in shoreline position that occur. Erosion is only predicted at South of Castle Corner. Here, the predicted band lies within the NCERM predictions for this location.

Table 4 Predictions of potential erosion or accretion rates calculated as part of the 2015 Capita study (only part of Table 3-6 is shown here) (Capita, 2015). Negative values indicate erosion, positive values indicate accretion.

Table 3-6: Predicted erosion/accretion rates and total figures for SMP2 epochs

Location	Predicted rate (m/yr)	20 years (m)	50 years (m)	100 years (m)
North of Dubmill Point	+0.23 to +0.75	+4.6 to +15	+11.5 to +37.5	+23 to +75
South of Mawbray	+0.56 to +0.73	+11.2 to +14.6	+28 to +36.5	+56 to +73
Mawbray Centre	+0.44	+8.8	+22	+44
North of Mawbray	+0.28 to +0.32	+5.6 to +6.4	+14 to +16	+28 to +32
South of Castle Corner	-0.31 to -0.41	-6.2 to -8.2	-15.5 to -20.5	-31 to -41
North of Castle Corner	+0.04 to +0.17	+0.8 to +3.4	+2 to +8.5	+4 to +17
South of Beckfoot	+0.51 to +0.54	+10.2 to +10.8	+25.5 to +27	+51 to +54
Beckfoot Centre	+0.56	+11.2	+28	+56
North of Beckfoot	+0.30 to +0.41	+6 to +8.2	+15 to +20.5	+30 to +41

For comment



(a) 2003 *(b) 2008* *(c) 2011*

Figure 12 Google Earth images showing how bars of sand move along the coast and subsequently become welded to the foreshore, resulting in volatile beaches fluctuating in level by over a metre.

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2.2 Outline of the problem

2.2.1 Background

The key risk along this frontage is from coastal erosion. Much of the shoreline is undefended and although some erosion was caused by the winter storms of 2013 and 2014, average year on year rates of erosion tend to be low, such that the coastline can be considered to be stable. Due to the wide dune systems of Mawbray and Silloth, limited assets are at risk. However, there are 'pinch points', where the coastal road (B5300) lies close to the current shoreline and also some properties within Beckfoot may become at risk should erosion rates increase. New defences have also been constructed since the SMP2, although these were only granted planning consent for a fixed five year term and are due for removal in 2018, so can be deemed to be in accordance with the SMP2 policy of Managed realignment.

2.2.2 Issues, constraints and opportunities

The B5300 runs adjacent to the coast between Dubmill Point and Beckfoot. Along much of this frontage it is protected by a wide dune system, but there are pinch points at Dubmill Point (although the road begins to move away from the shoreline on the north side of the defences) and just south of the Beckfoot village frontage (Castle Corner). Here temporary defences were built in 2013 to protect the road from erosion, but these were overtopped in places during the winter 2013 and 2014 storms, which caused erosion to the cliffs and dunes behind. There has also been some terminal erosion at the ends of the structure. Beach levels along this stretch are volatile, due to the movement of sediment up the coast as a series of bars, which lie oblique to the coast. Failure of the backshore results from erosion at the toe and subsequent cliff collapse.

A study has already been undertaken by Capita (2015) to consider longer term options for maintaining road access along this frontage and has considered various options, including maintaining or replacing existing defences and realignment of the road landwards. A feasibility study is also underway, looking at potential relocation options. There would also be impacts on United Utility (UU) infrastructure located along the shoreline, should the shoreline be allowed to retreat.

Silloth Dunes and Mawbray Bank dune system is a designated SSSI and one of only three sand dune systems in West Cumbria; it supports a range of habitats from vegetated shingle bank through mobile and fixed sand dune communities to dune grassland and maritime heath. The site also contains a number of important breeding localities for the nationally rare natterjack toad and great crested newt *Triturus cristatu* and rare plant species, namely the Isle of Man cabbage *Rhynchosinapis monensis* and sand leek *Allium scorodoprasum*. The fixed dunes are a qualifying feature for the SAC designation.

The beach and lower foreshore is included within the international designated sites of the Upper Solway Flats and Marshes SPA and Ramsar, and Solway Firth SAC. The flats and marshes of the Upper Solway form one of the largest continuous areas of intertidal habitat in Britain, and the whole estuarine complex is of importance for wintering wildfowl (ducks, geese and swans) and waders, and is a vital link in a chain of west coast UK estuaries used by migrating waterbirds. The site is also noted for its geomorphology which supports a range of qualifying habitats and species.

The coastline sits within an Area of Outstanding Natural Beauty (AONB) and is also designated as a World Heritage site: Frontiers of the Roman Empire (Hadrian's Wall) World Heritage Site due to its high heritage value. A number of watchtower sites lie adjacent to the coast, within the dunes, and there are potential remains of other Roman structures, that once formed part of the Roman defences which stretched along the Cumbrian coast. The site of Beckfoot Roman Foot, a Scheduled Monument, is located just to the south of Beckfoot along the remains of a Roman Road. There are also Grade II listed buildings on the seaward side of Mawbray, in Beckfoot Village and within the dunes south of Silloth Harbour.

For comment

2.2.3 Strategy considerations and general approach

Key considerations

Since the SMP was produced further monitoring data has been collated including beach profile data and asset inspections. There have also been studies undertaken to consider options for the B5300. The strategy has considered the following:

- current defence conditions and level of risk;
- future management options, taking account of findings of the ongoing feasibility studies considering the B5300.

Strategy approach

The following situations arise along this frontage, and will be addressed as follows:

- Possible change to SMP2 policy – issues have been raised regarding the current policy. The strategy will consider possible measures taking account of a possible change to policy. Future works to manage flood and erosion risk may be eligible for a proportion of FDGiA funding and the economic appraisal will consider costs and benefits, following FCERM-AG guidance. Since the SMP further studies have been undertaken to consider risks to the B5300 and possible options for managing this risk in the future. Findings from these studies will be used in consideration of options.
- SMP appropriate - the SMP2 policy does not need review so the aim of the strategy is to develop measures to implement the policy. Future works to manage flood and erosion risk may be eligible for a proportion of FDGiA funding and the economic appraisal will consider costs and benefits, following FCERM-AG guidance.

The southern end of this frontage comprises defences that essentially form terminal works to the more substantial defences across Dubmill Point, which are located in the adjacent policy unit (11e4.6). Whilst there is compatibility in the medium and longer term policy for both these units (Managed realignment), the short term policies are different. It is important therefore to ensure that the preferred option at this location in this unit is not incompatible with the preferred option in the adjacent unit.

2.3 Options development and appraisal

The main Options Development report defined the long list options, each of these has been screened at a high level against technical, economic and environmental criteria to develop a list for final detailed appraisal.

For the single priority unit of 11e5.1, the following long listed options have been considered:

- Do nothing
- Do minimum
- Hold the line: maintain through proactive maintenance
- Hold the line: maintain through reinforcing existing defences
- Hold the line: improve existing defences
- Hold the line: improve through constructing new shore control structures
- Hold the line: improve through constructing new revetments or seawalls
- Hold the line: improve through beach recharge
- Hold the line: improve through cliff or slope stabilisation measures
- Managed realignment: construct erosion slowing defences

For comment

- Managed realignment: construct defences once set back

As part of these options, it is also recognised that there is potential for adaptive management of assets.

The second stage has been to appraise the short listed options. Section 2.4 outline the identification of long listed options and the assessment of shortlisted options and approaches (measures) that could be adopted to achieve the SMP policy.

Additional information on environmental impacts is provided in a **Strategic Environmental Assessment: Environmental Report** which systematically appraises the potential environmental consequences of the proposed strategy and recommend any actions needed to mitigate and monitor identified adverse effects.

The economic feasibility of implementing a particular option has been appraised through considering the packages of measures required for its implementation have been costed and the benefits of the strategic options were identified and evaluated. The No active intervention option provides the baseline for the economic appraisal. This is reported in the **Economic assessment** report.

2.4 11e5.1 Dubmill Point to Silloth

2.4.1 11e5.1 - Initial screening of options

The existing SMP policy is Managed realignment from the short term, but with local limited intervention to manage risk to assets whilst adaptation is considered. The policy also allows for private funding of defences if required and they meet overarching objectives for the unit as a whole.

Table 5 below summarises the rationale for taking long options forward to the short list stage.

Table 5 Screening of long list options for 11e5.1

Long list options	Description	Short listed?	Rationale
Do nothing	No further works undertaken, defences left to deteriorate and fail.	Baseline only	Required to assess benefits of other options and in practical terms the approach applying across the majority of the unit
Do minimum	Reactive repair to defences only.	Baseline only	Minimum investment baseline, only applicable as short term measure, until longer term strategic approach is confirmed.
Hold the line: maintain through: proactive maintenance	Programme of monitoring and scheduled maintenance to defences	No	Not strictly applicable unless change in medium to long term policy. In the short term this option is not feasible given the defences current poor condition, therefore this is not considered further.
Hold the line: maintain through reinforcing existing defences	Provision of essential measures to extend residual life of current defences	Yes	Potentially appropriate measure to carry out such works that are necessary to maintain appropriate protection to highway infrastructure in the short term.
Hold the line: improve existing defences	As maintain but provision of measures to improve defence resilience, such as rock toe works, raising crest levels	No	Same as maintain (reinforce) option but due to short term nature no real requirement to improve standard over short timescale.
Hold the line: improve through constructing new shore control structures	Measures to retain beach material, such as timber or rock groynes, breakwaters.	No	Not considered generally suitable for short lengths of intermittent defences and would be cost prohibitive, potentially be considered as an alternative to shore parallel defences at Castle Corner within any subsequent detailed assessment.

For comment

Hold the line: improve through constructing new revetments or seawalls	New shore parallel defences replacing or extending existing defences	Yes	Only potentially applicable in medium to longer term if strategic defence across 11e4.6, identified as being required.
Hold the line: improve through beach recharge	Addition of new material to beaches.	No	Not considered generally suitable for short lengths of intermittent defences and would be cost prohibitive.
Hold the line: improve through cliff or slope stabilisation measure	It is likely that the most appropriate solution would be provision of a rock toe. Therefore, this option has been considered as part of "Hold the line: Improve existing defences" and has not been taken forward as a separate option.		
Managed realignment: construct erosion-slowing defences	Low tech measures such as gabion baskets to reduce erosion rates.	Yes	Not applicable in relation to works to protect vital infrastructure but could be locally considered in future to improve resilience of shoreline where isolated property and infrastructure is at risk
Managed realignment: construct defences once set back	Allow defences to fail or remove and then construct on setback alignment	No	Not applicable given closeness of highway, as would still require realignment of highway or acceptance of damages that would occur due to loss of coastal access road.

2.4.2 11e5.1 - Development and appraisal of short listed options

Do nothing (Option 1)

This is considered as a baseline against which other options can be appraised. Under this option all maintenance and management of the defences at the north end of Dubmill Point and at Castle Corner would cease and defences would be allowed to fail.	
Technical	Part of the defences on the north side of Dubmill Point (gabions) have already failed and are now playing a role in slowing rather than preventing erosion. The adjacent section of near vertical wall is showing signs of movement and is considered likely to fail in the immediate term (0 to 5 years). This would expose the northern end of the concrete defences at Dubmill Point to outflanking and closure of the road permanently on Health & Safety grounds, within the short term At Castle Corner, similar near vertical armour defences are in danger of being outflanked due to terminal erosion, which will compromise their function. Similarly, closure of the road permanently on Health & Safety grounds, would take place at this location within the short term. Elsewhere the presently undefended shoreline would react to forcing conditions, with the potential for increased exposure and risk of erosion to isolated properties in the longer term. The assessment assumes that the Hold the line policy at Silloth Harbour continues to be implemented into the long term, as this is important for the stability of the dune system south of the Harbour.
Environmental	Failure of defences would release broken concrete, tarmac and other fill material onto the beach. Shoreline setback would lead to changes in process behaviour which could potentially impact on habitats. This would reinstate natural interaction between shoreline and foreshore potentially improving sediment supply to the north. This option would not reduce flood or coastal erosion risk to this frontage. This may result in increased risk of damage to residential properties near Beckfoot and other isolated properties along the frontage in the longer term. There are also two caravan sites and the Bitterlees Golf Course within this frontage that may, in the long term also be impacted by damage from flooding or coastal erosion. The B5300 runs adjacent to the coastline and is the key link between small communities along the Cumbrian coast. This road may be at risk of reduced operation or damage and so this may impact on the isolation of these communities. There is a licensed historic landfill site located in the dunes seawards of Mawbray that could become at risk in the long term. There are around nine scheduled monuments and three listed buildings along the frontage which may be at risk of damage or loss to erosion. These are features of the Frontiers of the Roman Empire World Heritage Site, and contribute to the setting and value of this designation and this value may be impacted as a result of this option. These coastal heritage assets are features of the AONB and the national character area of the frontage and so impacts on these could affect the landscape value of the frontage as well.

For comment

	Most of the frontage is undefended, however, by doing nothing, there may be opportunity for more natural processes to be reinstated which could enhance the various coastal designations (Upper Solway Flats and Marshes SSSI and Ramsar; Solway Firth SAC and pSPA; Silloth Dunes and Mawbray Banks SSSI) and the BAP habitats of the frontage (sand dunes, lowland heath, coastal and floodplain grazing marsh). Full impacts on the pSPA, SAC and Ramsar would have to be assessed under the Habitats and Species Conservation Regulations (2017). Impacts to the SSSI must be assessed under the Countryside and Rights of Way Act (2000). This option may also alter the hydromorphological processes of the frontage, and impacts on the WFD objectives of the relevant waterbodies.
Cost	There are no direct costs associated with the Do nothing option.
Damages	Loss of public highway access requiring diversion routes in place (short term), increased risk to life due to longer response times for emergency services and increased stress, specifically for residents of Allonby (short term), loss of access from the north to Seacroft Farm and loss of archaeological or heritage (SAM) sites. The damages are estimated to be £2,850 k.

Do minimum (Option 2)

This would carry out works to maintain existing defence function in the short term only which could extend timeframe before the highway had to be closed. This is more achievable at Dubmill Point but would likely not achieve anything at Castle Corner where, without reinforcement of defences, terminal erosion would continue.	
Technical	This would maintain the protection where current defences exist in the short term by repairing any damage. However, the terminal undefended sections would continue to erode and the risk of outflanking would remain. In reality, this would probably have a similar time horizon as the Do nothing scenario but could buy time to confirm exact arrangements regarding the precise nature or implementation of the strategic proposals. On its own not sustainable over strategy timescale.
Environmental	Once the defences fail, the impacts will be as in option 1.
Cost	There are no Present Value Capital Works. The Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £160 k.
Damages	Potential for intermittent highway closure during storm events in the short term but as for Do nothing thereafter if policy continued. The damages are estimated to be £2,850 k (assumes no delay over Do nothing).

Hold the line: maintain through reinforcing existing defences) (Option 3)

This option provides for greater certainty with regard to maintenance of the integrity of the existing defences in the short term by proactively maintaining the structures and specifically reinforcing the terminal ends of the structures to prevent outflanking.	
Technical	This would maintain the protection where current defences exist in the short term by repairing any damage and by reusing or importing some additional rock to reinforce the current terminal ends. However, the terminal undefended sections would continue to erode and the risk of outflanking would remain. As with the Do minimum it only buys more time to confirm the longer term arrangements. On its own this option is not sustainable over strategy timescale. This is similar to one of the options considered for the south end of the Dubmill Point Frontage at Oldkin (11e4.5).
Environmental	Once the defences fail, the impacts will be as in option 1.
Costs	The Present Value Capital Works are estimated to be £480 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £360 k. (assumes 20 year design life)
Damages	Potential for intermittent highway closure during storm events in the short term but as for Do nothing thereafter if policy continued. The damages are estimated to be £2,850 k (assumes no delay over Do nothing).

Hold the line: improve through constructing new revetments or seawalls (Option 4)

This option assumes that the current defence arrangements would be removed and a new defence would be constructed. This currently does not accord with the SMP2 policy but is considered here ahead of the results of the study to examine the strategic impacts of the removal of all the defences across Dubmill Point would have on the frontages to either side.	
Technical	The existing defences are effectively life expired. Replacement, in the event that detailed study identifies adverse impacts on adjacent frontages, would most appropriately take the form of an extension of the rock armour revetment, incorporating a new walkway, crown wall etc. as considered within the option appraisal

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	for 11e4.6. Rock armour would be more efficient in dissipating wave energy, allowing a lower crest level than an impermeable concrete structure and would provide an improved interface with the existing beach. At Castle Corner the proposals would provide a more robust defence extended beyond its present limits. This would have the effect of creating an intermediate promontory between Dubmill Point and Silloth Harbour. This could potentially exacerbate erosion effects modifying shoreline alignment in the unit.
Environmental	This option may reduce risk of damage to assets and property from coastal erosion, including the scheduled monuments and listed buildings. However, this option may not prevent frequent overtopping which may result from rising sea levels in the future. Road closures and increased maintenance of the B5300 could be required as a result of this. As this option would require construction on the shoreline, there could be impacts on the intertidal habitats which are designated under multiple designations present and support the pSPA. Full impacts on the pSPA, SAC and Ramsar would have to be assessed under the Habitats and Species Conservation Regulations (2017). The new structure would also be a change to the landscape within the frontage and as such may impact on the visual amenity of the area. The AONB may be affected as a result, similarly as this frontage contributes to the setting of the scheduled monuments which are features of the World Heritage Site and so changes to this may impact on the overall heritage value of the frontage. Impacts of this option on the WFD objectives of the relevant waterbodies must be considered.
Costs	The Present Value Capital Works are estimated to be £4,950 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £8,330 k. (assumes 100 year design life)
Benefits	By preventing further setback of the shoreline erosion damages would be zero, although overtopping could lead to temporary road closure. The benefits are estimated to be £2,850 k.

Managed realignment: construct erosion slowing defences (Option 5)

This option is considered for future use where erosive conditions may pose a threat to isolated properties, infrastructure, environmental habitats or heritage interests in the future.	
Technical	The use of planting, fencing and other dune management techniques such as small scale rock toe protection or gabions will slow erosion of natural features whilst still maintaining a degree of natural interaction between the dunes and the foreshore.
Environmental	Any intervention would impact on natural foreshore or dune behaviour but impacts would largely be localised. This option would defend the frontage from losses to erosion in the short term, which may maintain the sand dunes (BAP habitat) present along the frontage. These impacts will be localised. There may be impacts of installing hard structures such as rock gabions on the SAC, SSSI, Ramsar and pSPA habitats and the dunes themselves. Full impacts on these designations would have to be assessed under the Habitats and Species Conservation Regulations (2017). Impacts to the SSSI must be assessed under the Countryside and Rights of Way Act (2000). These would also result in a change in landscape as the frontage is currently undefended. This may have an impact on the visual amenity of the beach and the value of the AONB designation of the area. Any planting used in dune management must be considered for its suitability within the surrounding environment. There may be hydromorphological changes to the frontage and so it is important to ensure that its implementation does not impact on the WFD objectives of the relevant waterbodies. If there are no additional works the impacts will be as option 1 in the long term.
Costs	a) Construction of rock toe: The Present Value Capital Works are estimated to be £630 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £1,030 k. Assumes works applied from year 20 for 400m length. Does not protect road in existing location. b) Construction of rock gabion: The Present Value Capital Works are estimated to be £640 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £1,150 k. Assumes works applied from year 20 for 400m length. Does not protect road in existing location.
Damages	The damages are estimated to be £2,850 k (assumes no delay over Do nothing).

The above options assume that the existing road would be maintained in its current position. If the road were to be rerouted, then there would be no justification for coastal defence expenditure across the frontage other than to protect historical assets (if sustainable and affordable). Once new highway routes are implemented, the current defences could be removed and the natural interface between the foreshore and the hinterland reinstated. The historic landfill site at Mawbray will

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remain at risk under all options above, although localised dune management or reinforcement could be undertaken here under Option 5. At locations where the existing road is at risk of loss the surfacing would have to be removed in order to avoid pollution of the shoreline (Capita, 2015). There would also be a need to relocate services under or adjacent to the road.

Economic damages associated with loss of B5300 equate to the lower of PV diversion costs over the strategy timescale and the cost of implementing a permanent diversion. In this respect if diversions are proposed in other parts of the policy unit then care has to be taken to ensure that double counting of benefits does not occur.

2.4.3 11e5.1 - Discussion

Table 6 summaries the cost and benefit calculations for the various options presented above.

As across adjacent units to the south (11e4.5 and 11e4.6), the choice of option depends on whether the proposed SMP2 policy is confirmed. If it is then there is no need to maintain present defences, although heritage features will eventually be lost and there will need to be discussions with the statutory bodies with regard to future arrangements. The erosion risk assessment assumes that the Hold the line policy at Silloth Harbour continues to be implemented into the long term, as this is important for the stability of the dune system south of the Harbour.

The options examined above consider arrangements that could Hold the line at pinch points where erosion threatens the road in either the short, medium or long term. If Hold the line was confirmed as being required in the long term then on the north side of Dubmill Point, the works would need to be compatible with the proposed arrangements in 11e4.6 with Option 3 compatible with the likely preferred option in that unit.

At Castle Corner the present defences were only intended to be a temporary measure, presumably to buy time for alternative highway alignment plans were confirmed. Although the Capita (2015) studies have considered the implications ultimately it may be economics that will determine whether realignment talks place across this section as it is likely that costs to Hold the line will be substantially less than the cost of diverting the highway that will determine whether the SMP2 policy is modified here.

The SMP2 Action Plan for this policy area identified that a study be carried out to examine the effects of defence removal at Dubmill Point, as there could be wider implications for frontages bay wide if the proposed policy is confirmed. It would be appropriate if that study also included for examination of the local effects of modifying the policy at Castle Corner as well, as holding the line here could have an effect (albeit more local) on adjacent shorelines.

As identified in the units to the south (11e4) there is currently no evidence to suggest that Mawbray, would be impacted by removal of the defences at Dubmill Point. Most of Mawbray village is set back over 250 m and is also on slightly higher ground, sited on a ridge of till that extends from Dubmill Point. Historically the frontage north of Dubmill has accreted pre-defences, but there is also little evidence of significant erosion since defences were put in at Dubmill. The scale and timing of impacts from realignment of Dubmill Point is however very uncertain. This depends on when defences would be allowed to fail, if they are removed or allowed to deteriorate in place and so have some residual impact. Monitoring would therefore be required. The extent of any subsequent erosion and any interaction with the banks and channels of outer Solway are uncertain. The more detailed study recommended in the SMP would need to include numerical modelling of waves, tidal flows, sediment transport and shoreline change, which is beyond the scope of the present Cumbria wide strategic study. It is recommended that the study recommended in the SMP2 is carried out as soon as possible as the policy is dependent upon the outcome and the most cost effective approach to defence management.

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Table 6 Policy unit 11e5.1 Summary of economics

Option		Present Value Capital Works £m	Present Value Total cost (PVc)* £m	PV Benefit (Damage Avoided) £m	Average Benefit Cost Ratio
Option 1 Do nothing		0.00	0.00	0.00	-
Option 2 Do minimum		0.00	0.16	0.00	0.00
Option 3 Hold the line: maintain through reinforcing existing defences		0.5	1	2.85	2.8
Option 4 Hold the line: improve through constructing new revetments or seawalls		5	8.3	2.85	0.3
Option 5 Managed realignment: construct erosion slowing defences	a	4.5	7	-	-
	b	4.3	7.5	-	-
**Present Value cost (PVc) inclusive of 60% optimism bias*					

For comment

3 References

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For comment