Cumbria Coastal Strategy

Technical Appraisal Report for Policy Area

11c11 Outer Leven Estuary

(Technical report by Jacobs)

Policy area: 11c11 Outer Leven Estuary

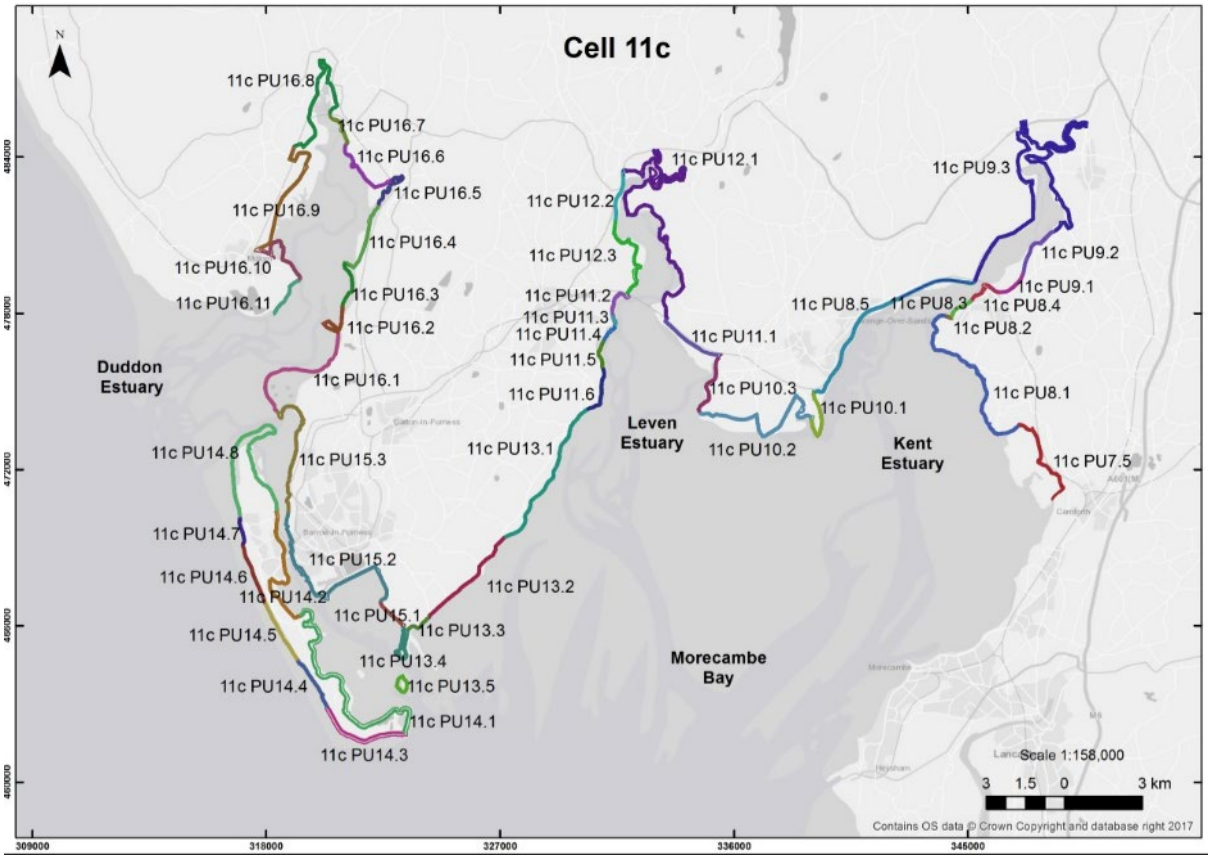

Figure 1 Sub Cell 11c Arnside to Hodbarrow Point Location Plan of policy units. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

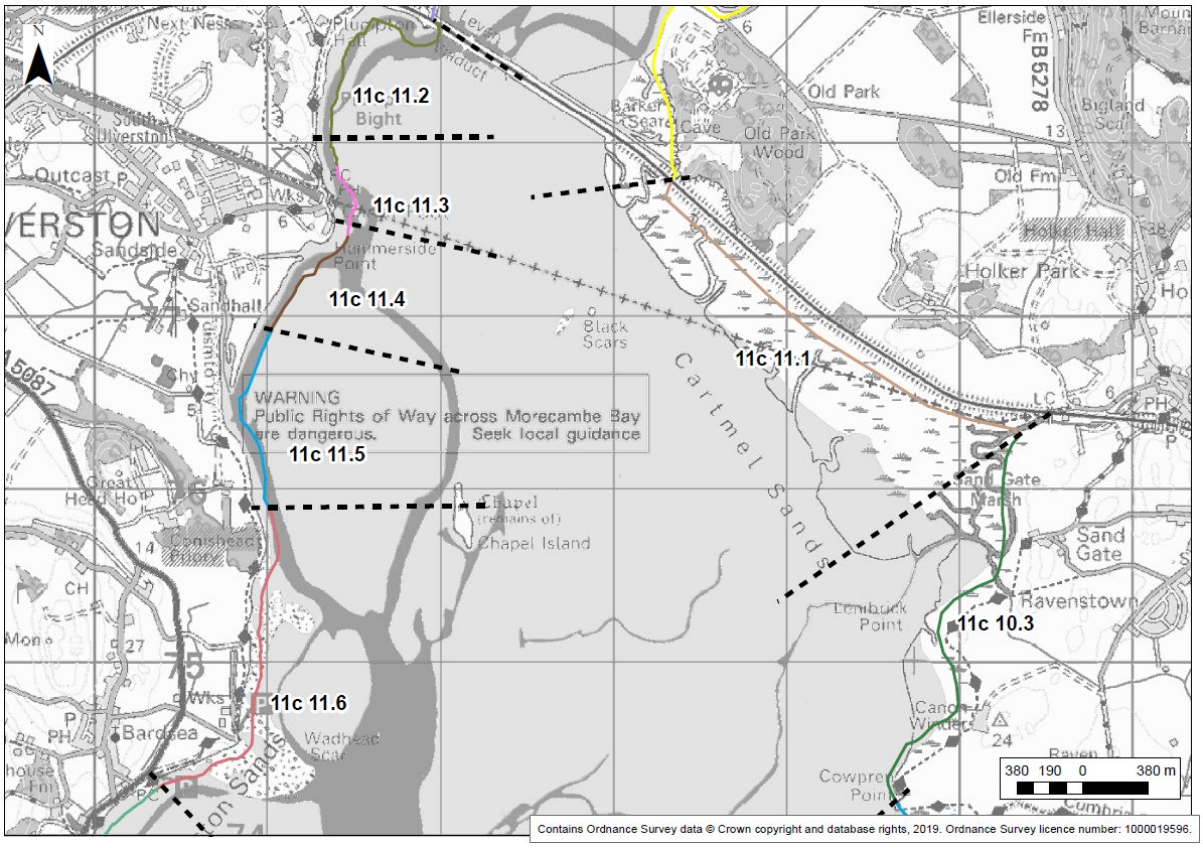

Figure 2 Location of Policy Area 11c11: Outer Leven Estuary. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

1 Introduction

1.1 Location and site description

Policy units:	11c11.1 Cark to Leven Viaduct 11c11.2 Leven Viaduct to Canal Foot cottages 11c11.3 Canal Foot **11c11.4 GlaxoSmithKline Factory Site (south) (priority unit)** 11c11.5 Sandhall to Conishead Priory 11c11.6 Conishead Priory to Bardsea
Responsibility:	Network Rail South Lakeland District Council Environment Agency Private GlaxoSmithKline
Location:	The policy area falls within Sub cell 11c (part) Arnside to Hodbarrow Point and covers both the east and west banks of the Leven Estuary, up to the viaduct. It extends from Cark Village in the east to Bardsea in the west.
Site overview:	The Outer Leven Estuary comprises of a small area of saltmarsh on the eastern bank and an easterly facing shoreline characterised by low glacial till cliffs on the western bank. The Leven Estuary is macrotidal and flood dominant and despite local changes through erosion and accretion, the estuary presently appears to be in a state of relative equilibrium in terms of the extent of mudflat and saltmarsh area. High ground fronted by saltmarsh and mudflats extends between the Leven Viaduct and Canal Foot (11c11.2), except for a 400 m long, old flood defence structure located on the northern end section between the railway embankment and the junction with the Plumpton Hall Road. This old flood defence pre-dates the construction of the railway in the 1850s. A section of defended frontage continues south in 11c11.3 protecting a small number of properties extending until the frontage meets the Sealed Lock Gate at Canal Foot. Another defended frontage around the rock outcrop at Hammerside Point protects the part of the Glaxo Site located landward. The remainder of frontage in 11c11.4 consists of high ground and reclaimed land comprising of waste material from when the site was used as a metal works. National and international nature conservation designations cover the foreshore area, namely Morecambe Bay Ramsar, SAC and SSSI and Morecambe Bay and Duddon Estuary SPA. The frontage also includes part of Bardsea County Park. Whilst there are no Scheduled Monuments within the area, there are a number of listed building potentially at risk including Plumpton Hall, a Grade II listed building. There is also potential for buried archaeology. Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale, which includes this section (see https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england). Access is expected to be ready in 2020.

1.2 Current SMP policy

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

Overview: *The long term vision here is to manage risks to the railway and agricultural land where economically justifiable, but to generally allow the shoreline to set back from the present alignment and respond to coastal change, by allowing additional saltmarsh development and habitat creation. By maintaining defence to the major assets and population whilst also allowing sections of the frontage to behave naturally and erode, most of the SMP objectives are met. However, there are locations where the potential erosion resulting from a naturally functioning shoreline could have negative impacts, such as the release of contaminants into the estuary; in these locations the impacts will need careful monitoring or investigation in order to inform future defence policy.*

Location		Policy and Approach (from 2010)		
		0-20 years	20-50 years	50-100 years
11c11.1	Cark to Leven Viaduct	**No active intervention** – Monitor flood and erosion risk to railway, only carry out works if the railway is at risk.	**No active intervention** – Monitor flood and erosion risk to railway, only carry out works if the railway is at risk. Consider regulated tidal exchange habitat scheme to offset future habitat loss losses due to railway.	**No active intervention** – Monitor flood and erosion risk to railway, only carry out works if the railway is at risk.
11c11.2	Leven Viaduct to Canal Foot cottages	**No active intervention** – Allow shoreline to continue to evolve naturally while investigating contamination risks.	**No active intervention** – Allow shoreline to continue to evolve under natural processes unless contamination risk identified.	**No active intervention** – Allow shoreline to continue to evolve under natural processes unless contamination risk identified.
11c11.3	Canal Foot	**Hold the line** – Manage flood and erosion risk by maintaining existing defences.	**Hold the line** – Manage flood and erosion risk by maintaining or improving defences.	**Hold the line** – Manage flood and erosion risk by maintaining existing defences.
11c11.4	GlaxoSmith Kline (GSK) Factory Site (south)	**No active intervention –** No defences present, allow natural processes to continue. Hold the line if eroding material presents pollution risk.	**No active intervention –** No defences present, allow natural processes to continue. Hold the line if eroding material presents pollution risk.	**No active intervention** – No defences present, allow natural processes to continue. Hold the line if eroding material presents pollution risk.
11c11.5	Sandhall to Conishead Priory	**Hold the line** – Manage flood risk by maintaining existing defences. Investigate opportunities to set back defences in the medium term.	**Managed realignment** – Depending on studies, manage flood risk by setting back defences if appropriate.	**Managed realignment** – Manage flood risk by maintaining existing or set back defences to an adequate standard.
11c11.6	Conishead Priory to Bardsea	**No active intervention** – Limited defences present, allow natural processes to continue. However private defences may be permitted subject to consent.	**No active intervention** – Allow natural processes to continue. However private defences may be managed subject to consent. Investigate long term flood risk to coast road.	**No active intervention** – Allow natural processes to continue. However private defences may be managed subject to consent.

2 Appraisal of priority units

One policy unit within this area has been defined as a priority unit:

- 11c11.4 Glaxo Factory Site (south)

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: limited assets at risk.
- Environmental: No active intervention will help to result in a more naturally functioning coastline. However other actions are required if the eroding material poses a pollution risk.
- Economic: Defences cannot be justified due to lack of risk to assets in this policy unit.

2.1.2 Current defences

Along this frontage the defences comprise a mixture of defence types (see Figure 3 and Table 1). They are commonly set back from the estuary shoreline, fronted by fringing marsh or reclaimed land, for example see Figure 4 (policy unit 11c11.4), where a slag (spoil) bank fronting the existing defences provides protection. Wave overtopping is known to occur at the lowest section of that slag bank at the south east end (ARUP, 2014).

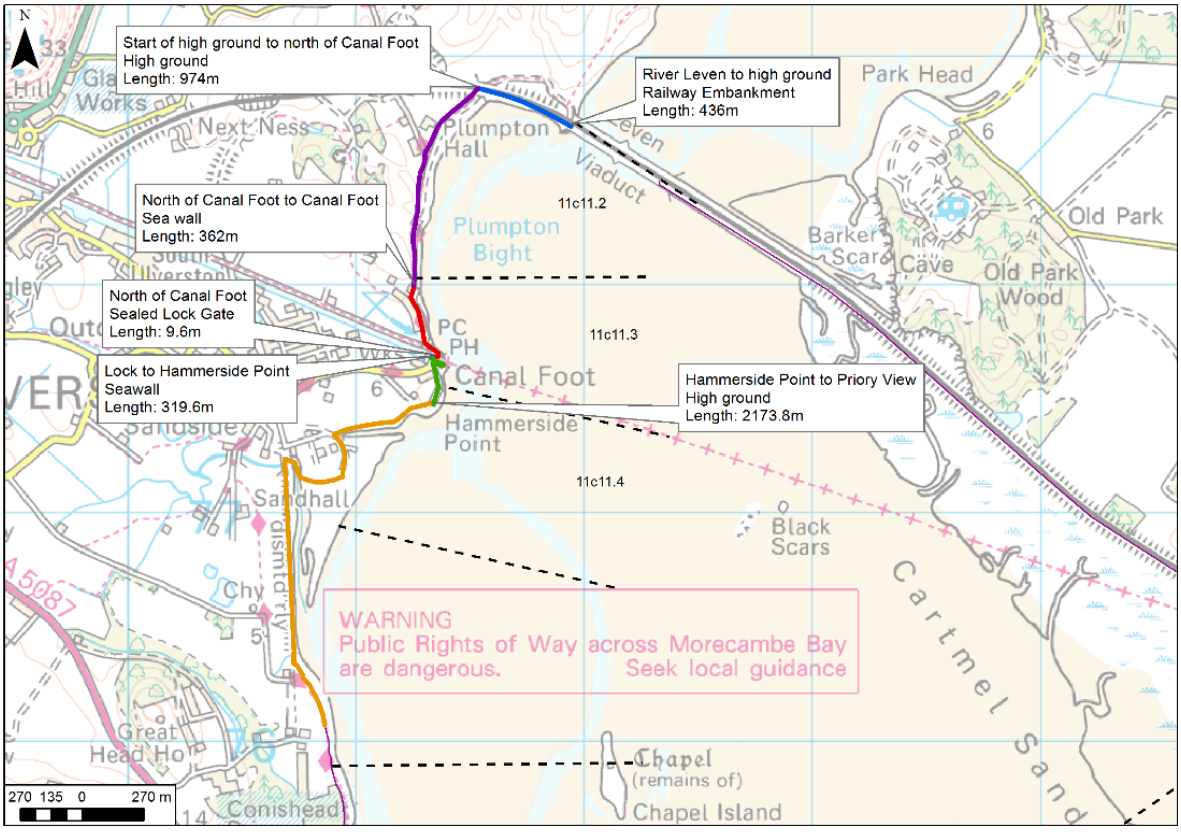

Figure 3 Policy unit location plan and defence overview. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

Figure 4 11c11.4 reclaimed land fronting the Glaxo Factory Site © North West Regional Monitoring Programme, 2015

Table 1 Existing Defence Details, taken from the latest asset inspection report (CH2M, 2018b).

Unit	Location	Structure Type	Length (m)	Crest Level (mOD)	Responsibility	Condition	Residual Life (years)
11c11.3/ 11c11.4	Lock to Hammerside Point	Sea wall	320	-	Private	Fair	10-20
11c11.4/ 11c11.5	Hammerside Point to Priory View	High ground	463	-	Private	Fair	20-50

Lock to Hammerside Point (11c11.3 and 11c11.4) - Along this frontage a sea wall is present; this is currently in good condition and is fronted by a sloped revetment in fair condition with vegetation covering most of the element (Figure 5). Gabions are located at the western end of the asset, which are in good condition (Figure 6). Vegetated saltmarsh with numerous creeks and drainage depressions are visible along the length of the asset and cliffing of saltmarsh is visible at the seaward extent (CH2M, 2017). For the purpose of this assessment it is assumed that the 11c11.3 and 11c11.4 boundary is located at the south end of the defences at Hammerside Point.

Figure 5 Policy unit 11c11.3 and 11c11.4 Lock to Hammerside Point - Seawall

Figure 6 Policy unit 11c11.3 and 11c11.4 Lock to Hammerside Point – Gabions

Hammerside Point to Priory View (11c11.4 and 11c11.5) - All the elements along this section of the frontage are in poor condition (Figure 7). High ground[1] consisting of made ground at Ainslie Pier is in poor condition and nearly vertical in places (Figure 8). The steep slope is unstable in places and cliffing visible along the length of this section.

The sloped revetment along the dismantled railway is in good condition, though the exposed face, crest and landward face of the vertical wall is in very poor condition with missing blockwork at numerous locations (Figure 9).

Figure 7 Hammerside Point to Priory View (11c11.4 and 11c11.5) - mixture of rock armour revetment and sloped revetment

[1] In accordance with the Environment Agency's "FRCM Asset Templates & Weightings Guidance": Small wall structures found along channels that offer no flood defence or questionable erosion protection are defined as Defence - High Ground.

Figure 8 Hammerside Point to Priory View (11c11.4 and 11c11.5) - Ainslie Pier

Figure 9 Hammerside Point to Priory View (11c11.4 and 11c11.5) - revetment along the dismantled railway

2.1.3 Shoreline change

The stability of the Outer Leven shoreline is largely controlled by the mobility of the low water channel of the Leven (CH2M, 2017). The main source of sediment to the estuary is provided by Morecambe Bay and is not deemed to be sediment limited (Halcrow, 2013). Channel migration within the outer estuary is generally facilitated by strong tidal currents but the flow of the Leven has been restricted by the construction of the railway viaduct and breakwater and has been redirected westwards through the viaduct (Shoreline Management Partnership, 1999). At the large scale, the estuary presently appears to be in a state of relative equilibrium in terms of the extent of mudflat and saltmarsh area (Halcrow, 2011), but locally there are trends of erosion and accretion.

Since the early 1900s there has been little change in the plan form of the outer estuary where defences exist, but both erosion and accretion of the backshore has occurred along the undefended sections (Halcrow, 2013). The most recent data (reported in CH2M, 2017) show that although steady vertical accretion of the saltmarsh occurred between 2006 and 2016, there was up to 450 m landward retreat of the saltmarsh edge between 2012 and 2016, with the greatest retreat towards the northwest of the marsh, where the main Leven channel lies close to the shoreline.

Cliff erosion has been relatively insignificant along the western frontage, due to the sheltered orientation of the shore (Halcrow, 2011). Beach profiles along 11c11.4, which comprises the industrial area of Canal Foot, have shown very little net change since monitoring began, despite large cyclical changes in response to channel movement (CH2M, 2017). The presence of Wadhead Scar, which juts out into the channel at Bardsea, is believed to shelter this shoreline from wave action (CH2M, 2017).

2.1.4 Flood risk

There are three main sources of flooding for the area protected by this frontage, fluvial, tidal and surface water. The fluvial flood risk is from the Dragley Beck and Ulverston Canal at either end of the policy unit. The tidal flood risk is from Morecambe Bay both due to extreme water levels and wave overtopping. Surface water flooding is caused by drains and sewers becoming overwhelmed by rainfall runoff from the surrounding area. It is understood that the Environment Agency is currently appraising a South Ulverston Integrated Flood Risk Management Scheme to address surface water and fluvial risk in the short term and to allow for tidal flood risk management schemes in 20 to 30 years.

There is no record of flooding from drains or surface water within the policy unit (Royal HaskoningDHV, 2014). The Environment Agency flood zone maps indicate that the hinterland falls within a tidal flood zone 2, medium risk (assessed as having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year). The western half of the frontage is also at risk from fluvial flooding (Dragley Beck) and is located within EA Flood Zone 3, high risk (a 1 in 100 or greater annual probability of river flooding (>1%).

Further fluvial risk has been addressed through the Ulverston Town Beck Flood Alleviation Scheme (http://www.townbeckfas.co.uk/). In partnership with the Environment Agency, Cumbria County Council, Network Rail, South Lakeland District Council and United Utilities, work to reduce the risk of flooding to 407 residential and 118 commercial properties from Town Beck was completed in May 2018. The works have provided over £9 million of investment related to flood alleviation infrastructure in Ulverston.

Town Beck lies within a steep catchment and the watercourse is mainly underground through the town centre. Ulverston has a history of flooding from various sources, most recently flooding in 2009 and 2012 when Town Beck burst its banks and caused flooding through the town centre. The construction included:

- Raising existing flood defence walls,
- Installation of new floodgates,
- Repairing and refurbishing the underground watercourse (culvert),
- Building a swale in the natural flood plain to ensure that there is no increase to flood risk in South Ulverston.

The works have improved the standard of defence to a 1% Annual Exceedance Probability (AEP). This is a flood event that has a 1% probability of occurring in any given year or alternatively can be explained as having an average recurrence interval of 100 years. This is a significant increase on the previous level of protection in Ulverston which ranged from imminent risk to 1 in 50 (2%) AEP.

2.1.5 GlaxoSmithKline site

GlaxoSmithKline (GSK) are the current landowner of a 25 ha site which includes their existing business operational area. This area is included in policy unit 11c11.4. Outline planning permission (SLDC ref. SL/2014/0615) was granted in December 2014 to GSK for a proposed biopharmaceutical development on the proposed “South Site” and a new sports and social centre on the “West Site”. This planning consent has not been implemented and has now lapsed. The proposed West and South Sites are shown in Figure 10. The West Site is bounded by North Lonsdale Road and the Ulverston Canal and the South Site is bounded by Pulman Road, South Road and Morecambe Bay.

GSK publicly announced in July 2017 that they will be “downsizing” their operations at the Ulverston site; the proposed biopharmaceutical development will not be developed out by GSK. It is understood that GSK are currently in discussion with partners, including South Lakeland District Council, about future prospects for the parts of their site, that going forward, are surplus to their operational needs.

The GlaxoSmithKline (GSK) South Site, as shown in Figure 10, ground comprises thick deposits of artificial ground which consists of mainly ironworks slag that was tipped from 1870s until the 1960s. It is clear from satellite imagery that erosion of this material (slag) is already taking place.

The site investigations undertaken by GSK as part of their proposed site development (lapsed planning consent) confirmed no significant soil contaminations, although a trace of asbestos was encountered in one location and it is possible that further asbestos exists. Pockets of water within the made ground were identified as containing heavy metal contamination (Royal HaskoningDHV, 2014).

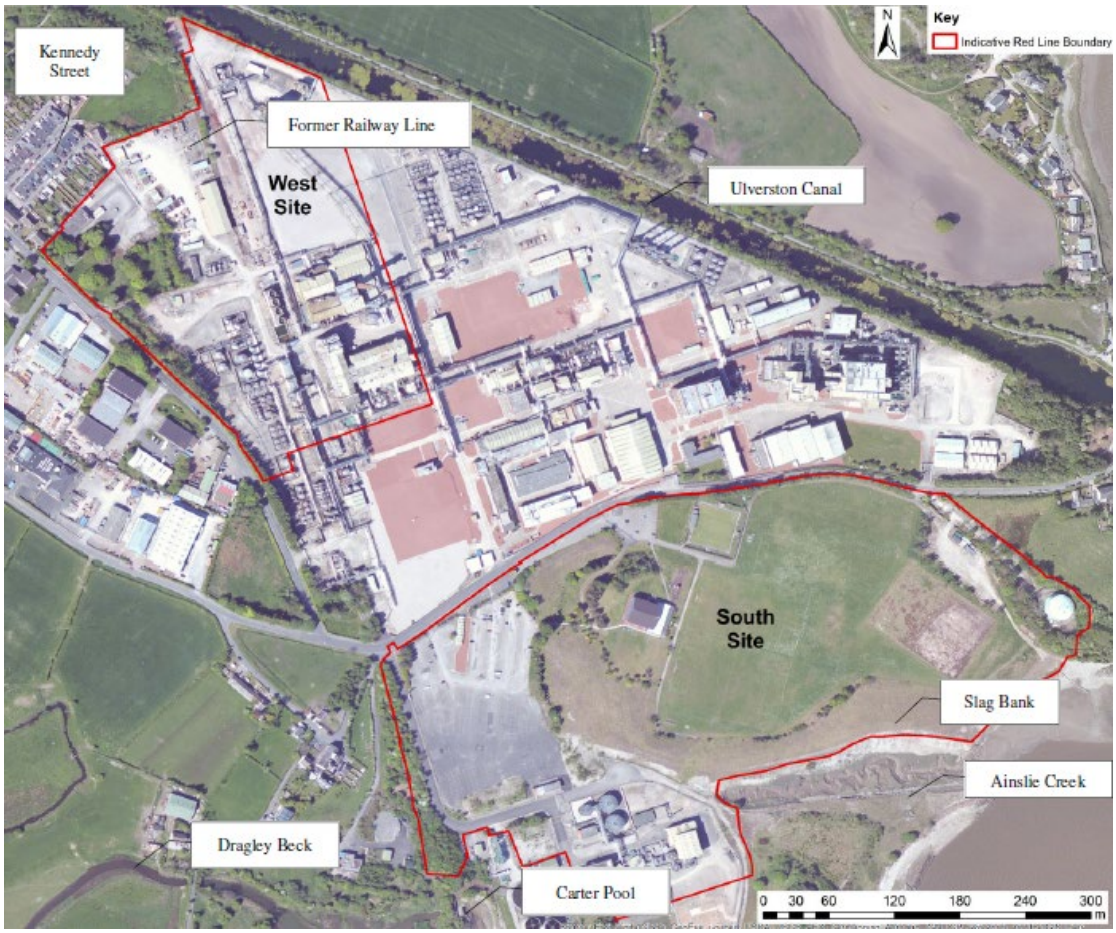

Figure 10 GSK Development Site Overview, with indicative red line boundary (ARUP, 2014). This was part of supporting information for the now lapsed outline planning permission.

2.2 Outline of the problem

2.2.1 Background

There are limited assets are at risk of coastal erosion, but there is potential contamination risk due to erosion of the slag fronting the GSK Factory Site. Although the latest monitoring data has shown little net change since monitoring began, satellite imagery indicates that there appears to have been some erosion here.

Assets at risk of flooding include properties and amenities within Ulverston and transport links including major roads A5087 and A590 and the railway. Large tracts of agricultural land and farmsteads are also at risk of flooding.

2.2.2 Issues, constraints and opportunities

Since the SMP2 there have been proposals for development within and on the edge of Ulverston and its infrastructure, which would have implications for the areas at risk. This includes the potential for construction of an Ulverston bypass (beyond 2025); a possible southern route could pass through Cross Moor to Nook Farm and Gascow Farm.

It is understood that the proposed biopharmaceutical development referred to in Section 2.1.5 will now not be taken forward and developed out by GSK. Any future development /redevelopment proposals for the site (the areas that are surplus to GSK's operational needs) will need to be taken into account.

The Ulverston Wastewater Treatment Works (WwTW) owned by United Utilities (UU) is located inland of policy unit 11c11.4. The Glaxo (GSK) site and UU share a combined sewer outfall into the channel, where there is significant sediment movement. The structure is understood to be at risk of undermining by loss of sediment due to channel movement, potentially compromising the outfall. This WwTW has its final effluent discharge to the deep section of the channel in the River Leven Estuary, which could be potentially compromised due to channel migration and significant sediment movement. The slag bank area of land adjacent to the WwTW includes a historical landfill site with inert glass waste and hosts rare flora and fauna.

National and international nature conservation designations cover the foreshore area, namely Morecambe Bay Ramsar, SAC and SSSI and Morecambe Bay and Duddon Estuary SPA. There are potential environmental opportunities, if Managed realignment is viable. This could offset losses due to habitat loss, however would have an impact on adjacent agricultural land. Currently the SSSI units covered by this policy area are in favourable condition, although the impact of defences is noted within the most recent assessments (2010), which recognises that these represent a constraint on the transition between lower saltmarsh and upper saltmarsh or terrestrial habitats.

2.2.3 Strategy considerations and general approach

Key considerations

Since the strategy was produced further monitoring data has been collated. The strategy has considered this more recent data to appraise:

- Current defence conditions and risks
- Contaminated land and flood risk study available for the GSK outline planning application approval site (SLDC ref. SL/2014/0615 – planning consent now lapsed);
- Consider the viability, including potential impacts on the wider estuary of implementing Managed realignment.
- Since the SMP there have been development proposals both within and on the edge of Ulverston's development boundary[2]. There have been development proposals for sites (South Lakeland Local Plan 2003 – 2005 Land Allocation sites) including the completed Trictech development at Canal Head and a residential development proposal adjacent to Lund Farm, east Ulverston. Outwith the Local Plan Land Allocation process, there has been a proposal (planning consent now lapsed) for parts of the existing GSK site. At present, future proposals for parts of the GSK site that are surplus to GSK's operational needs remain uncertain. Going forward, options need to be flexible to take account of future changes in land use and any potential development proposals, particularly with regard to the existing GSK operational site, measures to Hold the line to be considered.

[2] South Lakeland Local Plan, Part 2 – Land Allocations Development Plan Document, Policy LA1.1 – Development Boundaries, South Lakeland District Council, Dec. 2013.

- South Lakeland District Council is currently in the early stages of preparing a new single Local Plan (2016 – 2040).

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.
- Proposed future developments – these are locations where the SMP policy may still be appropriate for current hinterland assets but where future developments are proposed. Here the strategy will consider possible measures taking account of a possible change to policy. Future or proposed developments cannot be included in FDGiA - here the focus will be on considering varying costs of approaches, environmental impacts on the wider coast and making recommendations accordingly.

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 11c11.4, the following long listed options have been considered:

- Do nothing
- Do minimum
- Hold the line: improve existing defences
- Hold the line: improve through constructing new revetments or seawalls
- Managed realignment: construct erosion slowing defences
- Managed realignment: construct secondary embankments

The second stage has been to appraise the short listed options, section 2.4 outlines the shortlisted options and approaches (measures) that could be adopted to achieve these.

Do nothing has been appraised as a baseline in all frontages. This option assumes that no further works would be undertaken and the existing defences would deteriorate over time, resulting in failure.

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. These have been costed and the benefits of the strategic options identified and evaluated. The Do nothing option provides the baseline for the economic appraisal. This is reported in the **Economic assessment** report.

2.4 11c11.4 GlaxoSmithKline (GSK) Factory Site (south)

Along the 11c11.4 frontage there are limited assets at risk of coastal erosion, but there is potential contamination risk due to erosion of the reclaimed land and licenced historical landfill south of the GSK Factory Site. The assessments for the GSK south site (supporting information for the now lapsed outline planning application) did not find significant contamination pollution risk but it is unclear if

they considered the southern extent of the slag bank towards the licensed landfill. Further investigation into the potential contamination risk posed by ongoing erosion is therefore recommended.

There are existing defences that extend from within policy unit 11c11.3 into this area including a sea wall in a fair to good condition. However, for this assessment it has been assumed that the policy unit boundary should be located at the southern end of the defences at Hammerside Point. The former quay wall and defences at Ainslie Creek on the reclaimed ironworks are classified as high ground.

The slowly eroding peninsular area adjacent to the WwTW that forms much of 11c11.4 is understood to be owned by UU as part of their Ulverston project. The land has special properties acting as limestone pavement supporting rare flora and fauna. The site also includes the historical landfill site, believed to be an old glass tip, which cannot be removed. Sediment and channel movement could potentially compromise the capability of discharge of the Ulverston WwTW final effluents discharge outfall.

2.4.1 11c11.4 - Initial screening of options

Table 2 below summarises the rationale for taking long options forward to the short list stage.

Table 2 Screening of long list options

Long list options	Description	Short listed?	Rationale
Do nothing	No further works undertaken, defences left to deteriorate and fail	Baseline only	This would not manage the increasing flood risk to the hinterland, but feasibility is dependent on any proposed development at/or on part of the existing operational GSK site.
Do minimum	Reactive patch and repair of defences only	No	The frontage is undefended at present (the unit boundary is taken to be at the southerner end of the seawall), therefore this is the same as Do nothing.
Hold the line: improve existing defences	Measures to improve defence resilience, such as rock toe works, raising crest levels.	No	Would only apply to existing defended lengths until such time that they were outflanked. Existing defence remnants considered ineffective. Alone, does not accord with strategic approach.
Hold the line: improve through constructing new revetments or seawalls	New shore parallel defences replacing or extending existing defences	Yes	Does not accord with SMP2 policy or strategic approach of No active intervention, although consideration should be given if further developments within Ulverston are undertaken or proposed, including as part of any existing adopted or future Local Plan. Options would provide a consistent and resilient defence along the frontage.
Managed realignment: construct erosion slowing defences	Low tech measures such as gabion baskets to reduce erosion rates.	Yes	This option would include protection to the existing slag embankment, which is currently providing protection against tidal flooding and wave overtopping. Measures to slow erosion of this 'bank' have been considered further. Does not accord with SMP2 policy or strategic approach of No active intervention, although consideration should be given if further developments within Ulverston are undertaken or proposed, including as part of any existing adopted or future Local Plan.

Managed realignment: construct secondary embankments	Allow erosion to continue and then construct defences	No	Effectively this would allow the shoreline to retreat with the eventual loss of the existing reclaimed slag embankment and then works to the secondary alignment to provide protection to the hinterland. Consistent with the 'Hold the line: improve or construct new revetments or seawalls' therefore not considered as a separate option.

2.4.2 11c11.4 - Development and appraisal of short listed options

The sections below outline for each frontage the shortlisted options and approaches (measures) that could be adopted to achieve these.

Do nothing has also been appraised as a baseline. This option assumes that no further works would be undertaken and the existing defences would deteriorate over time, resulting in failure.

There is a shared tidal flood risk area for this frontage, which covers the frontages: 11c11.2, 11c11.3, 11c11.4, 11c11.5 and 11c12.3.1 (policy area 11c12 Leven Estuary). Due to the shared risk the costs and benefits for these frontages need to be considered together within the strategy in order to avoid double counting of benefits.

Do nothing (Option 1)

This is considered as a baseline against which other options can be appraised. There is still uncertainty surrounding the future proposals (potential development/ redevelopment) on part of the existing operational GSK site which may require future change of policy. The future new single South Lakeland Local Plan (2016 – 2040) may also require a future change of Policy.	
Technical	Under this option, no works would be undertaken, erosion of the shoreline would continue; releasing any potential contaminants from the reclaimed land into the estuary. Estimated rates of erosion are low and the bank is likely to provide some protection in the short to medium term. In the medium to longer term the reclaimed land would come under increased erosive pressure. Current predictions suggest that the embankment width could be lost within strategy timescale. Throughout the strategy period, with future sea level rise intermittent overtopping could lead to increasing flood damages as the embankment erodes and the existing defences meet the end of their residual life within 10 to 20 years.
Environmental	Continued No active intervention will in time help to result in a more naturally functioning coastline. However other actions are required if the eroding material poses a pollution risk. Current indications are contamination risk is low but this requires confirmation. This option would not reduce risk of flooding or coastal erosion to the frontage. This may in the longer term impact on the risk of flooding to a number of properties and amenities within the flood risk area protected by the eroding slag bank, including the WwTW, GSK South Site, a number of isolated properties including the Bay Horse Hotel and Restaurant, the Priority View Caravan and Campsite, and the unclassified roads that connect them. Reduced operation of the road may lead to risks to the health and safety of the residents and worker associated with the existing GSK site as a result of increased emergency response times that could result from impacts to these roads (note that the future of this site/area is currently unknown in terms of future land use/ development proposals). While this option could allow for a more natural reinstatement of more natural coastal processes, thereby benefitting the various designations of the estuary, it could also result in risk of pollutants entering the wider environment.
Cost	There are no costs associated with the No active intervention option.
Damages	Assets at risk of flooding include properties and amenities within Ulverston and transport links including major roads A5087 and potentially in the long term the A590 and the railway. Large tracts of agricultural land and farmsteads are also at risk of flooding. The damages are estimated to be £148,260 k (this includes 11c11.3 , 11c11.5 and 11c12.3.1 due to the shared flood zone).

Hold the line: improve or construct new revetments or seawalls (Option 2)

This option assumes that a new defence would be constructed. This currently does not accord with the SMP2 policy but is considered should further developments on the site be undertaken and would provide a flood defence function for the hinterland in the medium to longer term.	
Technical	The construction of a consistent defence along the frontage would reduce the erosion and flooding risk by introducing a consistent and resilient solution for the length of the frontage. A suitable structure at this location would be a rock revetment with a tie in to the seawall along the existing alignment at the north in 11c11.3. A sloping revetment is preferred to reduce wave scour and offer a resilient solution that can be easily repaired, should channel migration occur and scour potential increases. Rock armour is likely to provide the best option, although other revetment armouring solutions could be considered.
Environmental	The existing protection to the hinterland would be maintained by preventing erosion of the slag bank and the longer term flood and erosion risk to properties, infrastructure, and recreational features would be reduced. Additionally, this option would mitigate future increasing risk arising from sea level rise or other climate change factors. This option would result in changes to the existing landscape and visual amenity through the introduction of new hard structures. Contamination risk may remain depending on chosen alignment for the new defences. This option would defend the property, infrastructure and land use from flooding and coastal erosion, both from the current risk of flooding and additionally mitigating against future flood risk by taking into account potential for sea level change as a result of climatic factors. This option may have impacts on the SAC, SPA, and Ramsar so must be assessed fully under the Habitats and Species Regulations (2017) and impacts on the SSSI must be assessed under the Countryside and Rights of Way Act (2000). This option would also result in hydromorphological changes to the frontage and so there may be impacts on the WFD objectives of the waterbodies and this must be assessed.
Cost	The Present Value Capital Works are estimated to be £4,300 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £7,520 k.
Benefits	This option would provide benefits by providing protection to the at risk of increased flooding along the frontage and future proofing the infrastructure against potential increases in sea level, changes in wave climate and storminess. The benefits are estimated to be £138,400 k (this includes 11c11.3 , 11c11.5 and 11c12.3.1) due to the shared flood zone.

Managed realignment: construct erosion slowing defences (Option 3a and b)

This would involve low tech measures to slow the rate of erosion along the existing reclaimed land: this could involve introduction of a (a) rock toe or (b) rock gabions.	
Technical	The use of planting, fencing and other erosion management techniques such as small scale rock toe protection or gabions should slow erosion of the existing reclaimed land embankment. However, in the long term there is still a risk of erosion and breach of the slag bank.
Environmental	This option would delay the erosion of the slag bank, thus extending period of defence to the property, infrastructure and land use from flooding and coastal erosion. The risk of pollution from the eroding slag bank and the licenced landfill remains and so would need further investigation, although the site is understood to be classed as inert waste. This option may have impacts on the SAC, SPA, and Ramsar so must be assessed fully under the Habitats and Species Regulations (2017) and impacts on the SSSI must be assessed under the Countryside and Rights of Way Act (2000).
Cost	Moderate capital costs associated with placement of rock or gabions, also maintenance costs associated with relocation of rock as required. Two options have been considered: a) Rock toe: The Present Value Capital Works are estimated to be £4,120 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £6,690 k. b) Rock gabions: The Present Value Capital Works are estimated to be £4,070 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £6,820 k.
Benefits	Potential delay to Do nothing damages by 10 to 20 years.

2.4.3 11c11.4 - Discussion

The predominant risk is from flooding to the hinterland, through the eroding and breaching the slag bank or former iron works site. The inland South Ulverston tidal flood risk area is also at tidal flood risk from adjacent frontages with 11c11.3, 11c11.4, 11c11.5 and 11c12.3.1 all providing potential flood routes. To avoid double counting of and benefits the costs and benefits for all these frontages need to be considered together. Table 3 provides a summary of costs for the various options considered above and Table 4 provides a summary of economics for coastal defences to the combined flood cell that is at flood risk from policy units 11c12.3.1, 11c11.3, 11c11.4 and 11c11.5.

Given the current erosion risk and limited assets at short term risk, a Do nothing approach is considered a valid management policy in the short to medium term but should be reconsidered in the medium to long term to assess breach risk to the eroding bank outflanking other defences to south Ulverston.

Further consideration of the need for a policy change would also need to take account of potential future developments/redevelopments. In which case Option 2, Hold the line through the construction of a new revetment or seawall would provide a resilient long term solution if the economic justification can be made based on any future developments/redevelopments. However, this may not apply to the whole policy unit frontage. The environmental assessment of the options considered that in the long term Option 2, constructing new defences would meet most of the objectives and that the Do Nothing option would perform worst in the long term.

Table 3 Economic cost of options for 11c11.4

Policy Unit	Option		Design Life	Capital Works year applied	Whole Life Cost (cash 2018)	Present Value (PV)			
						Capital Works	Maintenance and Operation Works	Total cost (PVc)	Total cost with Optimism
			Year	Year	£m	£m	£m	£m	£m
11c 11.4	Option 1	Do nothing	10	-	0.00	0.00	0.00	0.00	0.00
11c 11.4	Option 2	Hold the line: Improve- construct new revetments/seawalls	50	10	7.03	4.30	0.40	4.70	7.52
11c 11.4	Option 3a	Managed Realignment: Construct erosion-slowing defences (Rock toe)	20	5	4.98	4.12	0.05	4.18	6.69
11c 11.4	Option 3b	Managed Realignment: Construct erosion-slowing defences (Rock gabions)	20	5	5.12	4.07	0.19	4.26	6.82

Table 4 Policy units 11c11.3, 11c11.4, 11c11.5 and 11c12.3.1 Summary of economics

Option	Present Value Capital Works £m	Present Value Total cost (PVc 50yr)* £m	PV Benefit (Damage Avoided, 50 yr) £m	Average Benefit Cost Ratio
Option 1 Do nothing	0	0	0	-
Option 2 Hold the line: improve through constructing new revetments or seawalls (*11c11.4*) **Option 4 Hold the line: Improve through constructing new revetments or seawalls** *(11c12.3.1)*	9.4	16.1	113.6	7.1
Option 2 Hold the line: improve or construct new revetments or seawalls (*11c11.4*) **Option 3 Hold the line: Improve existing defences** *(11c12.3.1)*	9.7	16.4	113.6	6.9

**Present Value cost (PVc) inclusive of 60% optimism bias; includes allowance for maintenance of existing defences in 11c11.3,11c11.5*

+ Benefits for MR options not evaluated at this stage due to multiple alternative options

2.4.4 11c11.4 - Strategic way forward

The existing SMP2 policy for this frontage is No Active Intervention, subject to more information regarding the potential contamination risk from erosion of the slag deposits. The assessments for the GSK south site did not find significant contamination pollution risk but it is unclear if they considered the southern extent of the slag bank towards the licensed landfill. Further investigation into the potential contamination risk posed by ongoing erosion is therefore recommended. The longer term suitability of the SMP policy also depends upon future proposals for part of the existing operational GSK site – currently these are not known. There is also a potential linkage to a much larger flood area, if the slag bank continues to erode.

Given the limited assets directly at risk, in the short term, a do nothing approach remains appropriate, subject to further monitoring of the situation. The longer term approach remains uncertain, but even if part(s) of the existing GSK site are not developed/redeveloped, there is a need to monitor erosion of the slag bank and assess the risk of breach which could have wider reaching impacts.

If part(s) of the former GSK site are developed/redeveloped in the future, there could be a need to change policy to hold the line and under a hold the line policy the preferred approach would be to construct a new revetment or seawall (Option 2), subject to funding. A change in SMP policy would require a formal change process to be followed, including community and stakeholder consultation.

The following activities are recommended in the future:

- Monitoring of erosion to inform future assessment of risk of breaching the slag bank and allowing flooding to the hinterland.
- Further investigation into the potential contamination risk posed by ongoing erosion, particularly at the southern extent of the site.
- EA are currently progressing a scheme 'South Ulverston Integrated Flood Risk Management Scheme' considering tidal flood risk reduction measures (short term potential fluvial / surface water schemes and tidal defences scheme needed in 20 or 30 years). Consideration of this frontage should be an integral part of this scheme.

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

3 Appraisal of non priority units

There are five additional units within this area, which have been defined as non priority units:

- 11c11.1 Cark to Leven Viaduct
- 11c11.2 Leven Viaduct to Canal Foot cottages
- 11c11.3 Canal Foot
- 11c11.5 Sandhall to Conishead Priory
- 11c11.6 Conishead Priory to Bardsea

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

3.1 11c11.1 Cark to Leven Viaduct

3.1.1 11c11.1 - Existing approach to flood and coastal erosion risk management

The Cark to Leven Viaduct frontage (11c11.1) is located along the eastern bank of the Leven Estuary (see Figure 11).

The existing SMP policy for this frontage is for No active intervention from the short term, with works only undertaken if the railway is at risk. In the medium term this is extended to include the potential consideration of regulated tidal exchange habitat scheme to offset future habitat loss losses due to the railway.

Justification for the policy was that it would allow a natural functioning shoreline to form and there is insufficient justification to defend the land seaward of the railway on the present alignment, whilst allowing the important railway link to be maintained.

The SMP recommended that the viability of regulated tidal exchange habitat creation landward of the railway in conjunction with wider scale assessment of long term habitat loss of the internationally designated sites in relation to the railway be investigated. A potential funding partnership between Network Rail and the Environment Agency was proposed.

The railway embankment that extends along this frontage is understood to be in a fair condition, although the latest asset inspection (CH2M, 2018b) reported that it was largely unseen due to vegetation cover and access restrictions. Some heavy rutting due to vehicular traffic was reported at most eastern point of the asset, close to railway crossing and River Eea, (CH2M, 2018b).

Figure 11 11c11.1 Railway embankment and saltmarsh extending south; 2015 aerial images © North West Regional Monitoring Programme.

Network Rail's short term forward maintenance and renewals programme includes works to the Capes Head Embankment to remove vegetation growing on structure, point open joints and voided areas and on the Leven viaduct approaches repairs to pitching, and repair and installation of rock armour within NR boundary.

3.1.2 11c11.1 - Strategy considerations

The coastal monitoring undertaken under the North West Regional Monitoring Programme includes three profiles in this policy unit (CH2M, 2017). These indicate modest vertical accretion since 2006, but rapid erosion of the saltmarsh edge, causing retreat of up to 80 m in a single year between October 2015 and October 2016 and up to 450 m of overall saltmarsh edge retreat since 2012 (CH2M, 2018a). Ordnance Survey mapping shows that this is an area where the marsh has previously accreted significantly and that it is this accreted material which is now eroding. The limited saltmarsh towards the northwest of the marsh (see Figure 11, left image) is where the railway embankment crosses the estuary (i.e. to the west of the unit boundary) and is likely to be related to the proximity of main Leven channel to this shoreline at this location and increased pressure as the estuary is forced to narrow at the viaduct.

Along the western bank of the estuary, there has been cyclical behaviour, driven by the movement of the Leven channel. Since 2013, the channel appears to have been steadily moving back towards the western shoreline (CH2M, 2018a). This cyclical behaviour may result in the recent erosional trend in 11c11.1 switching back to accretion. It is recommended that the monitoring is reviewed annually to monitor the risk.

3.1.3 11c11.1 - Discussion

There are limited hinterland assets at risk, with the area mainly used for agricultural. The properties associated with Holker Farm are located on slightly higher land. The Furness Railway Line is therefore the key social and economic asset within the area.

National and international nature conservation designations cover the foreshore area, namely Morecambe Bay Ramsar, SAC and SSSI and Morecambe Bay and Duddon Estuary SPA. The SSSI unit covered by this frontage is currently in favourable condition (last assessed in 2010). It is noted that the railway line limits the transitions to terrestrial habitats and upper saltmarsh communities are poorly represented as a result. It is recognised that the area is used by roosting and breeding bids, but the SSSI assessment suggests the marsh is probably too low lying to support many breeding birds. Since the SMP2 was adopted there have been no changes in environmental designation.

Natural England is working on proposals to improve public access along this coast but as yet the route of the England Coast Path is undefined. The proposals are due to be published Autumn 2019, with access anticipated to be open in 2020.

The SMP policy allows for intervention only if the railway becomes at risk. The monitoring data indicates that the wide saltmarsh that provides natural protection to the railway has recently been progressively eroding, following a period of accretion, due to possibly cyclical movements of the low water channel from the Leven.

The latest data shows that there was about 450 m marsh width from the railway to the saltmarsh edge. It is anticipated that in the medium or long term with sea level rise there may be a need to protect the railway, for example with rock armouring, if the erosion trend continues. This would artificially constrain the coastal processes, and potentially result in direct and indirect losses of habitat in the internationally designated sites.

To mitigate or compensate for these potential impacts on the designated sites the SMP suggested that habitat creation through Managed realignment elsewhere in the estuary or through a regulated tidal exchange scheme to allow tidal inundation behind the railway should be considered. A separate supporting report has undertaken an initial review of estuary locations where the short, medium or long term policy is Managed realignment, and this includes the area north of the railway in 11c11.1.

3.1.4 11c11.1 - Strategic way forward

The current SMP policy is No Active Intervention, but refers to monitoring risk to the railway, with works undertaken if at risk. The recommended strategic approach would be to continue to manage the risk to the railway, through maintaining and if necessary upgrading existing defences in the future, should erosion of the fronting marsh increase exposure. A change in SMP policy to be consistent with elsewhere and to clarify the intention of management may be appropriate.

It is also recommended that opportunities for habitat improvement should also be sought, such as regulated tidal exchange.

Future activities include:

- Continued monitoring of intertidal change, as part of the North West Regional Monitoring Programme – specific focus is to identify whether the current erosion trend continues and to assess any increase in risk level. Three profiles cover this frontage, but it is recommended that this be supplemented or replaced by saltmarsh edge monitoring using remote sensing (CH2M, 2018a).
- Continued inspection and maintenance of the existing structures, with repairs and remedial works undertaken as necessary. Consider development of an asset management plan to indicate the need for advance planning of works, including identification of possible funding sources and suitable options, such as the viability of regulated tidal exchange habitat creation landward of the railway. Any modification to or replacement of the existing structures would also require consent from Natural England due to the designation of the intertidal zone and a scheme level HRA and AA could need to be undertaken. Therefore, earlier discussions between Network Rail, Natural England, Cumbria County Council and South Lakeland District Council are recommended.
- Safe siting of the England Coast Path; Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale. (see https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england).

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

3.2 11c11.2 Leven Viaduct to Canal Foot Cottages

3.2.1 11c11.2 - Existing approach to flood and coastal erosion risk management

The existing SMP2 policy for this frontage is for No active intervention from the short term. The aim of the policy is to allow the shoreline to continue to evolve naturally while investigating the contamination risk, then allowing an approach of No active intervention to continue unless a contamination risk is identified.

The railway embankment at the northern end of the unit consists of a sloped blockwork revetment (Figure 12). The latest asset inspection (CH2M, 2018b) identified the structure to be in fair condition with some vegetation cover and missing mortar in several locations. At the western end rock armour revetment has been added to the asset and is in a good condition (CH2M, 2018b). The railway line then moves away from the coast.

Immediately to the south of the railway there is a section of privately managed embankment, which is a flood defence pre-dating the construction of the railway in the 1850s. An unmetalled road runs along the top and is used by Network Rail for track maintenance access via the car park by the railway. The road is also used for access to farmland north of the railway, via an underpass bridge. On the seaward side, long-established saltmarsh runs right up to this road. On the landward side the

fields lie below high spring tide level and drain through an old culvert and modern flap valve. The flood defence has a slight low point about half way along its length, and this was overtopped by waves in 2009. Since then, the low point has been supplemented by large reinforced concrete blocks, made available following re-building work on the small underpass bridge. The flap valve and the adjacent section of culvert were repaired in 2017, in cooperation between land owners. The rest of the unit from where the track turns away from the shoreline to the Canal Foot cottages is undefended.

Figure 12 11c11.2 Railway embankment. Taken from CH2M (2018b).

3.2.2 11c11.2 - Strategy considerations

The area at risk from flooding narrows towards the south of the unit, constrained by naturally rising land. There are, however, properties at potential risk from flooding at Plumpton Hall and Canal Foot Cottages, although the latter are considered in 11c11.3. The Cumbrian Coastal Railway Line moves inland and therefore it is only the section which adjoins the viaduct that is at risk from erosion.

There are two historical licenced landfill sites at Plumpton quarries and the risk of contamination was raised by the SMP2. The SMP2 recommended investigations into these landfill sites, but these do not appear to have been undertaken to date.

National and international nature conservation designations cover the foreshore area, namely Morecambe Bay Ramsar, SAC and SSSI and Morecambe Bay and Duddon Estuary SPA. The SSSI unit covered by this frontage is currently in favourable condition (last assessed in 2010), with no signs of interference or damage occurring noted.

Natural England is working on proposals to improve public access along this coast but as yet the route is undefined – the proposals are due to be published Autumn 2019.

3.2.3 11c11.2 - Discussion

There are two monitoring points where data are collated as part of the North West Regional Monitoring Programme but these only cover the southern end of the frontage, at Canal Foot Cottages. The data indicates cyclical behaviour, probably driven by fluctuations in the position of the Leven Channel (CH2M, 2018a). Most recently there appears to have movement of the Leven Channel

towards the shoreline, with the position of mean high water in 2016 similar to that recorded in 2009 (CH2M, 2018a).

3.2.4 11c11.2 - Strategic way forward

There is currently no justification for any change in policy, subject to further investigation in the contamination risk from the landfill sites. Therefore, the recommendation would be for the policy to remain, through implementation of Do nothing (no new defences), but subject to monitoring.

It should be noted, however, that the SMP does not specifically include the Leven Viaduct. Under the No active intervention policy for 11c11.1 the SMP2 allows works if the railway becomes at risk, and therefore does not preclude the maintenance of the existing flood defences. It is assumed that a similar condition would apply to the short section of railway embankment and adjacent defences within this unit.

Future recommended activities include:

- Continued monitoring of intertidal change and channel movement, as part of the North West Regional Monitoring Programme – specific focus is to identify whether the current erosion trend continues, as a result of channel movement, and to assess any increase in risk level. There are currently only two profiles, therefore a recommendation would be for an additional profile along the Plumpton quarries frontage.
- Investigation into the potential contamination risk posed by future erosion of two historical licenced landfill sites at Plumpton quarries.
- Continued inspection and maintenance of the existing structures, with repairs and remedial works undertaken as necessary. Consider development of a management plan to indicate the need for advance planning of works, including identification of possible funding sources and suitable options, such as the viability of regulated tidal exchange habitat creation landward of the railway. Any modification to or replacement of the existing structures would also require consent from Natural England due to the designation of the intertidal zone and a scheme level HRA and AA could need to be undertaken. Therefore, earlier discussions between Network Rail, Natural England, National Trust, Cumbria County Council and South Lakeland District Council are recommended.
- Safe siting of the England Coast Path; Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale. (see https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england).
- Maintenance and repairs to existing defences to the railway embankment.

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

3.3 11c11.3 Canal Foot

3.3.1 11c11.3 - Existing approach to flood and coastal erosion risk management

The existing SMP2 policy is Hold the line, managing the flood and erosion risk to community and amenities by maintaining the existing defences. The SMP2 noted that the existing defences may not be adequate and may require upgrading in epoch 2. Hold the line policy was considered economically viable due to assets at risk in the south Ulverston flood cell; there is a flood route link to policy unit 11c11.5.

This frontage (Figure 13) consists of saltmarsh, shingle and boulders and the channel bank is at a shallow angle although some cliffing of the saltmarsh has been observed (CH2M, 2018b).

The latest asset inspection (CH2M, 2018b) noted that there are a number of structures present along the frontage, in variable condition, with some stretches in poor condition (Figure 14). It is also evident that works have been undertaken by residents to reduce overtopping, namely the placement of earth filled bags along the crest of the wall adjacent to the road. At the time of the inspection there was a parapet on the landward face of a flood gate which was loose and in need of immediate repair and to avoid becoming a health and safety issue.

Figure 13 11c11.3 Canal Foot. 2015 aerial photograph © North West Regional Monitoring Programme.

Figure 14 Canal Foot- vertical walls and earth filled bags. Taken from CH2M (2018b).

3.3.2 11c11.3 - Strategy considerations

The existing defences along the entire asset have not been consistently maintained, with a series of private defences constructed to protect housing. Their current condition and residual life is not considered to be sufficient to implement the current policy of Hold the line for the length of the strategy. Consideration of measures to maintain and possibly refurbish the defences will therefore need to be undertaken in future as part of a strategic approach for the overall flood cell.

There is a single beach monitoring point, where data are collated as part of the North West Regional Monitoring Programme. These data indicate cyclical behaviour in terms of bed levels at this location, with no obvious trend evident (CH2M, 2018a), but foreshore levels can fluctuate by over 1.5 m.

National and international nature conservation designations cover the foreshore area, namely Morecambe Bay Ramsar, SAC and SSSI and Morecambe Bay and Duddon Estuary SPA. The SSSI unit covered by this frontage is currently in favourable condition (last assessed in 2010), with no signs of interference or damage occurring noted. Since the SMP2 was adopted there have been no changes in environmental designations or in level of risk along the frontage.

Natural England is working on proposals to improve public access along this coast but as yet the route is undefined. The proposals are due to be published Autumn 2019, with access anticipated to be open in 2020.

3.3.3 11c11.3 - Discussion

There is no justification for any change in policy from Hold the line, due to the assets potentially at risk resulting from the flood route link to policy unit 11c11.5 and 11c12.3.1. Given their current condition, implementation of this policy will require defences to be upgraded in future. The asset inspection reported noted that in the event of a south westerly storm, floodwaters may become channelled through the area. If intervention does not occur, the properties behind the existing berm (road) will be at increasing risk from inundation from surges due to sea level rise. Also the road is the only access to these properties (CH2M, 2018b).

Possible options to address future risk could include:

- Rock toe works: this would be the construction of a rock toe as required along the existing defences. This would not, however, address any future deterioration of the existing defences and in places their current poor condition. Alone it would also not address the tidal flood risk due to the low crest level where there are no raised defences.
- New sea wall, with sheet piled toe and raised crest wall: this would be costly and would involve extensive and intrusive works with a larger footprint than the current structure. It would also significantly change the landscape. Impacts on the SSSI would also need to be considered as the designation extends to the existing wall. This option could, however, be considered as part of regeneration plans for the area and would provide long term protection to the frontage and wider flood cell and could be designed to improve access along the frontage.
- Full height rock revetment: rather than replacing the structure with a new seawall, an alternative could be to encase the existing structure with a full height rock revetment and crest wall. This would be fairly expensive and would change the landscape of the frontage. It would involve an increased footprint, with an impact on the foreshore. This option could, however, be considered as part of regeneration plans and would provide long term protection to the frontage and wider flood cell and could be designed to improve access along the frontage.
- Modifications to the existing structures: given the deterioration of the current structures and the variety of defences this would be difficult to implement to give a consistent standard of protection and further works are likely to be required at a later date. Modifications could include addition of a permanent or demountable crest wall, reconstruction or refurbishment within current footprints with sheet piled toe, a rock toe to reduce exposure of the structure and reduce reflectivity and encourage foreshore accretion. This option could be undertaken in stages but there is a risk it may not provide a consistent standard of protection for the wider south Ulverston flood cell.

3.3.4 11c11.3 - Strategic way forward

The preferred strategic approach is to implement the SMP policy of Hold the line. Some of the assets within this frontage have an expected residual life of more than 10 to 20 years and will only require proactive maintenance, but others require more urgent attention.

Future recommended activities include:

- Continued inspection and maintenance of the existing structures, with repairs and remedial repair works undertaken by private owners as necessary.
- Continued monitoring of intertidal change and channel movement, as part of the North West Regional Monitoring Programme.
- Investigation to allow a strategic defence to be developed along the frontage, inclusive of the lock gate, to manage and adapt to the increasing long term risk of flooding due to sea level rise. This work will need to consider flood routes through other linked policy units protecting the south Ulverston flood cell and also possible funding sources. Any modification to or replacement of the existing structures would also require consent from Natural England due to the designation of the intertidal zone and a scheme level HRA and AA could

need to be undertaken. Therefore, early discussions with Natural England are recommended. It is understood that the Environment Agency are considering a south Ulverston strategic defence studies.

- Safe siting of the England Coast Path; Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale. (see https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england).

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

3.4 11c11.5 Sandhall to Conishead Priory

3.4.1 11c11.5 - Existing approach to flood and coastal erosion risk management

The short term SMP2 policy for this frontage (see Figure 15) is Hold the line, managing the flood and erosion risk by maintaining the existing defences, while investigating the potential to set back the defences in the medium term (Managed realignment).

This approach will manage the flood risk to the communities and amenities in the large South Ulverston Flood cell, risk to the historically land fill sites and industrial or commercial sites, avoiding pollution risk. The SMP2 considered that the while there are limited assets at short term risk there is a potential flood route through to south Ulverston that would increase in flood risk with future sea level rise.

Figure 15 11c11.5 Sandhall to Conishead Priory. 2015 aerial photograph © North West Regional Monitoring Programme.

The banks of the channel are in a fair condition, comprising of shingle and sand. The higher ground consists of a dilapidated sea wall, rock debris, rock armour and earth (Figure 16) and the latest asset inspection (CH2M, 2018b) concluded that all defence elements are in poor condition with debris being strewn along the beach.

Figure 16 11c11.5, illustrating that debris is being strewn along the narrow backshore. Taken from CH2M (2018b).

3.4.2 11c11.5 - Strategy considerations

There is a flood route link to policy unit 11c11.5, although defence may not be necessary along the existing shoreline, but instead could be setback.

National and international nature conservation designations cover the foreshore area, namely Morecambe Bay Ramsar, SAC and SSSI and Morecambe Bay and Duddon Estuary SPA. The SSSI unit covered by this frontage is currently in favourable condition (last assessed in 2010), with no signs of interference or damage occurring noted. Since the SMP2 was adopted there have been no changes in environmental designations or in level of risk along the frontage.

Natural England is working on proposals to improve public access along this coast but as yet the route is undefined. The proposals are due to be published Autumn 2019, with access anticipated to be open in 2020.

3.4.3 11c11.5 - Discussion

There is no justification for a change in policy, due to the assets potentially at risk resulting from the flood route link to policy unit 11c11.5. A number of defences are already in poor condition and will need to be improved or replaced by a set back defence in the future. In the short term proactive management may be sufficient to allow time to develop an approach to reduce flood risk to south Ulverston.

3.4.4 11c11.5 - Strategic way forward

The preferred strategic approach is to implement the SMP policy of Hold the line, which will involve investigating opportunities and need to construct set back defences in the medium term as part of the ongoing south Ulverston strategic flood risk study.

Future activities include:

- Investigation of opportunities and need for set back the defences in the medium term, to reduce flood risk to south Ulverston and provide most cost effective approach to SMP policy delivery. Confirm preferred approach, extent of managed realignment and potential for habitat gains. This work will also need to consider possible funding sources.
- Any realignment of or capital works to the existing structures would also require consent from Natural England due to the designation of the intertidal zone and a scheme level HRA and AA could need to be undertaken. Therefore, early discussions with Natural England are recommended.
- Safe siting of the England Coast Path; Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale. (see https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england) – the route will need to take account of any future realignments planned.

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

3.5 11c11.6 Conishead Priory to Bardsea

3.5.1 11c11.6 - Existing approach to flood and coastal erosion risk management

The SMP policy for 11c11.6 Conishead Priory to Bardsea is No active intervention from the short term. However, private defences may be permitted subject to consent. The aim of the policy is to allow the shoreline to evolve naturally, providing sediment from the eroded low cliffs to the down

drift defences. The SMP considered that a Hold the line policy could not be justified on an economic basis, however private defences could be managed, subject to consent, if required.

There are variable defences along this frontage, which have been assessed as part of the latest asset inspections (CH2M, 2018b); these are described below.

From Red Lane south, the revetment is in a poor condition, but it does provide some residual protection given by presence of loose material from revetment at toe of slope (Figure 17).

Figure 17 11c11.6 – South of Red Lane – defences in poor condition. Taken from CH2M (2018b).

South of here, to Cooper Lane, a length of 280 m, there is a stone revetment, which varies from good to poor condition (Figure 18). Significant loss of stone blocks, which have been washed out in places, although the failed blocks are still providing some protection to toe of defence in some areas.

Figure 18 11c11.6 –non main water course to Cooper Lane – revetment varies from poor to good condition. Taken from CH2M (2018b).

From Cooper Lane to Wadhead Hill, a new rock armour revetment has been placed on top of the existing wall (Figure 19). Outflanking has occurred at the end of the defence, where the ground has become eroded. The rock armour is in fair condition with slumping visible in places and some rock displacement.

Figure 19 11c11.6 –Cooper Lane to Wadhead Hill – rock revetment. Taken from CH2M (2018b).

From Wadhead Hill to Coast Road there is a sloped revetment, which is in poor condition, with failed concrete patch repairs and large holes visible. The vertical masonry wall has failed and lost extensive sections of brickwork (Figure 20). The crest of the structure has lowered, with large area of crest missing. Rock armour has been placed to fill the gap between missing areas of wall but this is in poor condition.

Figure 20 11c11.6 –Wadhead Hill to Coast Road – revetment

3.5.2 11c11.6 - Strategy considerations

There are isolated properties and land at flood and erosion risk, but insufficient assets to justify strategic policy unit wide defences. There are highway assets at potential risk of flooding and erosion, namely the A5087 and coastal access roads (Red Lane and Cooper Lane). Near Wadhead Hill there is a factory and highway at tidal flood risk.

National and international nature conservation designations cover the foreshore area, namely Morecambe Bay Ramsar, SAC and SSSI and Morecambe Bay and Duddon Estuary SPA. There is also a Country Park at Bardsea. The SSSI unit covered by this frontage is currently in favourable condition (last assessed in 2010), with no signs of interference or damage occurring noted. Since the SMP2 was adopted there have been no changes in environmental designations or in level of risk along the frontage.

Natural England is working on proposals to improve public access along this coast but as yet the route is undefined. The proposals are due to be published Autumn 2019, with access anticipated to be open in 2020.

3.5.3 11c11.6 - Discussion

There is no justification for any change in policy, which supports the environmental designations for this frontage and recognises the limited assets at risk and insufficient justification for publicly funded intervention. Therefore, the recommendation would be for the policy to remain.

There are existing defences, some of which may be the responsibility of South Lakes District Council or private landowners. The SMP policy potentially allows continued maintenance of these, subject to consent.

Whilst defences to the whole shoreline are unlikely to be justified or affordable, localised or individual property resilience measures may need to be considered.

3.5.4 11c11.6 - Strategic way forward

The preferred strategic approach is to implement the SMP policy of no active intervention and not intervening to repair or refurbish the failing defences as there is limited justification for public expenditure. However, there may be a need for health and safety works to manage risks to the public from failing defences. Continued maintenance of private defences would be allowed, but any modification to or replacement of the existing structures would require consent from Natural England due to the designation of the intertidal zone and a scheme level HRA and AA could need to be undertaken.

Future recommended activities include:

- Continued monitoring of intertidal change and channel movement, as part of the North West Regional Monitoring Programme.
- Continued inspection and maintenance of the existing structures. Any modification to or replacement of the existing structures would also require consent from Natural England due to the designation of the intertidal zone and a scheme level HRA and AA could need to be undertaken.
- Undertake an initial assessment of local or property level options for managing flood risks to the factory and highway near Wadhead Hill.
- Safe siting of the England Coast Path taking account of a No active intervention policy along this stretch; Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale. (see https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england).

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

4 Summary of proposed strategy: 11c11

Preferred strategic approach: Limited intervention – manage risks to the railway, industrial sites, infrastructure and properties where economically justifiable and affordable, whilst generally allowing the majority of the shoreline to continue to behave naturally and respond to coastal change.

		Next 10 years	Beyond 10 years
11c11.1	**Cark to Leven viaduct**	Continue to minimise risk of erosion and flooding to railway. and viaduct approaches through maintaining existing defences.	Continue to manage risk of coastal erosion and flooding to railway line, with works undertaken to reduce risk when required. Also seek opportunities for habitat improvement, such as a regulated tidal exchange scheme.
11c11.2	**Leven viaduct to Canal Foot cottages**	Allow area to function as naturally as possible whilst recognising the need for further investigations into possible contamination risk due to erosion or flooding of landfill sites. Maintain defences to railway viaduct approaches and allow maintenance of existing private defences within existing footprints.	
11c11.3	**Canal Foot**	Hold the line through proactive maintenance of existing defences to consistently manage flood risk to south Ulverston.	Continue to manage risk of coastal flooding and erosion to community and amenities by upgrading existing defences, recognising potential flood risk links to wider South Ulverston area.
11c11.4	**GSK Factory Site (south)**	Implement No Active Intervention (no new defences) but continue to monitor risk of coastal flooding: investigate potential for future set back defences.	Continue to monitor risk of coastal flooding recognising potential flood risk links to wider South Ulverston area and possible future requirements for set-back defences.
11c11.5	**Sandhall to Conishead Priory**	Investigate need for future set-back defences to wider south Ulverston flood cell in medium or long term. Allow for maintenance of existing private defences.	Continue to manage risk to hinterland assets from coastal erosion and flooding, although this may not be along existing defence alignments, recognising potential flood risk links to wider South Ulverston area.
11c11.6	**Conishead Priory to Bardsea**	Allow area to function as naturally as possible, whilst recognising the need for localised defence measures to protect coastal roads and properties at Wadhead Hill.	

Key actions and activities (next 10 years):

- Monitor condition of defences
- Monitor marsh and intertidal change

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

- Management plans to indicate the need for advance planning of works (and funding sources)

	• Estuary-wide scale geomorphological study looking at current and potential future gains and losses in marsh and flats (with other Morecambe Bay policy areas) • Contamination risk assessments for historical landfills at erosion risk in 11c11.2 and 11c11.4 • Complete strategic studies of combined flood risk for south Ulverston
	• Initial assessment of local or property level resilience options for managing flood risk to the factory and highway near Wadhead Hill
	• EA to complete ongoing studies 'South Ulverston Integrated Flood Risk Management Scheme' including considering need for future tidal flood risk reduction measures and plan future scheme development

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

5 References

ARUP (2014). GSK Ulverston: GSK Biopham Development. Flood Risk Assessment. Doc no: ARUP-ENV-REP-018.

CH2M (2017) Lancaster, South Lakeland & Barrow Analytical Report 2016. Prepared for Lancaster City Council, Borough of Barrow in Furness, and South Lakeland District Council, as part of the North West Regional Monitoring Programme.

CH2M (2018a) Lancaster, Barrow & South Lakeland Coastal Processes Report, 2016. Prepared for Lancaster City Council, Borough of Barrow in Furness, and South Lakeland District Council, as part of the North West Regional Monitoring Programme. January 2018.

CH2M (2018b) South Lakeland Asset Inspection Report, 2018. Prepared for Lancaster City Council, Borough of Barrow in Furness, and South Lakeland District Council, as part of the North West Regional Monitoring Programme. January 2018.

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

Halcrow (2013). North West Estuaries Processes Reports – Leven Estuary. Prepared for Sefton Council. November 2013.

Royal HaskoningDHV (2014). GSK Ulverston Biopharm Project Environmental Statement. Volume 1. Non-Technical Summary.

Shoreline Management Partnership (1999) Cell 11c Wyre to Walney Island Shoreline Management Plan. Morecambe Bay Shoreline Management Plan Partnership.