



REPORT

Cocker Tidal Channel and Cockerham Marsh SSSI Restoration Investigation

Task 1 - Desk-Based Review and Site Visit

Client: Lancashire Wildlife Trust, Natural England & Environment Agency

Reference: PC7494-RHD-XX-XX-RP-X-0001

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Project related

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Preamble

The present study forms part of an initiative called 'Our Future Coast', which is instigated by the Department for Environment Food and Rural Affairs (Defra), Wyre Council and the Environment Agency.

'Our Future Coast' is focused on working with nature to safeguard coastal communities through seventeen projects across the North West of England, from Formby in the south to Millom Marshes in the north.

The 'Cocker Tidal Channel & Cockerham Marsh SSSI Restoration Investigation' is one of these projects, being led by Natural England in partnership with Lancashire Wildlife Trust and the Environment Agency.

The 'Our Future Coast' programme aims to develop a suite of natural buffer strips to increase coastal resilience of vulnerable hot spots in the North West. Natural coastal buffer strips can provide multiple benefits, including reducing flood risk, reducing coastal erosion, increasing biodiversity and water quality, providing carbon capture and other ecosystem services such as recreation and well-being.

Buffer strips with their rich vegetation, act as natural means of capturing sediment and dissipating wave energy. Buffer strips include developing salt marsh, managed realignment, reclaiming redundant brownfield sites, dune systems, and intertidal lagoons to provide storage of surface water during high tide.

Further information about the programme can be found here:

[Our Future Coast | The Flood Hub](#)

1 Introduction

The downstream reach of the River Cocker in Lancashire flows in a north-westerly direction, discharging into southeast Morecambe Bay across the intertidal expanse of Cockerham Sands (Figure 1). The 1.5 km reach between a sluice gate at Cocker Bridge and Morecambe Bay is tidal, flowing within an artificially straightened channel, which was cut in the 1960s.

The cut Cocker channel joins into a naturally meandering channel (Patty's Farm Creek) at a confluence just seaward of Bank End Farm. Beyond this confluence, the Outer Cocker Channel flows in a meandering manner across intertidal areas of Cockerham Sands.

Prior to the new cut in the 1960s (shown red in Figure 2), the natural outflow of the River Cocker was a meandering channel across Cockerham Marsh (shown orange in Figure 2). There is some argument that the new cut has placed increased energy at the confluence (shown as a yellow box in Figure 2) between the cut River Cocker channel and Patty's Farm Creek (shown blue in Figure 2), increasing the tendency for this combined outer channel to incise close to the flood embankment near this point.

Morecambe Bay is a highly dynamic environment, and the alignment of channels can change significantly within a short timescale in response to the governing tidal and sedimentary processes, freshwater discharge from rainfall across the catchment, and the effects of winds, waves and surges during storms.

Following a period of notable channel movement towards the north at the confluence of the cut Cocker Channel and Patty's Farm Creek in 2012, residents alerted the Environment Agency to the loss of saltmarsh fronting the flood embankment and raised concerns at that time about potential flood risk to Bank End Farm and Caravan Park and the nearby Bank Houses Caravan Park.

This prompted a Geomorphological Appraisal by the Environment Agency (Swift, 2013) which incorporated Historic Trends Analysis (HTA) of historic maps and datasets as well as Expert Geomorphological Assessment (EGA) informed by observations from a site visit. Recognising the uncertainties associated with the future extent of saltmarsh erosion due to the dynamic nature of the physical environment, the study recommended enhanced monitoring be undertaken, in combination with further assessment of the suitability of options to address the flood risk (whilst allowing the system to respond as naturally as possible to wider environmental forcing) by means of: (i) enhancing protection of the existing channel bank using bio-engineered brushwood mattresses (or similar); (ii) in-channel flow deflectors; and (iii) strengthening of the main flood embankment near Bank End Farm. The study also suggested that options to re-naturalise the tidal channel of the River Cocker could be considered if that too would alleviate erosion and associated flood risk pressure at Bank End Farm.

The present Cocker Tidal Channel and Cockerham Marsh SSSI Restoration Investigation more widely investigates potential for restoration of natural processes, morphology and habitat in this area and how this might provide other benefits to the estuary and the wider catchment, particularly land drainage and flood risk. The study comprises four main tasks, namely:

- Task 1 – Desk-Based Review and Site Visit
- Task 2 – Optioneering
- Task 3 – Catchment Nature Based Solutions
- Task 4 – Cockerham Marsh Site of Special Scientific Interest (SSSI)

This report relates to **Task 1 – Desk-Based Review and Site Visit**.

Project related

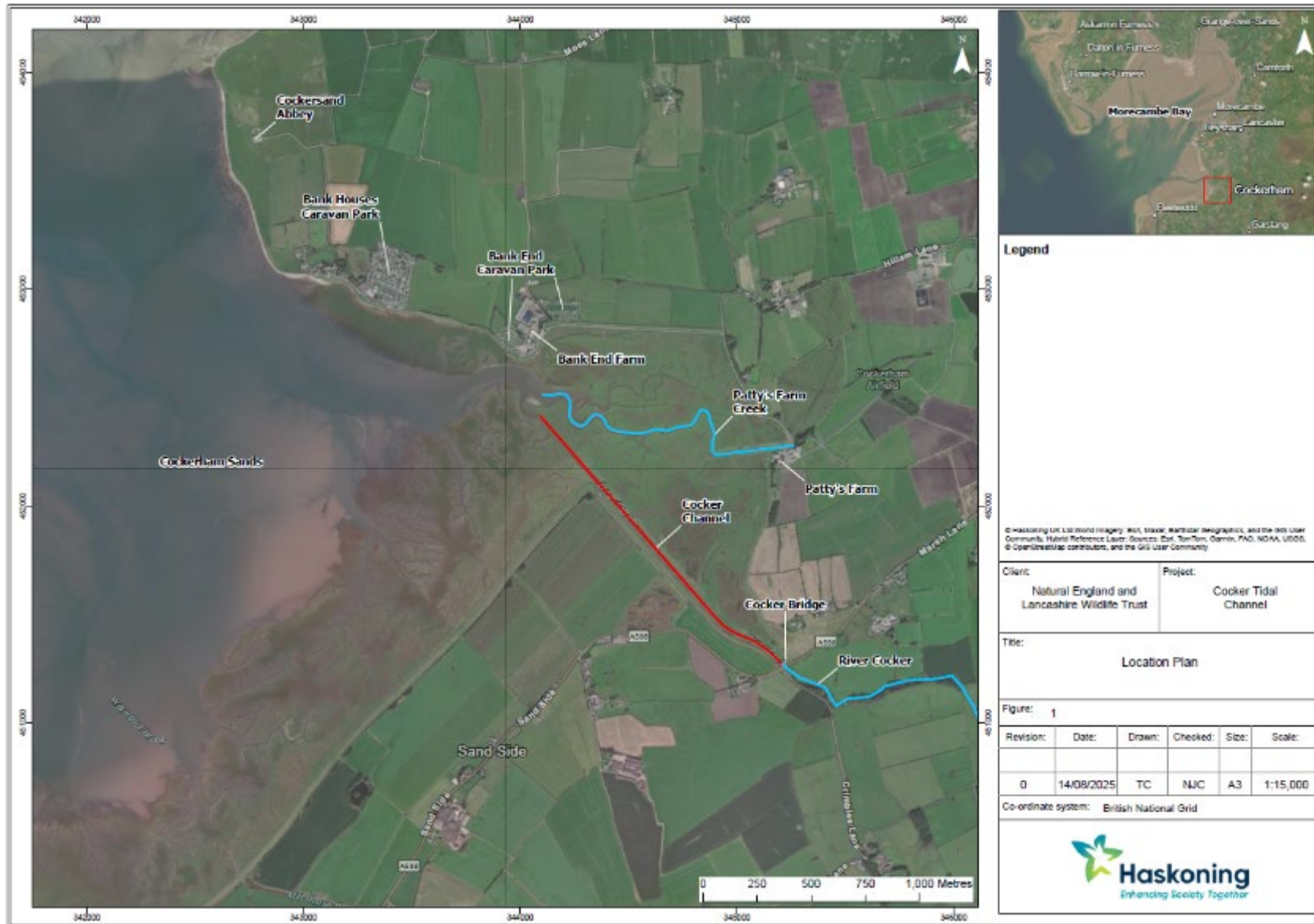


Figure 1 Location plan

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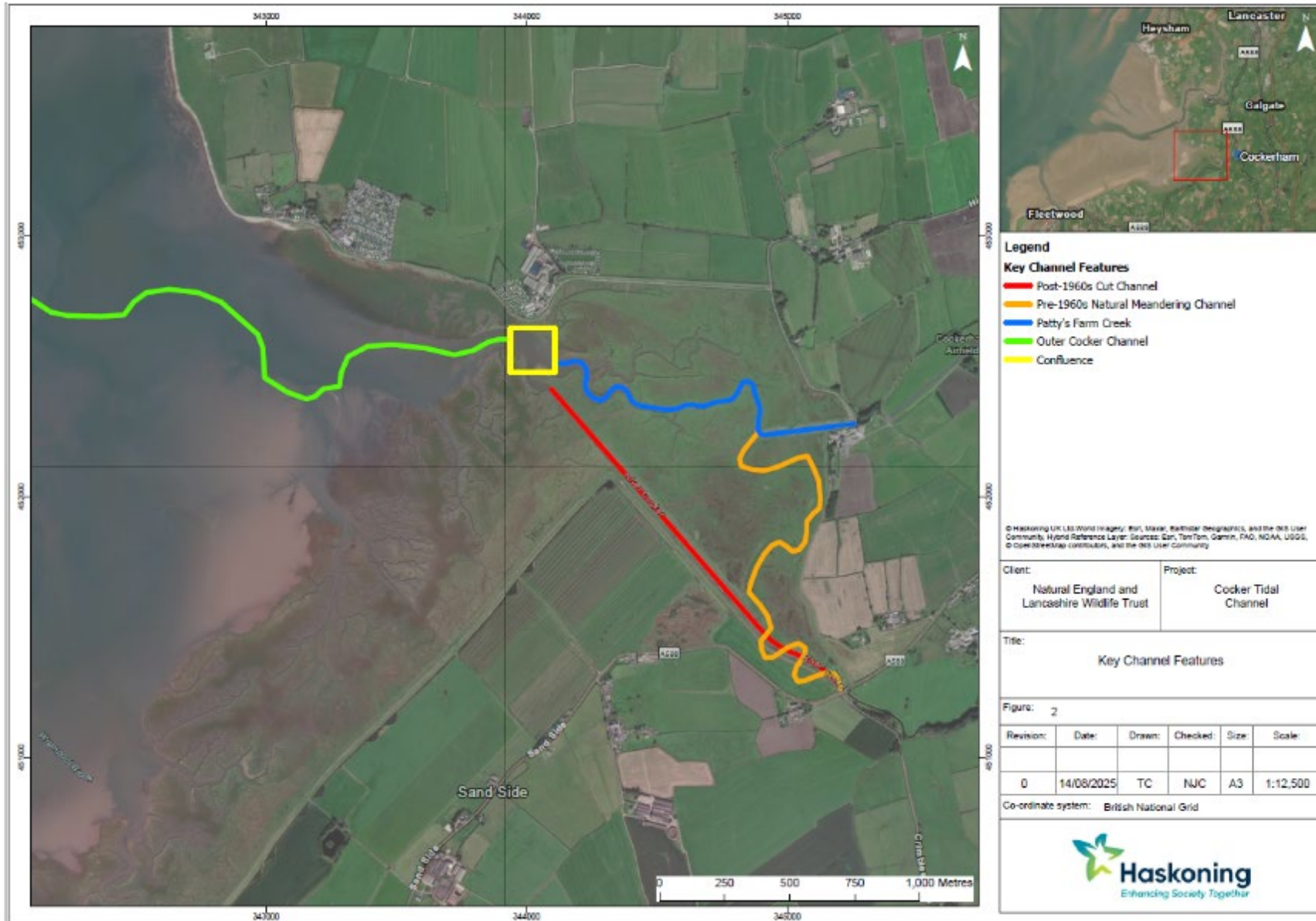


Figure 2 Key channel features (after Swift, 2013)

2 Task 1a – Desk-Based Review

2.1 Geomorphological Appraisal 2013

The Geomorphological Appraisal by the Environment Agency (Swift, 2013) provides an excellent starting point for understanding the physical and natural setting, historic evolution, geomorphology and environmental designations of the site (and wider environs), as well as appreciating the contexts governing the issues that were being manifest at the site in 2012 and the management options that were considered in the vicinity of Bank End Farm at that time. Box A provides a summary of its key findings and recommendations, whilst Figure 3 shows the locations of some of the key features to which the text refers.

Box A - Summary of Key Findings and Recommendations from previous Geomorphological Appraisal (Swift 2013)

Background

- By 2012, saltmarsh had eroded to within approximately 40m of the (then Environment Agency maintained) flood embankment adjacent to Bank End Farm, due to changes in channel alignment.
- This flood embankment is part of a wider system of flood defences protecting large parts of the low-lying Thurnham peninsula from sea flooding.
- Shoreline evolution in this area is linked closely to the configuration of the Cocker Channel.
- The study, involving site visit and desk study, was aimed at providing geomorphic understanding of historic and likely future movements in the channel to inform appraisal of potential flood risk management options at Bank End Farm.

Physical Setting

- Morecambe Bay has a semi-diurnal, macro-tidal tidal regime with a mean spring tide of approximately 8.5m.
- This large tidal range means that tidal currents dominate sediment transport under 'normal' conditions. Other factors, such as waves freshwater discharge and channel movement, become more important during extreme events.
- The tidal range is asymmetric, with the flood being shorter in duration than the ebb; meaning that flood currents are generally stronger and are able to transport more sediment than the ebb tide. As a result, there is a net landward movement of sediment and the bay is slowly infilling.
- Combined meteorological surge and astronomical tidal water level at Cockerham Sands for a 1 in 1-year event (100% Annual Exceedance Probability AEP) is 5.88m AOD and for a 1 in 100-year event (1% AEP) is 6.67m AOD.
- Large areas of the Thurnham peninsula are low-lying, at ground elevations of between 5 – 10m AOD and therefore some are at risk of sea flooding.
- Wave action has relatively small role in overall morphological change in the bay, with the largest effect in the outer bay.
- The underlying solid geology of the catchment is largely Sherwood Sandstone, with superficial (drift) geology of mostly tidal flat deposits and areas of glaciofluvial deposits and glacial till.
- The bed sediments are dominated by very fine and fine sands and muds in the inner bay.
- The vegetated areas of the intertidal attenuate wave and tidal energy, bind sediments within the roots and encourage additional sediment deposition.

Box A - Summary of Key Findings and Recommendations from previous Geomorphological Appraisal (Swift 2013)

- The saltmarshes in the vicinity of Bank End Farm, Patty's Farm and the Cocker Channel are grazed (predominantly by sheep but with some cattle towards the south) and are typically characterised by short, dense vegetation except for cattle grazed areas which are ranker).
- Land use in the catchment is primarily agricultural, with a small number of isolated properties.
- There is extensive protection of land by flood embankments and a history of large-scale land reclamation.

Geomorphological Characterisation

- The **cut channel** of the tidal Cocker conveys freshwater flows from the River Cocker into the Lune Estuary, where it joins the channel flowing from Patty's Farm Creek. The cut was made in the 1960s with the intent of improving flow conveyance and land drainage (in association with land reclamation to the south of the channel). The channel was dredged along its length to maintain its capacity.
- **Patty's Farm creek** drains agricultural land to the west of Cockerham village, flowing west through saltmarsh. The flow is regulated by tidal gates at the flood embankment and has been straightened in a westerly direction for approximately 350m from the gates. West of this point, the channel adopts a naturally meandering alignment.
- The **confluence** of the cut Cocker channel and Patty's Farm Creek contains a pronounced meander, and it is the deeper incision of this meander that caused erosion of the saltmarsh fronting Bank End Farm. The 2013 channel surveys commissioned by the Environment Agency showed shallower invert levels in the confluence than in the cut channel, suggesting some infilling in the confluence section.
- The **Outer Cocker Channel** crosses Cockerham Sands.

Geomorphological Assessment

- The cut channel has shortened the overall channel length (compared to the previous naturally meandering channel) and steepened the channel section. This means that more energy is focussed on the confluence section and is likely to be a factor in the evolution of the main channel adjacent to Bank End Farm.
- Land reclamation (post-1968) adjacent to the new cut channel has reduced the tidal prism and may have contributed to enhanced natural accretion as a result of reduced tidal current velocities through the main tidal channel.
- Historic maps (1914-19; 1955; 1971) and aerial photographs (1945; 1968; 2020) show relative stability within inner Cockerham Sands between 1914 and 1955, with progressive increase in sinuosity of the channel within the confluence area since the artificial cut and reclamation in the 1960s.
- Profile transect surveys from the embankment at Bank End Farm across the fronting saltmarsh to the channel were obtained from the North West Regional Coastal Monitoring Programme between 2006 and 2012 and analysed for changes. Over this period, the saltmarsh 'cliff' eroded by an average of 0.8 m/year, with the low flow channel margin moving landwards by 20-30m over this period.
- Saltmarsh erosion near Bank End is linked to changes in position of the tidal channel at the confluence. Continued bend migration is possible until a degree of dynamic equilibrium is reached. Existing defences could be vulnerable to toe scour and failure should channel bend migration incise further into the saltmarsh.
- Trampling and grazing by livestock could have some local impacts on the speed of erosion of the saltmarsh.

**Box A - Summary of Key Findings and Recommendations
from previous Geomorphological Appraisal (Swift 2013)**

Management Recommendations

- Potential future management options for the saltmarsh erosion issues that were being noted at Bank End Farm in 2012 were:
 - Option 1 - Do nothing
 - Option 2a - Saltmarsh protection works to hold the channel at its existing bend position (e.g. bio-engineering works such as brushwood fascines or similar)
 - Option 2b - Realign the channel to its former position by hard engineering (e.g. riprap/revetment)
 - Option 3a – In-channel interventions to divert flow (e.g. flow deflectors)
 - Option 3b – In-channel interventions to divert channel (e.g. dredge)
 - Option 4 – Allow channel migration but improve flood embankment
 - Option 5 – Enhanced monitoring (in association with trigger thresholds for interventions)
 - Option 6 – Land management (e.g. control grazing on saltmarsh)
 - Option 7 – Restore original natural Cocker channel
 - Combination of two or more above options.
- The study recommended enhanced monitoring be undertaken, in combination with further assessment of the suitability of options to address the flood risk (whilst allowing the system to respond as naturally as possible to wider environmental forcing) by means of: (i) enhancing protection of the existing channel bank using bio-engineered brushwood mattresses (or similar); (ii) in-channel flow deflectors; and (iii) strengthening of the main flood embankment near Bank End Farm. The study also suggested that options to re-naturalise the tidal channel of the River Cocker could be considered if that too would alleviate erosion and associated flood risk pressure at Bank End Farm.

Since the previous Geomorphological Appraisal concluded, there is over a decade of additional monitoring data now in existence from the North West Regional Coastal Monitoring Programme, as well as more up-to-date science and guidance on the effects of climate change (including sea level rise, wave heights, surges, and rainfall). In addition, it is understood that since 2012 the rate of change in the channel alignment seaward of Bank End Farm has notably reduced and the concerns raised previously have subsided. Over this period, there has also been increasing awareness of the value of Natural Flood Management (NFM) approaches (such as re-naturalising physical environments) and Nature Based Solutions (NBS), including in upstream catchments. Furthermore, there is a willingness to further attempt to alter the 'unfavourable declining' condition status of the Cockerham Marsh Site of Special Scientific Interest (SSSI) in relation to its interest feature the natterjack toad (*Epidalea calamita*).

The above aspects combined mean that the present study not only brings the previous study up to date by collating and analysing additional data, science and guidance, but also has a far greater remit by considering a broader geographical area and investigating a wider range of management interventions.

Project related

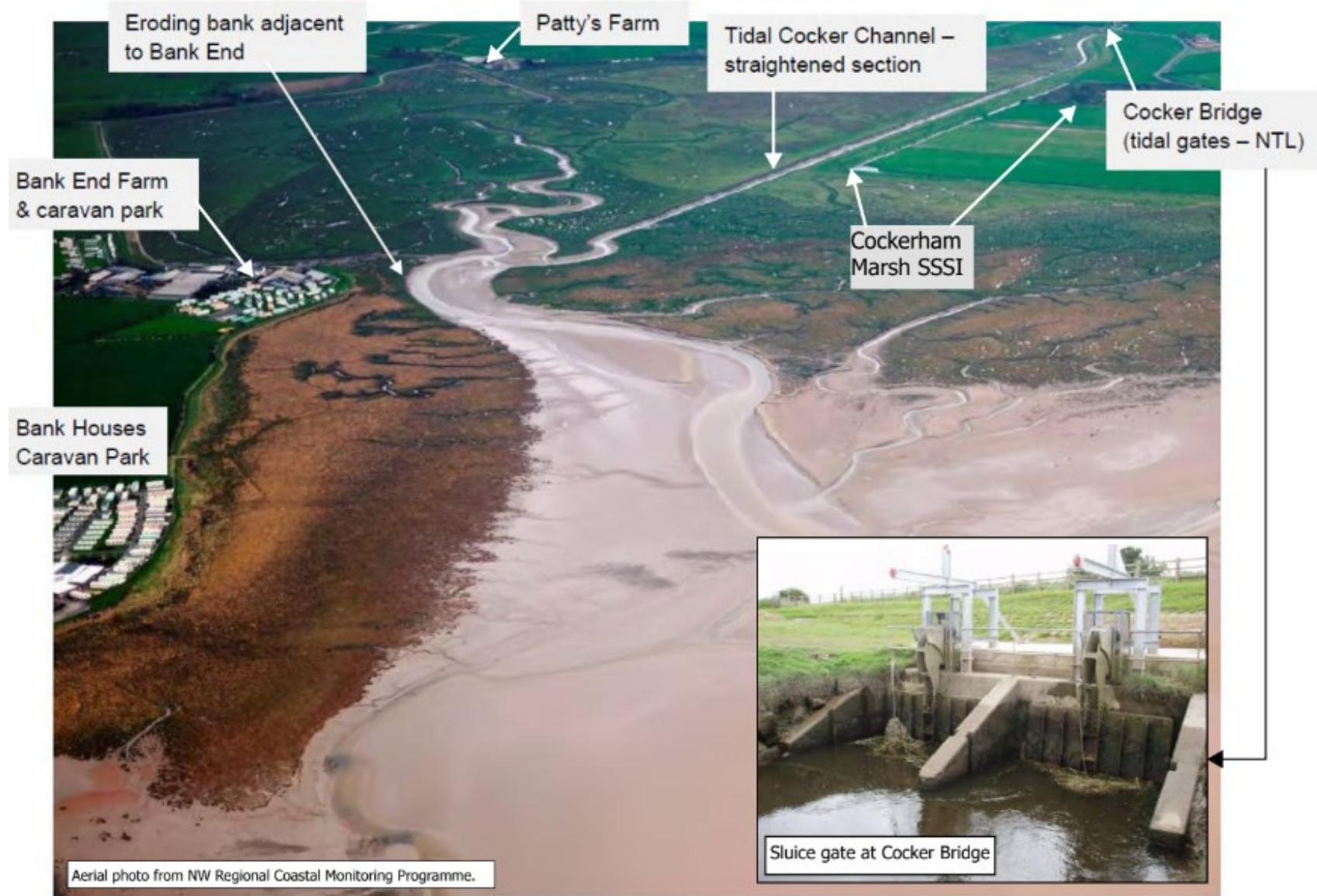


Figure 3 Key locations (reproduced from Swift, 2013)

2.2 North West England and North Wales Shoreline Management Plan 2 (SMP2)

2.2.1 Background Information

The following is taken from 'North West England and North Wales SMP2 Appendix C – Baseline Processes' - SMP 22 Great Ormes Head to Scotland Appendix C Section C4 – J – 2011.

'Cockerham Sands extends from Pilling, in the west to Plover Scar, in the north, at the mouth of the Lune estuary. The saltmarshes that make up Pilling Marsh and Cockerham Marsh front an area of low-lying and reclaimed land, protected by an embankment, and back the wide sandy intertidal zone of Cockerham Sands. In the north of the section, between Bank Houses and Plover Hill, the saltmarsh is replaced by two resistant scars (Long Tongue and Plover Scar) and an outcrop of sandstone, which forms a small headland.

Evolution of this coastline is dependent on changes in the flood / ebb regime of Morecambe Bay and the Lune Estuary. Shoreline exposure is linked to the width of the saltmarsh and to a lesser extent the position of the Cocker Channel, which flows into the east of the area and other main channels within Cockerham Sands (Cocker Channel, Wampool Brook and Broad Fleet). Changes in ebb/flood regimes and channel positions affect the locations of mobile banks and smaller channels, influencing the shoreline exposure to waves and currents, and consequently control erosion and accretion patterns along the frontage.

The influence of the Cocker Channel is most noticeable to the north of the channel where saltmarsh is limited; along the upper reaches, the channel has been trained and here a large area of saltmarsh has developed in its lea. Training of the channel has also resulted in reduced sediment volatility and consequently transfer of sediment northwards out of this area has reduced.

The majority of the frontage is relatively sheltered due to its orientation and due to the Lune Deep, which results in a change in wave refraction and consequently alters patterns of wave energy at the coast. However, the northernmost section of frontage is more exposed, due to its westerly orientation and to waves propagating down the Lune Channel. The scars in this area provide local stability but also influence intertidal levels either side of the features. Erosion of these scars only release minimal amounts of sand and shingle, which tends to stay within the frontage creating a storm strip beach at the toe of defences.

The key sources of sediment to the frontage are from the offshore zone in Morecambe Bay and the Irish Sea; fine material is moved onshore to be deposited on the flats and saltmarshes. There is a low rate of littoral drift eastwards, with sediment transport along the lower foreshore more significant than that on the upper foreshore due to negligible wave attenuation in this area. Although saltmarshes provide protection to the backing hinterland, the frontage is still vulnerable to high water levels, surges and storm events.

Movement:

Historical Ordnance Survey maps show that accretion along the frontage between Pilling and Bank End has resulted in a net seaward advance of the mean high water mark and sustained growth of saltmarsh over the past 150 years. Creeks and channels within the saltmarsh and intertidal areas have changed position over time, resulting in localised erosion which is exacerbated during storms.

Project related

Embankments have been constructed along the majority of this shoreline to reduce the risk to the low-lying and reclaimed land from flooding. Further marsh was reclaimed in the 1970s, following severe storms, when new defences were constructed seaward of original defences. The upper reaches of the Cocker Channel have been trained, resulting in the restriction of channel movement and a reduction in sediment volatility in that area, reducing the potential for sediment to be transferred northward; consequently, saltmarsh development has increased in this location.

Between Bank End and Bank Houses, where saltmarsh development has been limited, net change along the shoreline has been negligible. Over the past 30 years saltmarsh has developed further west towards Bank Houses where it now covers some 100 to 200 metres in front of the caravan park. In the past, the position of mean high water has, however, fluctuated in line with movement of the Cocker Channel, which in general has moved northwards at this location. To the immediate north of the frontage the scars have helped maintain the seaward position of the headland, however, since the late 1800s there has been a net retreat of mean high water associated with a gradual erosion of the scars’.

Future Projections:

‘For an unconstrained scenario, Futurecoast (Halcrow, 2002) predicted that evolution of this shoreline would be closely linked to the future configuration of the Cocker and Lune Channels, which will heavily influence the patterns of erosion, sediment transport and deposition within the intertidal areas and exposure of the shoreline to wave attack. The Futurecoast study suggested that, assuming a continued supply of sediment, the trend of saltmarsh accretion would continue, albeit at a potentially slower rate than historically, although localised erosion of saltmarsh edges would increase as sea levels rise. Low-lying land would become subject to inundation during high water levels and as sea levels rise. Saltmarsh may eventually develop in these previously reclaimed areas. The scars to the north of the frontage would continue to fix this headland in position until such time as their influence is reduced due to sea level rise. Loss of defences in this area would reactivate erosion of the low sandstone cliffs, releasing new sediments into the system.

The Futurecoast prediction for a ‘with present management’ scenario is for the defences to continue to protect the low-lying hinterland against flooding, however, localised overtopping and breaching could become more frequent as sea levels rise. Assuming a continued supply of sediment, the trend of saltmarsh accretion is expected to continue as the bay in fills. Saltmarsh development north of the Cocker Channel would be dependent on the channel position in the future. Continued movement of the channel landward would increase exposure along this frontage, restrict marsh growth and increase erosion of marsh edges. As sea levels rise the scars to the north of the frontage would become submerged and consequently exert less influence over time’.

Land reclamation around Morecambe Bay defended against the sea by embankments (both private and public assets) was widespread but has left a legacy of low-lying agricultural land on the landward side which is trying to drain ‘uphill’ through higher elevated saltmarshes to the sea. The constant sediment movement into the Bay which is acting as a sediment sink causes blockages to tidal gates and outfalls resulting in backed up surface water that cannot drain off of the agricultural land. This is an unsustainable situation that needs resolution as there is a conflict between the need to dredge the creeks and outfalls and the protected site status of the Bay’s saltmarshes.”

2.2.2 Shoreline Management Policies

The study area is covered by two frontages within the SMP2, namely:

- Fluke Hall to Cocker Bridge 11C2.3 (Cockerham Marsh SSSI located within) (Figure 4)
- Cocker Bridge to Glasson Dock 11C2.4 (Bank End Farm located within) (Figure 5)

2.2.2.1 Fluke Hall to Cocker Bridge 11C2.3

The summary management approach is:

- No case for national funding but works by landowners to maintain existing acceptable in short to medium term, subject to consent. This will enable a plan for managed realignment and adaptation to be developed so that a new defence line can be maintained in the longer term.

0 to 20 years (2005 to 2025)

- Hold the line - Repair not replace
- Where protection is currently provided by coastal defence structures that might be maintained or repaired if funding allows, but not replaced if they fail or reach the end of their design life.

20 to 50 years (2025 to 2055)

- Managed realignment
- Set back defence
- Where the intention is to defend elsewhere in flood plain inland from present shoreline or allow erosion/recession to a defined alignment. New defences might be constructed at that new location if needed. This may involve the creation of inter-tidal habitat.

50 to 100 years (2055 to 2105)

- Hold the line - New defences
- Where there is little or no protection currently, and the intention is for new defences to be introduced, if funding allows.
- Introduction of new defences may follow a period of Managed Realignment or No Active Intervention.

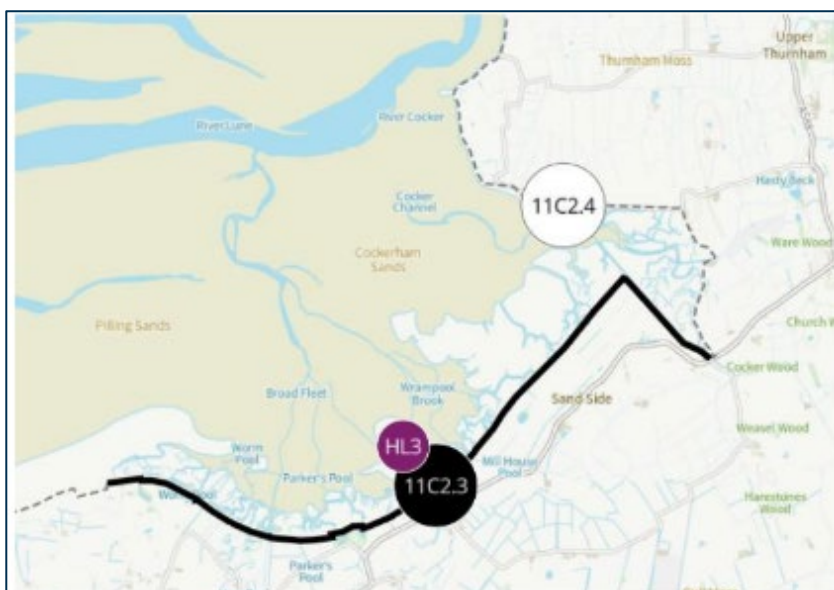


Figure 4 Fluke Hall to Cocker Bridge 11C2.3

2.2.2.2 Cocker Bridge to Glasson Dock 11C2.4

The summary management approach is:

- Maintain existing defences and investigate potential opportunities for managed realignment to create more sustainable and economically and environmentally viable defence alignments to manage risk from erosion and flooding.

0 to 100 years (2005 to 2105) – all three epochs

- Hold the line - Repair not replace
- Where protection is currently provided by coastal defence structures that might be maintained or repaired if funding allows, but not replaced if they fail or reach the end of their design life.

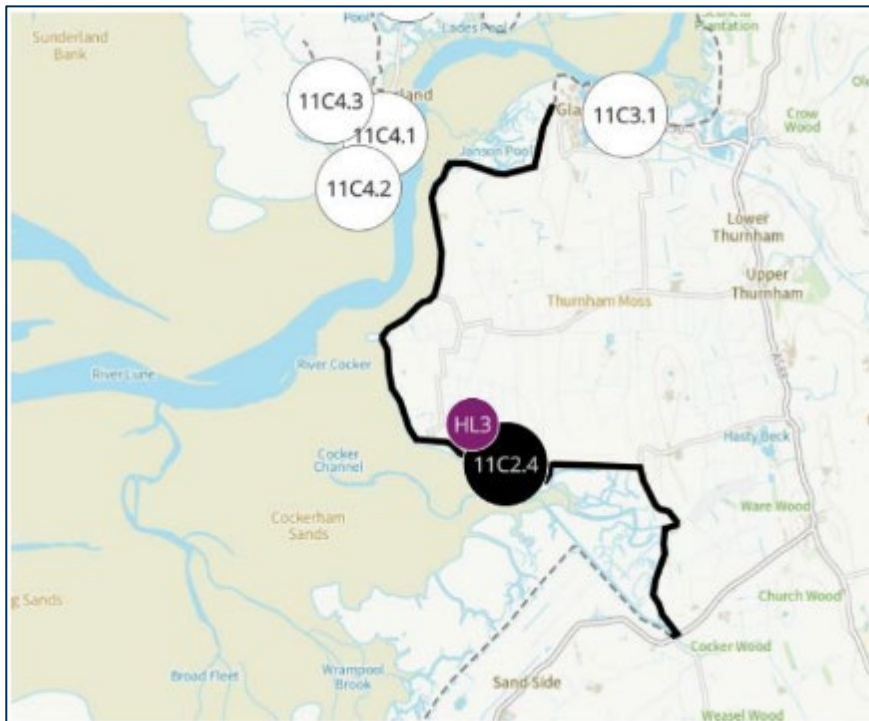


Figure 5 Cocker Bridge to Glasson Dock 11C2.4

2.3 Designated Sites

The study area is within, or adjacent to, several sites that are designated as being of importance for nature conservation, most notably:

- Cockerham Marsh SSSI
- Lune Estuary SSSI
- Morecambe Bay Special Area of Conservation (SAC)
- Morecambe Bay & Duddon Estuary Special Protection Area (SPA)
- Morecambe Bay Ramsar
- Wyre-Lune Marine Conservation Zone (MCZ)

The locations of these sites are shown in Figure 6.

Project related

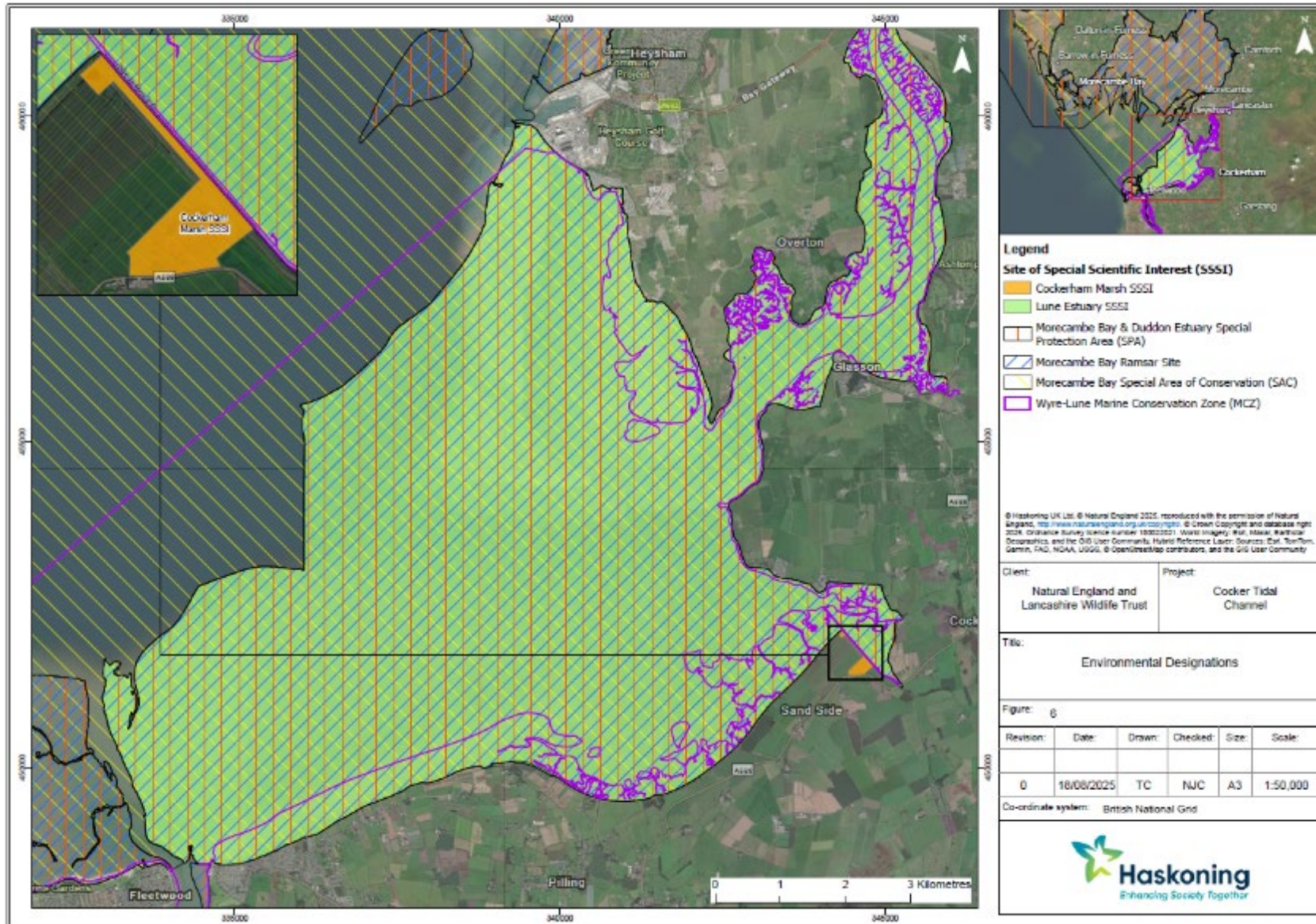


Figure 6 Environmental Designations

Cockerham Marsh SSSI, which is to the immediate south the cut Cocker tidal channel (see Figure 7), is an area of land that became disconnected from any tidal influence following the construction of the sea defence embankment in 1981 by the Environment Agency. It is a single unit site that is notified as a SSSI for the endangered natterjack toad (*Epidalea calamita*) which historically lived in the upper saltmarsh pools. This site has been in 'Unfavourable Declining' condition for many years and attempts at toad translocations and reintroductions have failed. This has been caused by the land becoming scrubbed over, the pools filling-in with sediment and the original saltmarsh habitat being totally lost.

There is an opportunity to combine the need to restore saltmarsh habitat *per se* (bringing all the intrinsic benefits and ecosystem services values of saltmarsh itself, such as natural flood defence, carbon storage, ecological function, etc.) with efforts to achieve government targets for biodiversity and species recovery through an innovative approach to community engagement.

The investigation will explore in later Tasks options to restore tidal influence to Cockerham Marsh SSSI, either for full saltmarsh restoration or for creation of a brackish environment with pool reinstatement.

2.4 Water Bodies

The area falls within two Water Framework Directive (WFD) surface water bodies:

- (i) The freshwater part of the River Cocker is water body number GB112072065880 – designated as being heavily modified for flood defence and navigation purposes and in moderate status;
- (ii) The tidal part of the river lies within the Morecambe Bay and Duddon Sands water body, number GB64121117000 – designated as being heavily modified for fin fisheries and shell fisheries and in moderate status.

The location of these water bodies is shown in Figure 8.

The area is underlain by two WFD groundwater water bodies:

- (i) The downstream River Cocker (including the freshwater reaches immediately upstream of the tidal sluice and the tidal channel) and Cockerham Marsh SSSI are underlain by the Fylde Permo-Triassic Sandstone Aquifers (GB41201G100500) which is in poor overall status;
- (ii) The inland sections of the wider Cocker (Lune) WFD waterbody catchment are underlain by the Lune and Wyre Carboniferous Aquifers (GB41202G102700) which is in good overall status.

The location of these water bodies is shown in Figure 9.

Project related

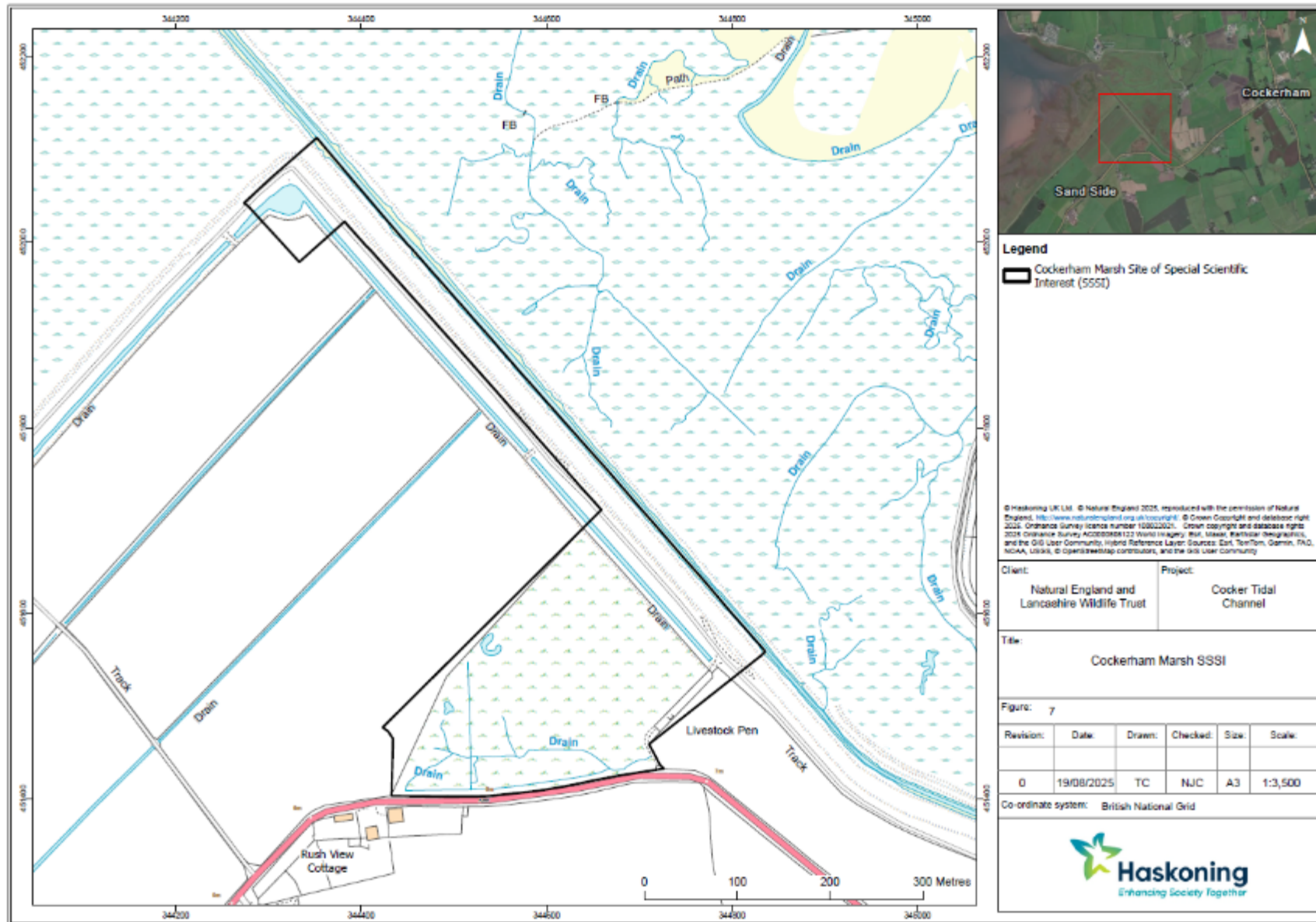


Figure 7 Cockerham Marsh SSSI

Project related

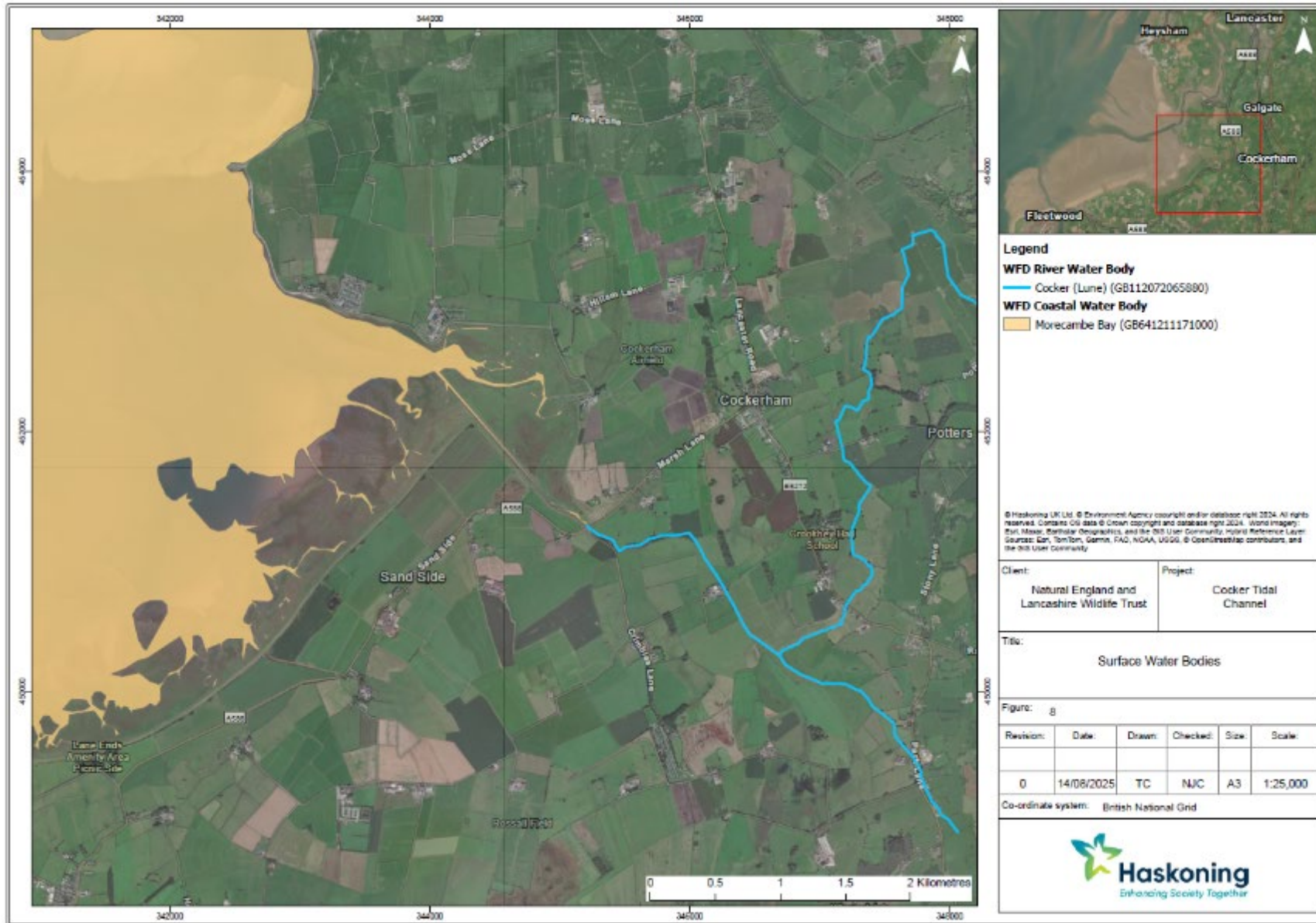


Figure 8 Surface Water Bodies

Project related

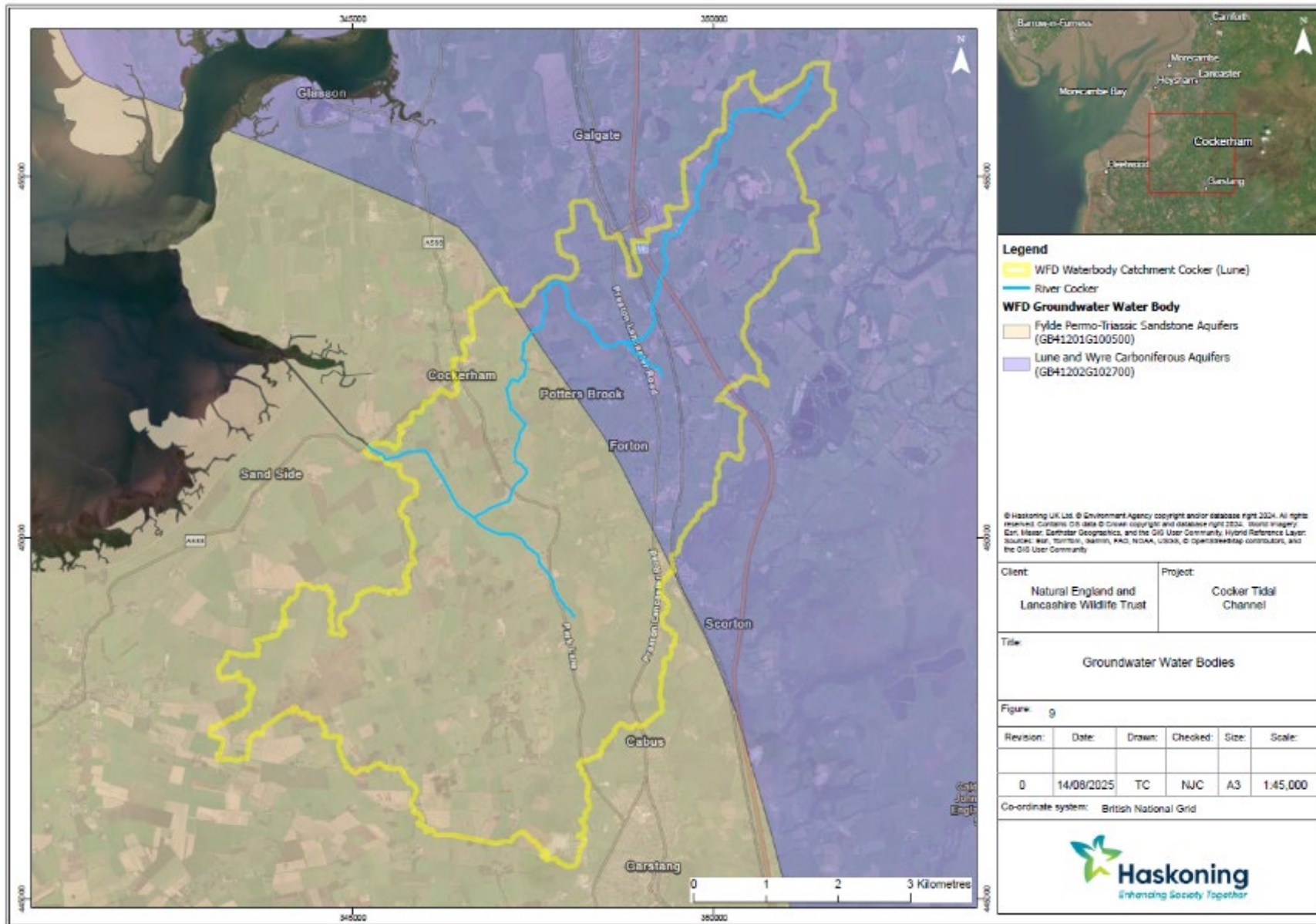


Figure 9 Groundwater Water Bodies

2.5 Community Engagement

A report (Halcrow, 2010) on the public consultation responses to the SMP2 in 2008 shows the depth of concern about the risk to properties, land, caravan park sites, and historic artefacts in sub-cell 11c 2.4 to the extent that the policy for this sub-cell was changed from Managed Realignment to Hold the Line:

‘There were further significant concerns relating to the impact of realignment on businesses, specifically farmland and caravan parks, and the knock-on effects on the local economy should these be lost. Concerns were also raised regarding the risk to Cockersand Abbey Scheduled Monument’.

However, most notable was that the over-riding matter coming from the consultation responses was the reported lack of direct consultation with the community and a high level of anger, frustration and distress caused. Considering there has not been much progress with the two sub-cell policies since the review and yet our understanding of climate change and flood predictions has moved on it seems appropriate and urgent that bringing the community into the heart of investigations and decision making should be enabled.

More recently through attendance at the Glasson and Thurnham Flood Forum (March 2025) it has become apparent that the Environment Agency is no longer in a position to maintain the sea defences along this frontage and fears abound within the community of the increased risk of erosion to the wall currently protecting the historic Cockersand Abbey and the shoreline to Glasson Marsh (Grade II listed farm buildings at Crook Farm).

Natural England has discussed some of the above with Environment Agency colleagues who share the ambition to make progress with the sub-cell 11c 2.3 policies and to enhance understanding of the hydrodynamics, options and risks along this section of coast.

A separate but associated project to the present study will be carried out simultaneously for engagement with local stakeholders, residents and politicians. Engagement will be carried out by the Project Manager and Our Future Coast Communications & Engagement team and will complement the investigation, providing opportunities to link in with these conversations which may also influence the investigation direction and outcome.

Engaging the communities and stakeholders around this area, including any grazers of the saltmarsh, is critical to developing an action plan that will benefit them by adapting to protect their assets and livelihoods into the future making them resilient against climate change while reaping additional benefits for habitat and species restoration.

2.6 Researchers

The eminent Professor Steers (1946) referred to the Cockerham to Pilling frontage as comprising *“the finest development of true salt marshes in Morecambe Bay ... [which] extend east and west for about four miles and vary in width from a quarter of a mile to a mile. They are not quite natural, since in the extreme western part Salicornia spp. (Samphire) is cultivated, and much of Cockerham marsh is exploited for turf. This is favoured by allowing sheep to crop the grass, a practice which also works to the detriment of other plants such as aster, lavender and arrowgrass. In parts the marshes have an intricate system of creeks and pans, while near the river Cocker is a transitional area between salt marsh and freshwater fen. All the Morecambe Bay marshes are very flat and the impression of flatness is intensified by the close cropping of sheep.”* He also reports that Cockersand Abbey was built upon an outcrop of Red Sandstone of Permian age, but there are no other solid rocks on the coast between Heysham and the Wirral peninsula.

Some decades later, Robinson & Pringle (1987) noted the reclamation of 270 ha of the Pilling-Cockerham Marshes by a flood embankment constructed by the North West Water Authority (NWWA) in 1980-81. Serious flooding by breaches of the old defences in November 1977 led to proposals for a straighter embankment further out on the saltmarsh, combining sea defence with agricultural reclamation. At this time the A588 from Cockerham to Pilling, which formerly ran along the top of the saltmarsh, was brought behind the new flood embankment. As originally proposed, the embankment presented a conflict with nature conservation as it would have enclosed the entire saltmarsh including the Fluke Hall wader roost, the main roost for the Lune Estuary. After lengthy consultation by the NWWA with the agricultural and nature conservation interests, a modified line acceptable to all parties was adopted.

2.7 Tidal Parameters

2.7.1 Astronomical Tidal Levels

The United Kingdom Hydrographic Office (UKHO) annually published predicted astronomical tidal levels at a series of 'standard ports' around the UK coastline. The nearest standard ports to Cockerham Sands are Fleetwood and Heysham (see Figure 10). The astronomical tidal level values for 2025 from the UKHO are reproduced in Table 1.

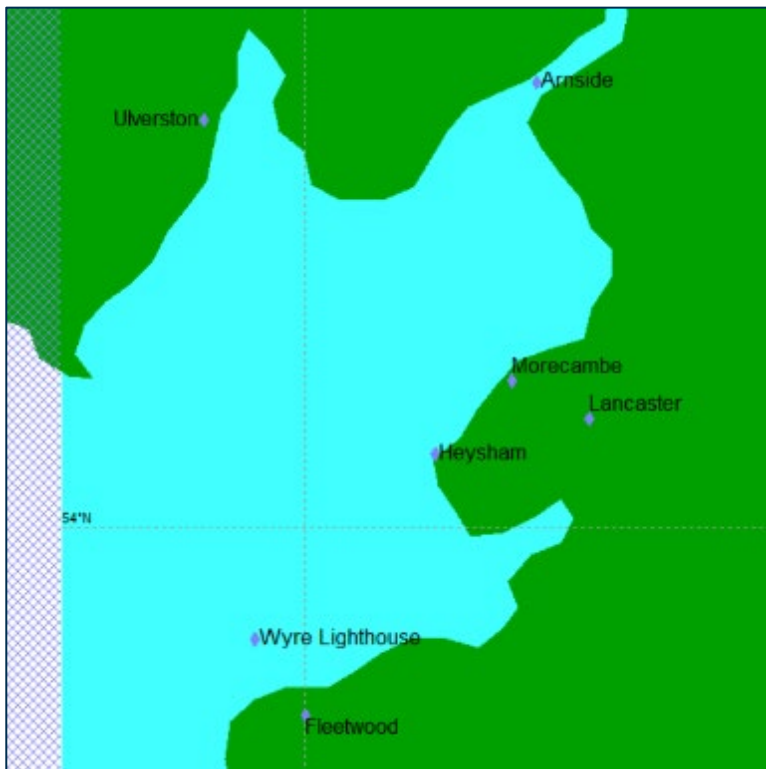


Figure 10 Location of UKHO Standard Ports used in the Study

Table 1 Astronomical tidal levels (base date 2025)

Tidal Parameter	Astronomical Tidal Level (mAOD)	
	Fleetwood	Heysham
Highest Astronomical Tide (HAT)	5.7	5.9
Mean High Water Springs (MHWS)	4.5	4.7
Mean High Water Neaps (MHWN)	2.4	2.5
Mean Low Water Neaps (MLWN)	-1.8	-1.8
Mean Low Water Springs (MLWS)	-3.7	-3.7
Lowest Astronomical Tide (HAT)	-4.7	-4.7

Note: Chart Datum is 4.90 m below Ordnance Datum.

2.7.2 Extreme Sea Levels

Astronomical tidal levels can be elevated or suppressed by meteorological events such as wind set-up and surge. Flood risk is mostly influenced by positive surge events which can elevate water levels by more than 1 m within Morecambe Bay. The Environment Agency has published Coastal Flood Boundary (CFB) conditions around England and two sites are close to Cockerham Sands, namely model points 1244 and 1242 (see Figure 11). The extreme sea level values (with a base date of 2008) from the CFB outputs are reproduced in Table 2.

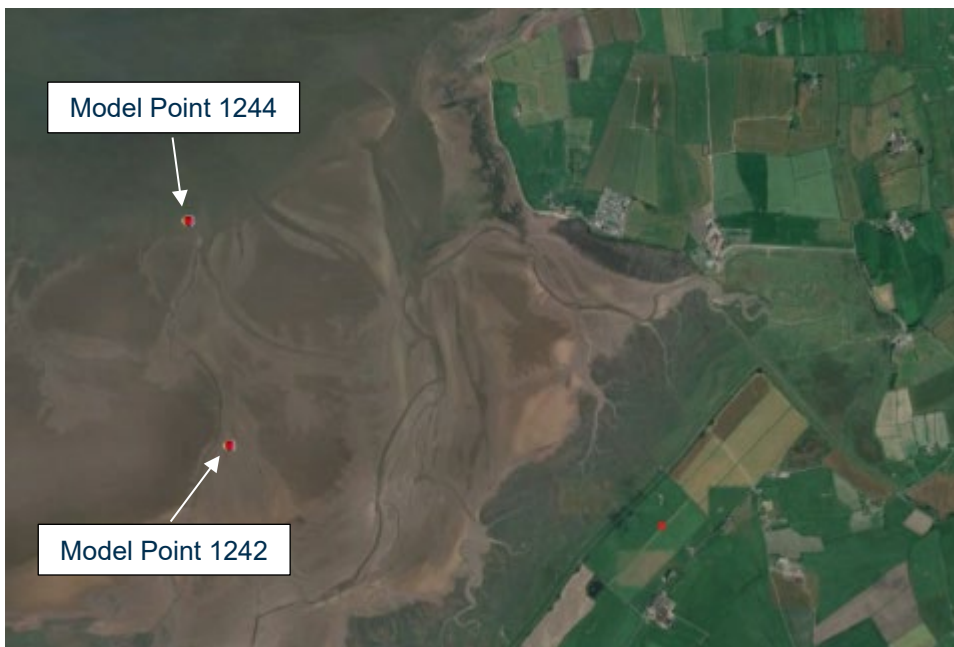


Figure 11 Location of CFB Model Points used in the Study

Table 2 Extreme sea levels (base date 2007)

Return Period (1 in X years)	Extreme Sea Level (mAOD)	
	Model Point 1244	Model Point 1242
1	5.85	5.80
5	6.15	6.11
10	6.27	6.23
25	6.44	6.40
50	6.56	6.52
100	6.68	6.65
200	6.82	6.78
1,000	7.10	7.07

2.8 Saltmarsh Extent and Zonation

Environment Agency mapping of the extent and zonation of saltmarsh (from 2012) has been downloaded from the Defra data portal (Figure 12). This shows that at the time of that classification there were several areas at the seaward marsh edge dominated by pioneer species, with occasional areas of *Spartina spp.* A much wider and more extensive section of low to mid saltmarsh dominates much of Cockerham Sands, with the landward margins throughout characterised by upper saltmarsh species. The width of upper marsh is greater along the Pilling-Cockerham Marsh and adjacent to the cut Cocker Channel, with only a narrow strip (or in some places isolated patches) present along the Bank End Farm frontage.

Natural England has Priority Habitat Mapping of the study area (Figure 13). This shows the seaward areas dominated by 'Coastal saltmarsh' priority habitat, with much of the backing land (including Cockerham Marsh SSSI) classified as 'Coastal and floodplain grazing marsh'.

Project related

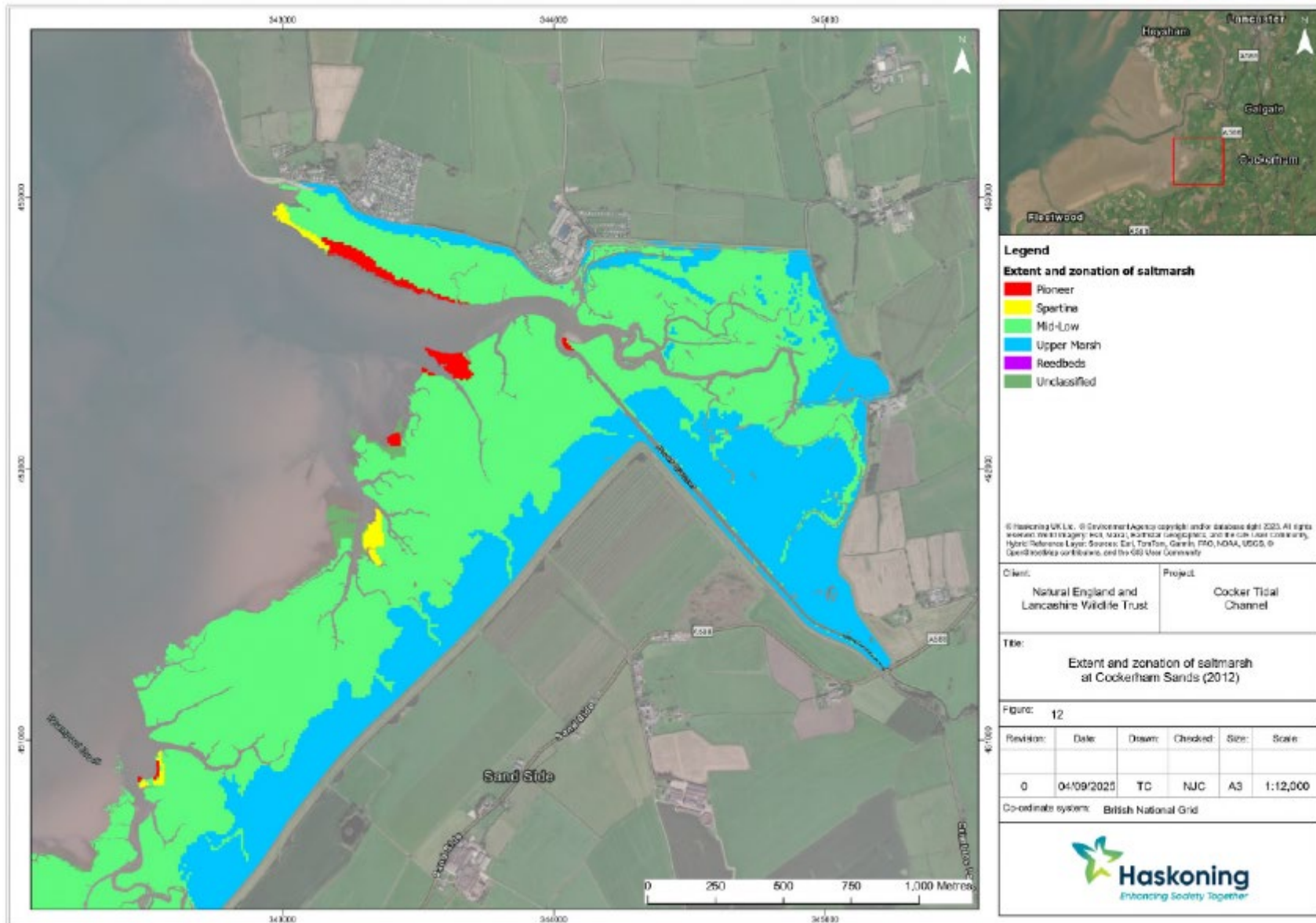


Figure 12 Extent and zonation of saltmarsh at Cockerham Sands (2012)

Project related

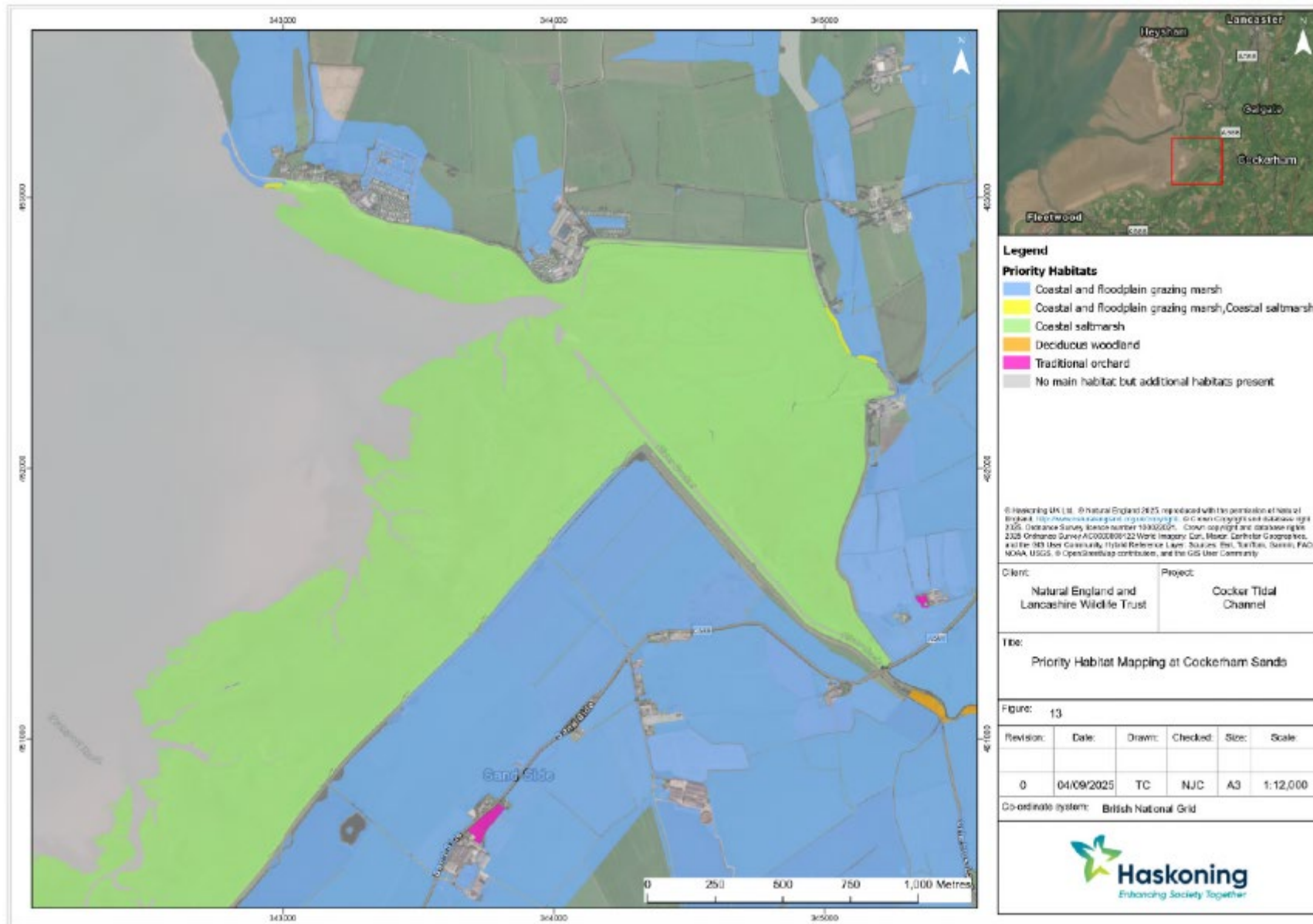


Figure 13 Priority Habitat Mapping at Cockerham Sands

2.9 Flood Risk

Environment Agency maps of flood extents from fluvial and tidal sources for flood zones 2¹ and 3² and flood extents from surface water flooding for various annual likelihoods of occurrence (both present-day and with future climate change) are available from the Flood maps for planning website. These have been reproduced below in Figure 14 to Figure 22. It can be seen that even with the presence of existing flood defences, considerable areas of the hinterland across the Thurnham peninsula would become inundated by sea flooding. If the tidal and river flood defences were not present, then extensive areas of land would be at risk of flooding from the rivers and the sea.

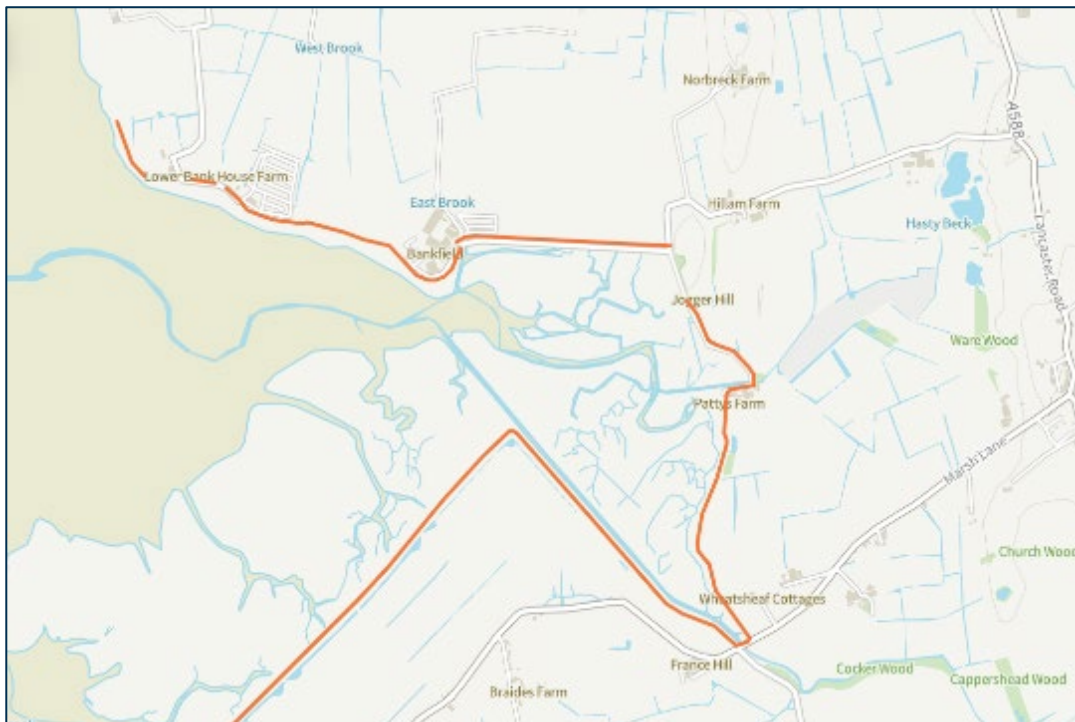


Figure 14 Location plan with existing defences (shown in orange)

¹ Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.

² Land having a 1 in 100 or greater annual probability of river flooding or a 1 in 200 or greater annual probability of sea flooding.

Project related

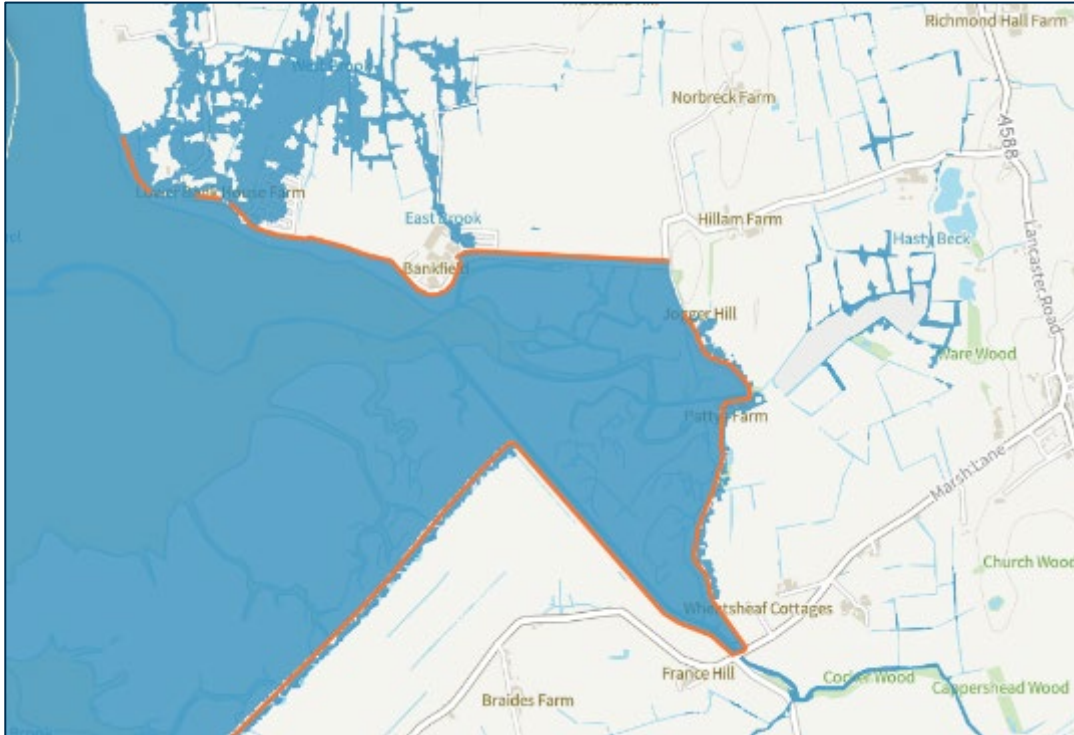


Figure 15 Extent of present-day river and sea flooding with existing defences (1 in 30 annual likelihood of occurrence)



Figure 16 Extent of present-day river and sea flooding with existing defences (1 in 100 for river and 1 in 200 for sea annual likelihood of occurrence)

Project related



Figure 17 Extent of present-day river and sea flooding with existing defences (1 in 1,000 annual likelihood of occurrence)

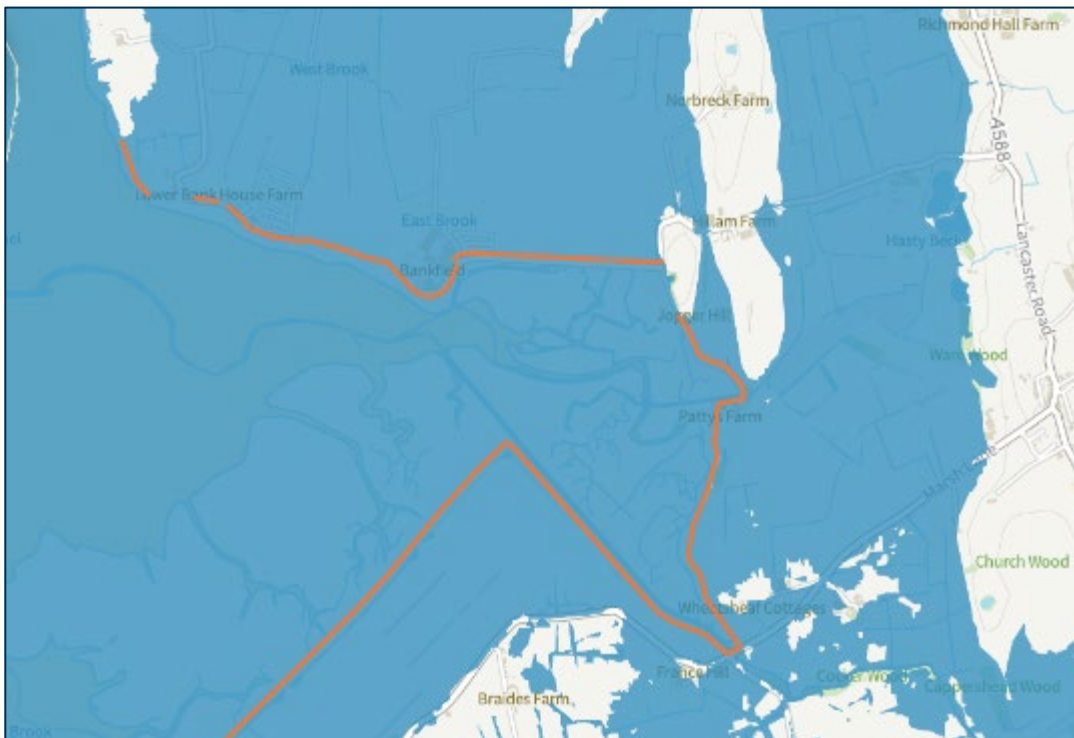


Figure 18 Extent of future (with climate change) river and sea flooding with existing defences (1 in 30 year annual likelihood of occurrence)

Project related

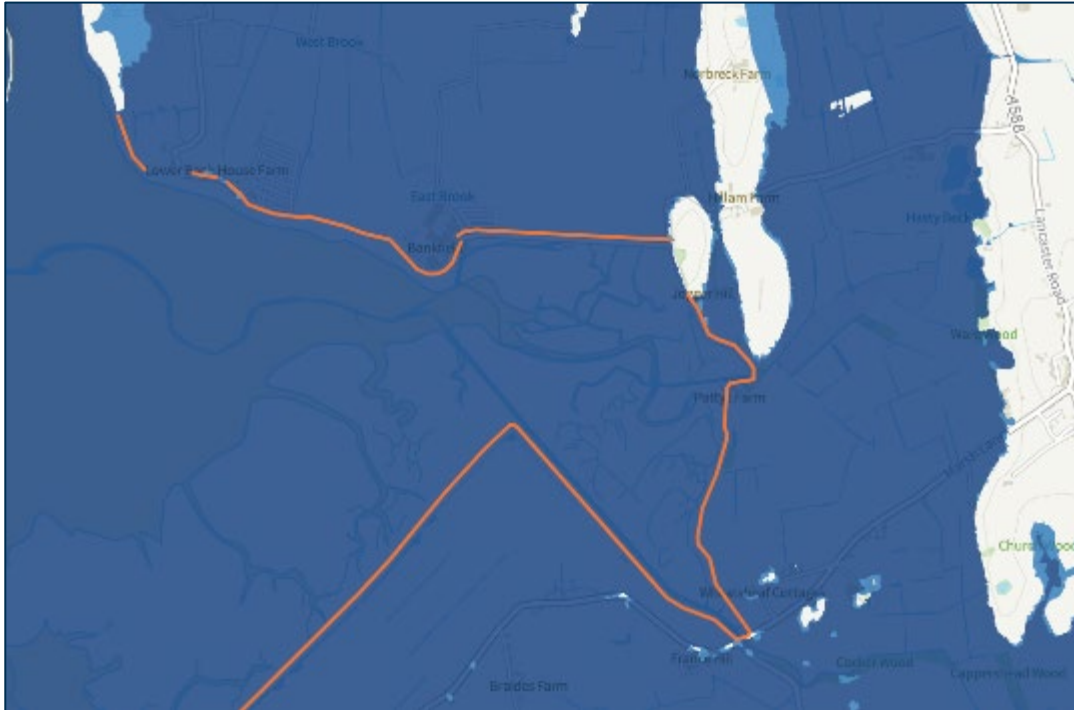


Figure 19 Extent of flood zone 2 (light blue) and flood zone 3 (dark blue) from the rivers and the sea

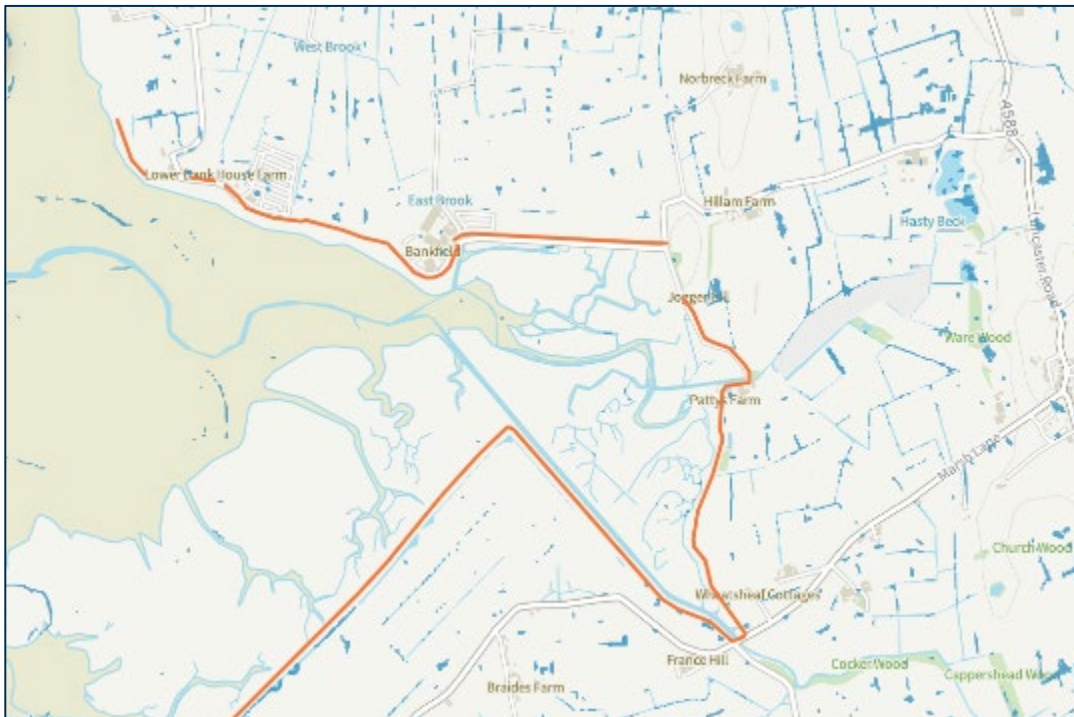


Figure 20 Extent of surface water flooding under a 1 in 30 annual likelihood of occurrence

Project related



Figure 21 Extent of surface water flooding under a 1 in 100 year annual likelihood of occurrence



Figure 22 Extent of surface water flooding under a 1 in 1,000 annual likelihood of occurrence

Additionally, the JBA Trust's *Working with Natural Processes* website³ contains mapping of flood extents under historic flood events (Figure 23).

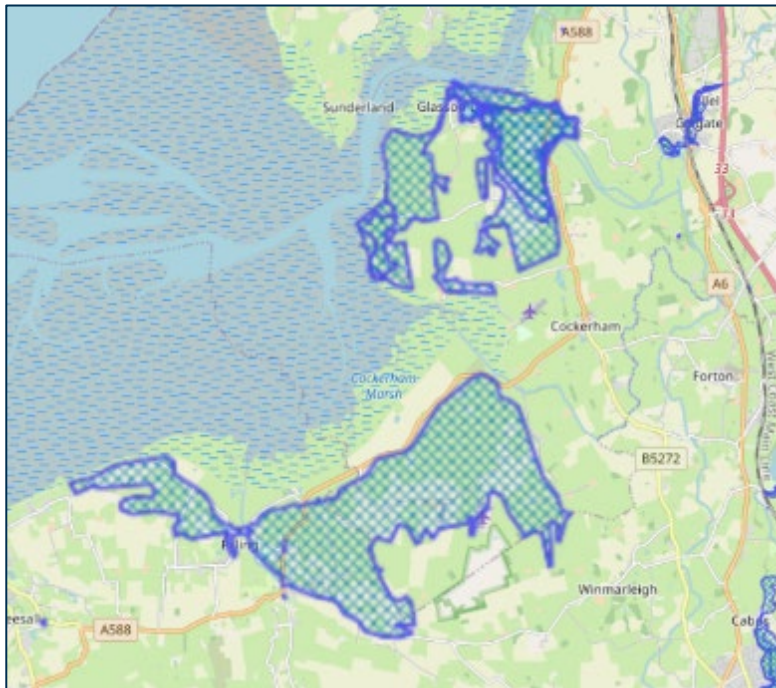


Figure 23 Extent of flooding under historic flood events

2.10 Climate Change Projections

2.10.1 Background

The latest published science on climate change in the UK is the UK Climate Projections 2018 (UKCP18). The online User Interface of UKCP18 has been interrogated to obtain projections of changes in sea level, surge, temperature and rainfall, under representative concentration pathway (RCP) 8.5. Outputs are presented in this section.

In addition, Environment Agency guidance for flood and coastal risk projects⁴ exists which translates the scientific output into recommended guidance allowances for sea level rise, rainfall and river flow. These have been referred to where applicable in this section.

2.10.2 Sea Level

The marine projections for a model grid cell covering Cockerham Sands (Figure 24) yields sea level rise projections as shown in Table 3 and Figure 25. The Environment Agency recommendation is to base projections on RCP8.5 and use the 70th percentile (higher central) as the design allowance and use the 95th percentile (upper end) allowance in planning for more severe climate impacts. It recommends adding the sea level rise allowance for a particular epoch (from a 2018 base date) to the extreme sea levels from the CFB project (which uses a 2018 base date) to yield extreme sea levels for future epochs.

³ *Working with Natural Processes: Map*

⁴ *Flood and coastal risk projects, schemes and strategies: climate change allowances*

Project related

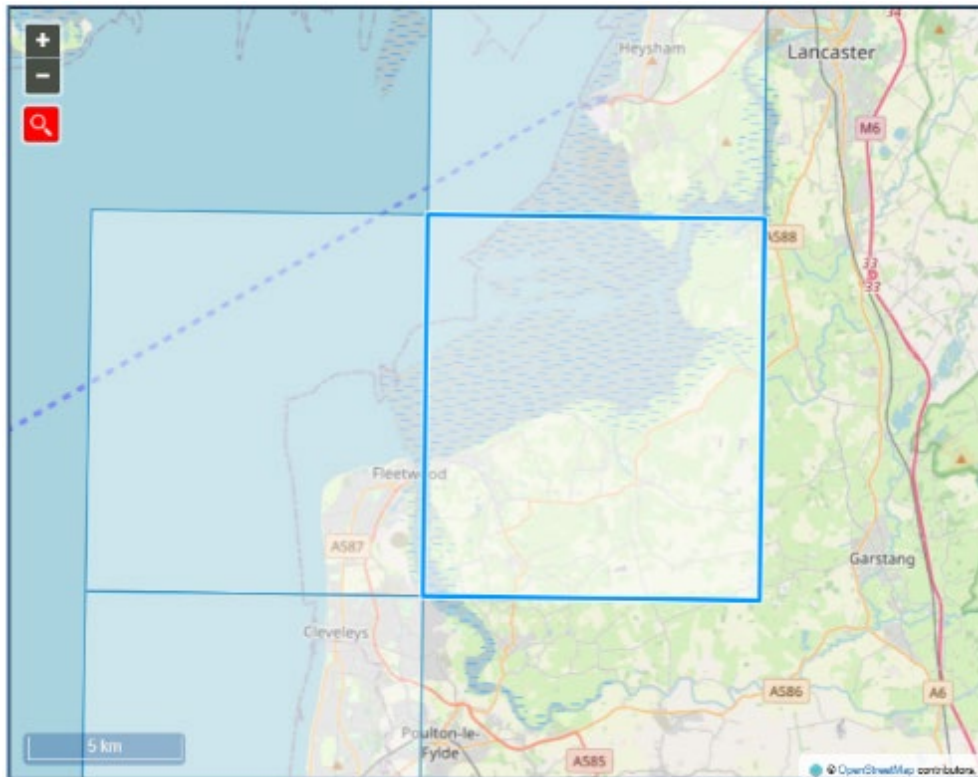


Figure 24 UKCP18 Model Grid Cell for Sea Level Rise Projections

Table 3 UKCP18 RCP8.5 Projections for Sea Level Rise (base date 2018)

Epoch	Sea Level Rise (m)	
	Higher Central (70 th percentile)	Upper End (95 th percentile)
2025	0.03	0.04
2050	0.19	0.24
2075	0.41	0.55
2100	0.68	0.93

Project related

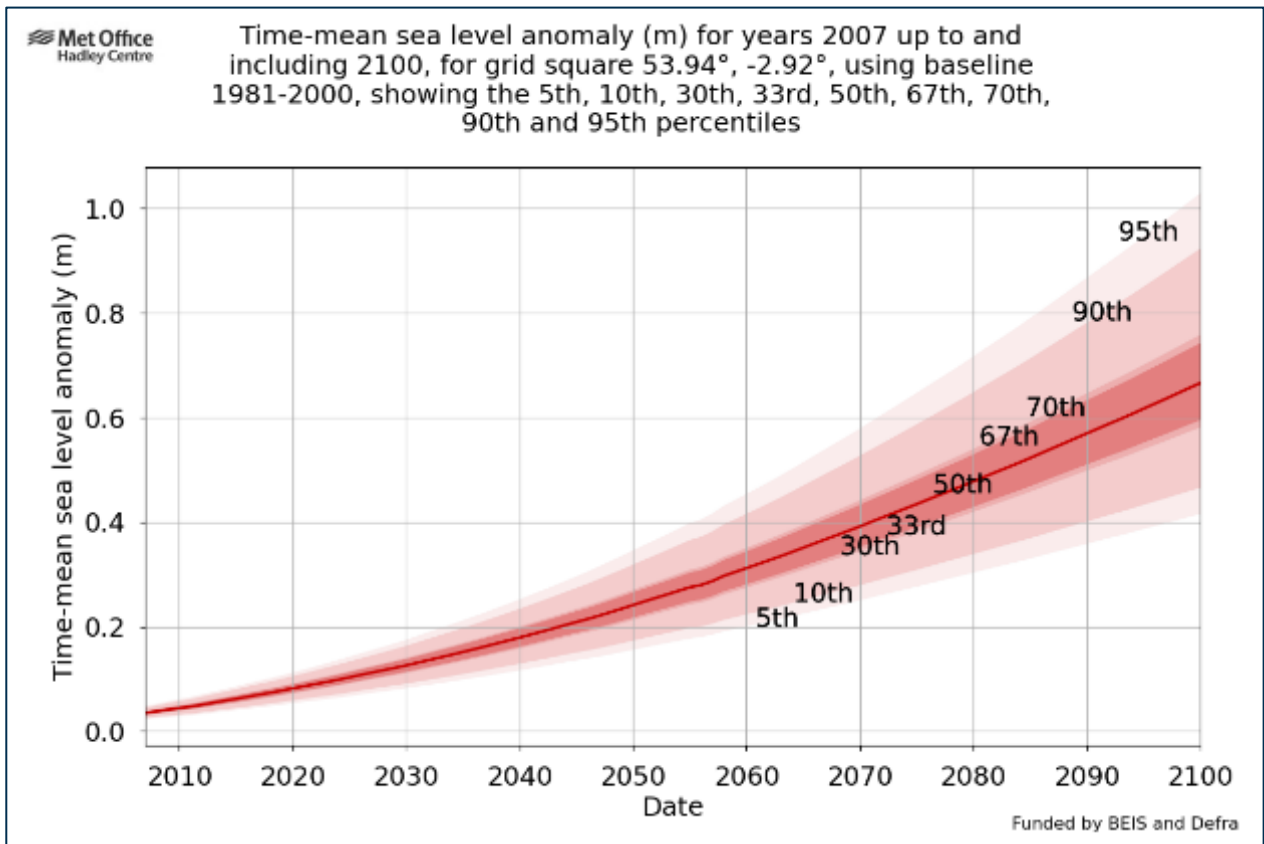


Figure 25 UKCP18 RCP8.5 Projections for Sea Level Rise (base date 2018)

2.10.3 Storm Surge

The Environment Agency guidance recommends adding the sea level rise allowance for a particular epoch (from a 2018 base date) to the extreme sea levels from the CFB project (which uses a 2018 base date) to yield extreme sea levels for future epochs. When the Higher Central (70th percentile) sea level rise allowances are applied to the 2018 extreme sea level base date, the resulting projected extreme sea levels for future epochs are shown in Table 4.

Table 4 UKCP18 RCP8.5 Projections for Extreme Sea Levels (base date 2018)

Return Period (1 in X years)	Extreme Sea Level (mAOD) for Model Point 1244					Extreme Sea Level (mAOD) for Model Point 1242				
	2018	2025	2050	2075	2100	2018	2025	2050	2075	2100
1	5.85	5.88	6.04	6.26	6.53	5.80	5.83	5.99	6.21	6.48
5	6.15	6.18	6.34	6.56	6.83	6.11	6.14	6.30	6.52	6.79
10	6.27	6.30	6.46	6.68	6.95	6.23	6.26	6.42	6.64	6.91
25	6.44	6.47	6.63	6.85	7.12	6.40	6.43	6.59	6.81	7.08
50	6.56	6.59	6.75	6.97	7.24	6.52	6.55	6.71	6.93	7.20
100	6.68	6.71	6.87	7.09	7.36	6.65	6.68	6.84	7.06	7.33
200	6.82	6.85	7.01	7.23	7.50	6.78	6.81	6.97	7.19	7.46
1,000	7.10	7.13	7.29	7.51	7.78	7.07	7.10	7.26	7.48	7.75

2.10.4 Wind

The Environment Agency guidance recommends the allowances in Table 5 for offshore wind speed from a base date of 1990.

Table 5 Environment Agency Allowances for Offshore Wind Speed (base date 1990)

Epoch	Allowances for Offshore Wind Speed	
	Allowance	Sensitivity Test
2200 to 2055	5%	10%
2056 to 2125	10%	10%

2.10.5 Waves

The Environment Agency guidance recommends the allowances in Table 6 for offshore wind speed from a base date of 1990.

Table 6 Environment Agency Allowances for Extreme Wave Height (base date 1990)

Epoch	Allowances for Extreme Wave Height	
	Allowance	Sensitivity Test
2200 to 2055	5%	10%
2056 to 2125	10%	10%

No specific allowances are recommended by the Environment Agency for changes in wave period.

2.10.6 Rainfall

Climate change allowances for peak rainfall in the Lune Management Catchment are provided from Defra via the Hydrology Data Explorer⁵ and are summarised in Table 7.

Table 7 Environment Agency Allowances for Rainfall (base date 1990)

Epoch	3.3% annual exceedance event		1% annual exceedance event	
	Central (50 th percentile)	Upper End (95 th percentile)	Central (50 th percentile)	Upper End (95 th percentile)
2050s	25%	35%	25%	45%
2070s	35%	45%	35%	50%

2.10.7 River Flow

Climate change allowances for peak river flow in the Lune Management Catchment are provided from Defra via the Hydrology Data Explorer⁶ and are summarised in Table 8.

Table 8 Environment Agency Allowances for River Flow (base date 1990)

Epoch	Central (50 th percentile)	Higher (70 th percentile)	Upper (95 th percentile)
2020s	20%	24%	33%
2050s	30%	38%	58%
2080s	49%	61%	92%

⁵ [Climate change allowances for peak rainfall](#)

⁶ [Climate change allowances for peak river flow](#)

2.11 Other Datasets

2.11.1 Historic Maps

Historic maps for the UK are available to view and use from the National Library of Scotland. Of those available, geo-rectified maps from 1845, 1862, 1910, 1951 and 1970 (as well as contemporary Ordnance Survey mapping) were obtained and used within a GIS to map changes in alignment of the Cocker Channel. The maps clearly show the area before and after the channel was cut in the 1960s. The historic maps pre-date construction of the Pilling-Cockerham sea defence embankment, which was used to enclose large areas of saltmarsh along this frontage in 1981.

These historic maps are shown in Figure 26 to Figure 30 with a contemporary OS map in Figure 31 and these have been used in an updated assessment of changes in channel alignment, presented in Section 3 of this report.



Figure 26 Historic map from 1845 (reproduced with the permission of the National Library of Scotland)



Figure 27 Historic map from 1862 (reproduced with the permission of the National Library of Scotland)

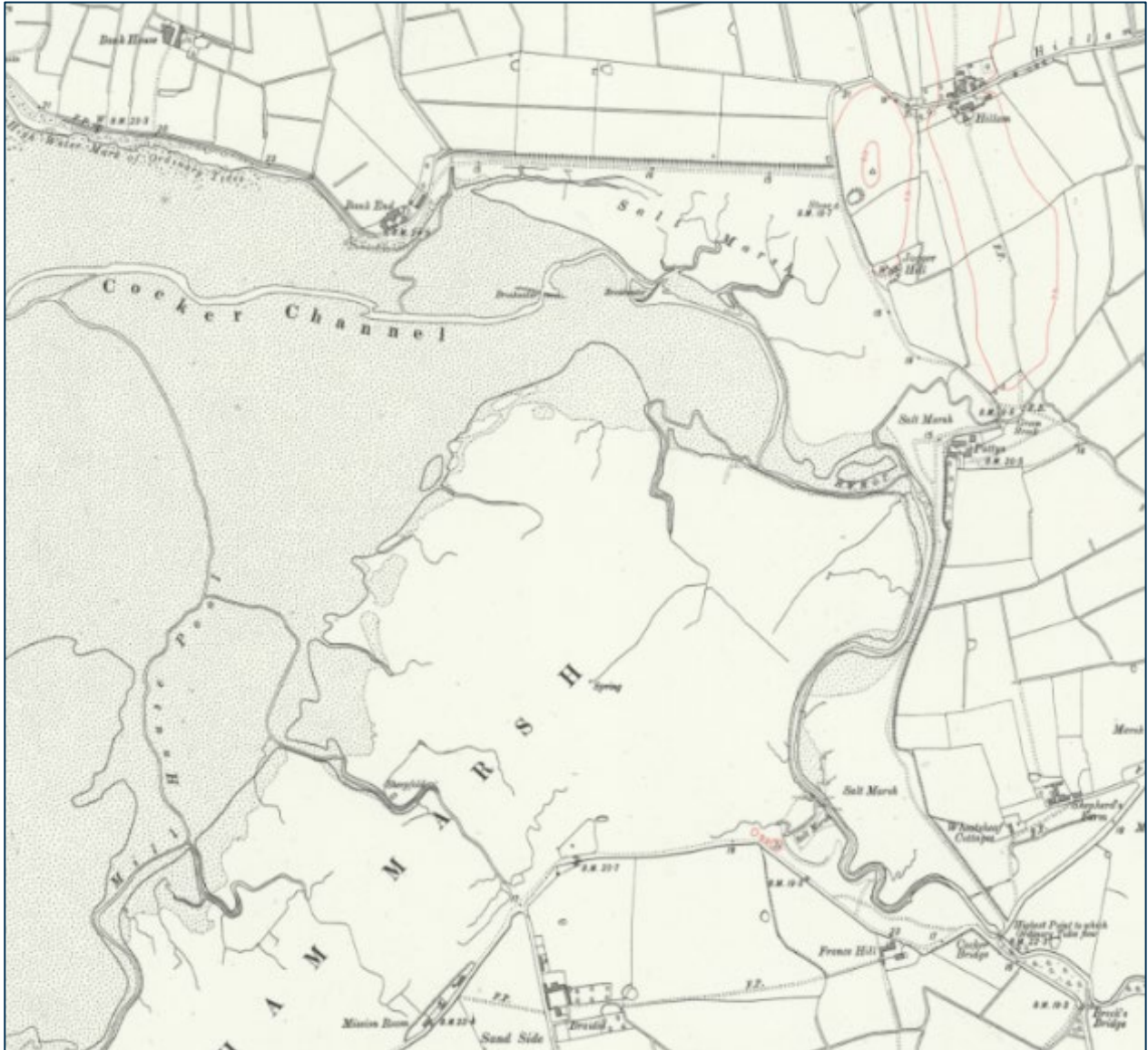


Figure 28 Historic map from 1910 (reproduced with the permission of the National Library of Scotland)

Project related

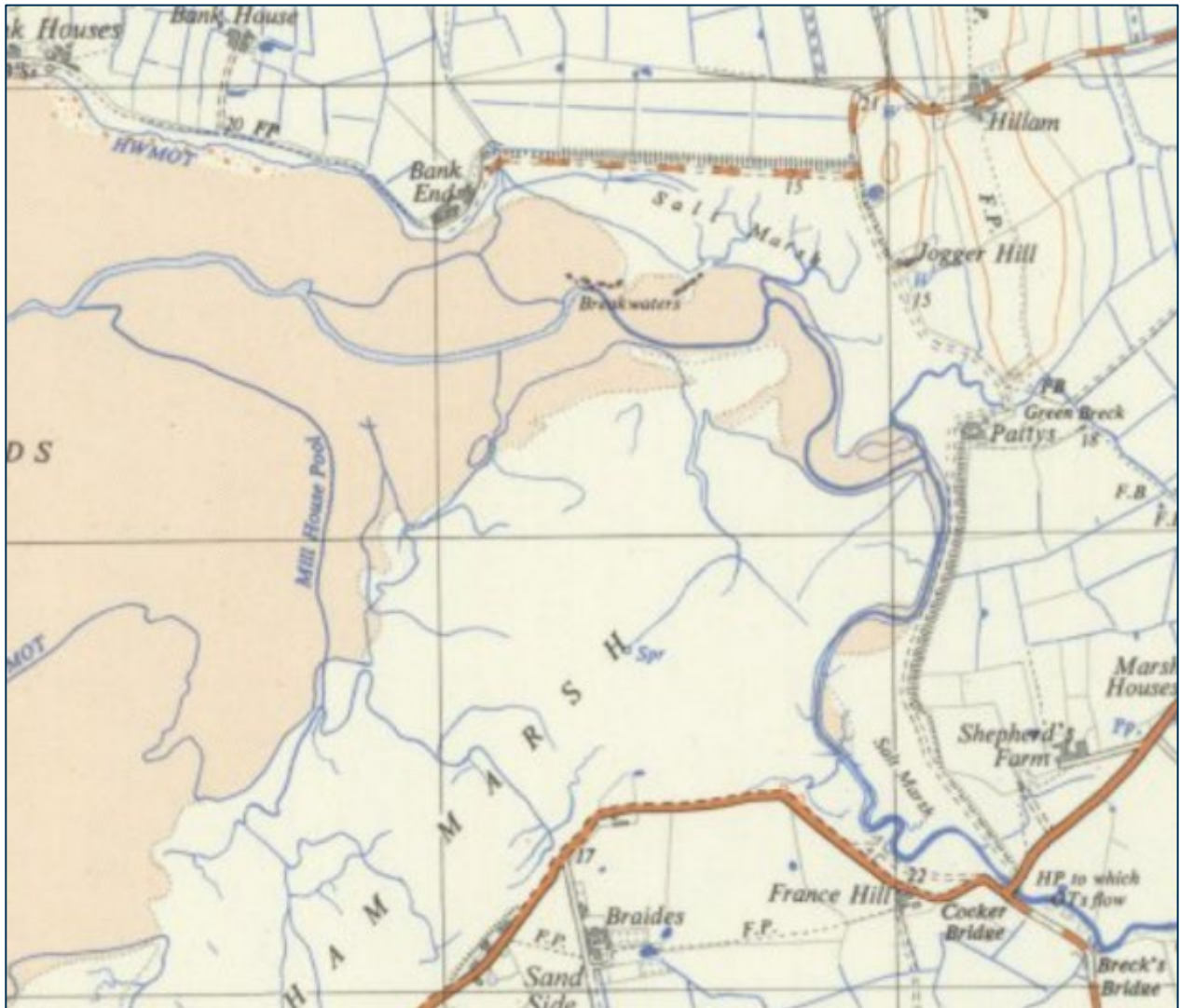


Figure 29 Historic map from 1951 (reproduced with the permission of the National Library of Scotland)

Project related



Figure 30 Historic map from 1970 (reproduced with the permission of the National Library of Scotland)

Project related

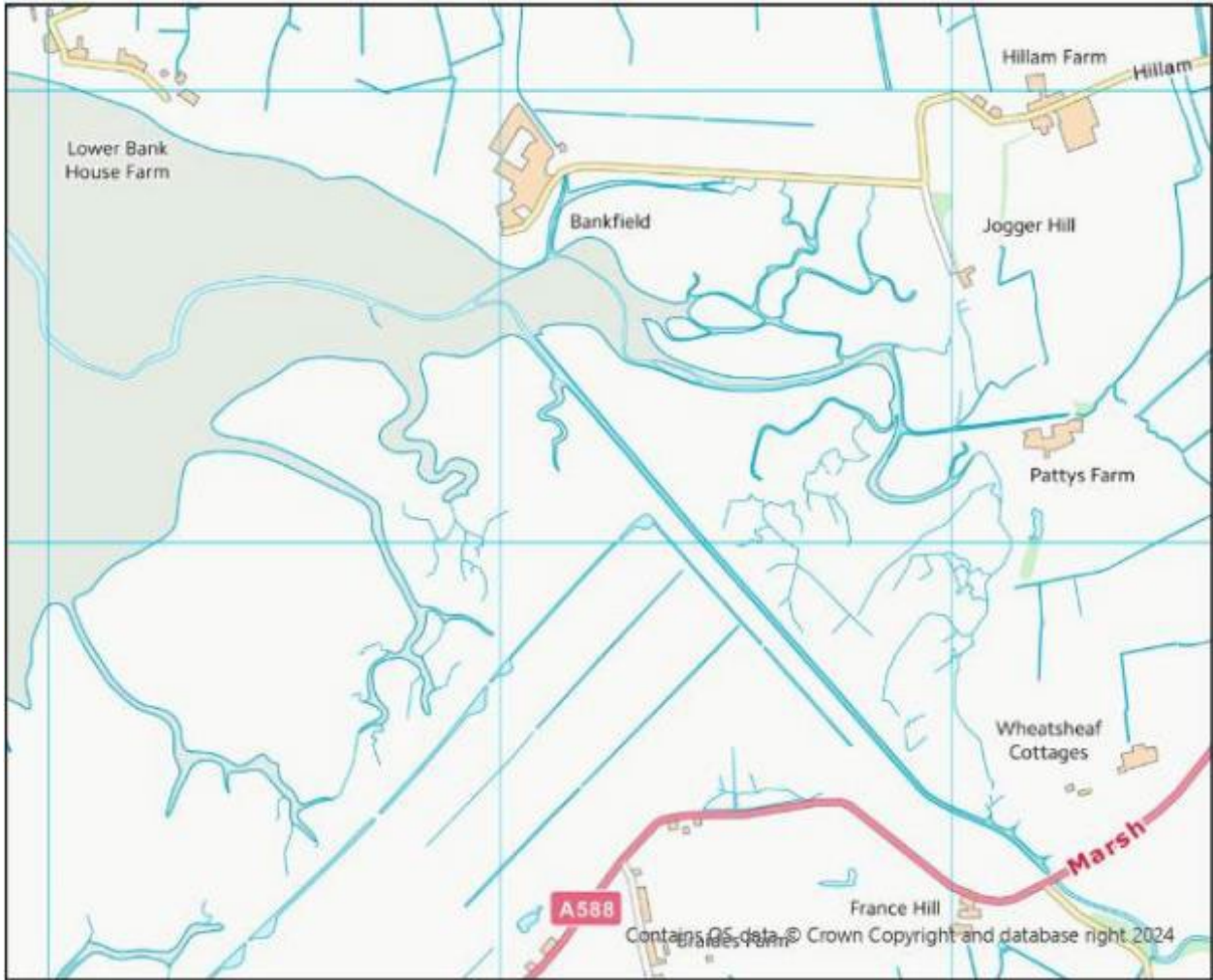


Figure 31 Contemporary Ordnance Survey map from 2024

2.11.2 Profile Transect Surveys

Profile transect surveys at locations across Cockerham Sands are collected by the North West Coastal Monitoring Programme. These are grouped into their respective SMP units, so some transects cross unit 11c2-4 and some cross unit 11c2-3 (although the latter are further west of the present study area and have not been collated during Task 1). Surveys within unit 11c2-4 at locations CC01 to CC06 (see Figure 32) have been obtained from all survey dates between 2007 and 2024.



Figure 32 Location of profile transects available from North West Coastal Monitoring Programme

These survey data have been used in an updated assessment of changes in channel alignment, presented in Section 3 of this report.

2.11.3 Aerial Photography

The North West Coastal Monitoring Programme has collected aerial photography data covering Cockerham Sands. Vertical aerial photography has been obtained from 2012, 2017 and 2023, and oblique aerial photography from 2018.

These have been supplemented with aerial photographs from 1948 (from Heritage England) and 2000 (from Emap) which were purchased specifically for this study. Google Earth also contains aerial images from the years 2000, 2002, 2010, 2015, 2017, 2018, 2020, 2021 and 2023 which are suitable for online viewing (but cannot be downloaded for use).

These aerial photographs (excluding the Google Earth aerial images) are shown in Figure 33 to Figure 37 and have been used in an updated assessment of changes in channel alignment, presented in Section 3 of this report.

Project related



Figure 33 Aerial photograph from 1948



Figure 34 Aerial photograph from 2000

Project related



Image (2012) courtesy of Channel Coastal Observatory.

Figure 35 Aerial photograph from 2012



Image (2017) courtesy of Channel Coastal Observatory.

Figure 36 Aerial photograph from 2017



Figure 37 Aerial photograph from 2023

2.11.4 LiDAR

Light Detection and Range (LiDAR) data is available for Cockerham Sands and the Cocker Catchment from the North West Coastal Monitoring Programme in 2017 and from the Environment Agency in 2023 (grid format) and 2024 (point cloud format). These data (shown as a contour plot in Figure 38) will be used in Task 2 of the study.

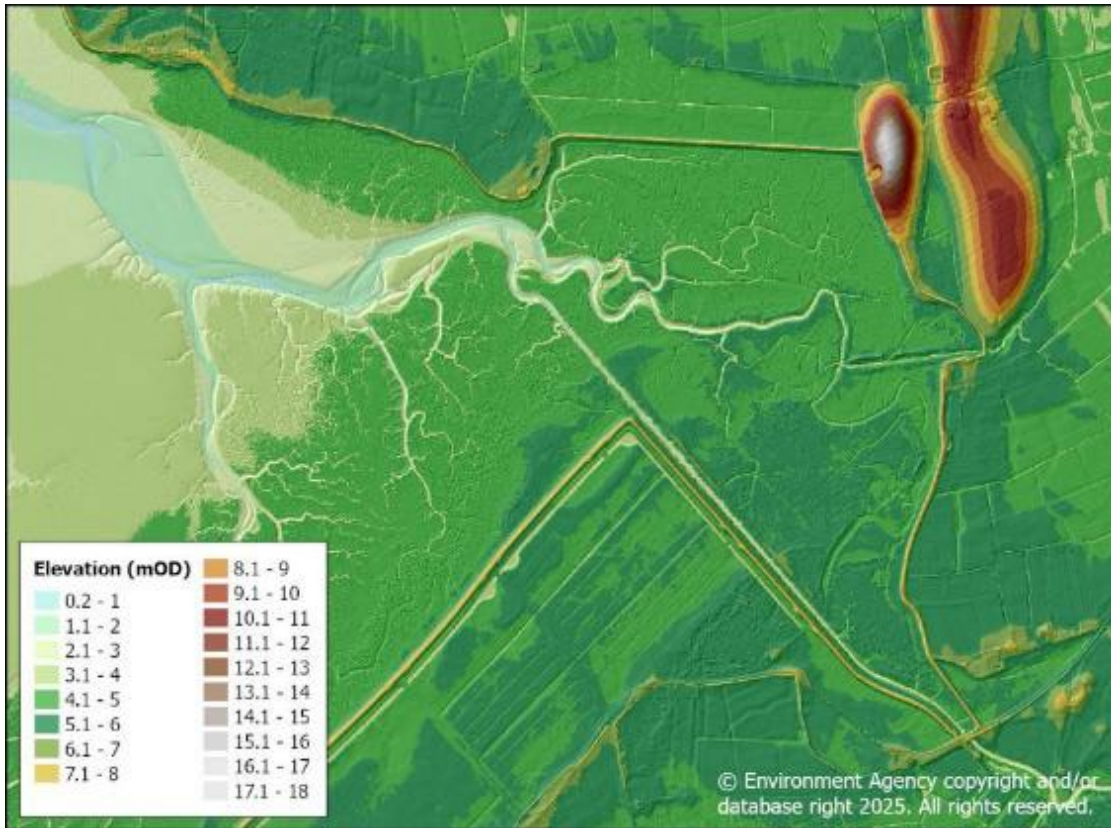


Figure 38 Contour plot based on LiDAR data from 2024

2.11.5 Drone Laserscan and Aerial Photography

As part of the regional work by the the North West Coastal Monitoring Programme, Andrew Martin of Sefton Borough Council and Mandy Knott of Natural England kindly undertook a drone laserscan and aerial photography survey of the Cockerham Marsh SSSI, tidal River Cocker Channel and parts of the surrounding areas on various dates in August 2025. These surveys were bolstered by a drone survey by Amy Collier from Our Future Coast. These datasets will prove useful for Task 2 of the study, during each of the optioneering, modelling and design stages. An example image from the drone laserscan point cloud data is shown in Figure 39 and an example image from the drone aerial photography is shown in Figure 40.



Figure 39 Drone laserscan point cloud data from 2025



Figure 40 Drone aerial imagery from 2025

2.11.6 Bathymetry

To inform Task 2b (modelling) we will use the most recently available Environment Agency LiDAR data (for above low water levels) and combine this with C-Map data and EMODnet data for the bathymetry below low water.

These data will be used in Task 2 of the study.

2.11.7 Channel Sections

In March 2013, a long section of the tidal Cocker Channel was surveyed by Survey Operations Limited. This covered the channel seaward of the tidal sluice at Cocker Bridge and covered both the new cut and the natural Outer Cocker Channel. Records were provided of the water level, soft bed level and hard bed level, along with a series of accompanying channel section photographs.

These data will be used in Task 2 of the study.

2.11.8 Tidal Water Level

Measured water level data are available from the British Oceanographic Data Centre (BODC) at Heysham, whilst astronomical tidal predictions are available from the United Kingdom Hydrographic Office (UKHO) at both Heysham and Fleetwood. These will be downloaded from the respective websites and used for modelling during Task 2 of the study.

2.11.9 River Flow

The Environment Agency does not have any continuous flow data from the River Cocker, but was able to provide 'spot gauging' at various locations along the freshwater reaches from surveys in 1963, 1979, 1982, 1983 and 1995. This will be reviewed during the modelling activities in Task 2b.

2.11.10 Channel Dredging

The previous Geomorphological Appraisal (Swift, 2013) referred to the Environment Agency having undertaken some past maintenance dredging of the new cut of the tidal Cocker Channel by mechanically removing accumulated silt so the channel could continue to convey the required discharge downstream of the tidal sluice.

To date the Environment Agency has provided notes from a meeting in 2014 which confirmed that the channel used to be dredged yearly until some point in the 1990s, with the arisings used to strengthen embankment between Cocker Bridge and Patty's Farm. It was envisaged that after new tidal gates were installed in 2014 on the sluice at Cocker Bridge, the channel would be cleared by flushing with freshwater

It is understood that the channel is owned by Morecambe Bay Wildfowlers Association. As recently as December 2024 / January 2025 deposited sediment was cleared from the channel.

It will be useful to learn whether maintenance dredging and/or sluice clearance (by mechanical means or 'flushing') continues. Any further information obtainable on this matter will be useful during Task 2 of the study.

2.11.11 Land Drainage

A Delph ditch on the landward side of the 1981 Pilling-Cockerham sea defence embankment is used to drain water off the reclaimed agricultural land at, and adjacent to, Cockerham Marsh SSSI and to catch any tidal overflows. The ditch starts at Cockerham Marsh SSSI and drains first northwest and then southeast (to the rear of the embankment) towards an outfall at Mill House where there is a tidal flap to prevent tidal inflows. The section between Cocker Bridge and Cockerham Marsh SSSI, which was also enclosed by the Pilling-Cockerham sea defence embankment in 1981 does not have an open Delph ditch but does have a series of man-hole covers to the rear of the embankment, implying a buried toe drain drains into the Delph ditch.

2.11.12 Nature Based Solutions Opportunities

JBA Trust has developed a *Working with Natural Processes* website⁷ hosting known NFM projects and areas of mapped NBS potential around Great Britain. It is intended that this is used in Task 3 as a starting point upon which the work within this study will be developed.

⁷ [*Working with Natural Processes: Map*](#)

2.11.13 SSSI Condition Assessment

Natural England has kindly provided the following mapping and information relating to Cockerham Marsh SSSI for use in Task 4 of the study:

- Location plan of SSSI
- Land ownership plan of SSSI
- Location of ponds within SSSI
- Location of ponds and proposed land levelling within SSSI
- Cockerham Marsh SSSI Citation
- Cockerham Marsh SSSI Operations Likely to Damage the Special Interest
- Cockerham Marsh SSSI Views About Management (VAM)
- Cockerham Marsh SSSI Management Plan 2010
- **CONFIDENTIAL – FOR PROJECT USE ONLY** Cockerham Marsh SSSI Definitions of Favourable Condition for Designated Features of Interest
- Cockerham Marsh SSSI Designated Site View (DSV) Feature Condition (dated 31st July 2025).

Natterjack toads were first recorded at Cockerham Marsh's upper saltmarsh ponds in 1969, with breeding first confirmed in 1970. At the time of the site's notification in 1979, it consisted of several pools on the upper saltmarsh and breeding was confirmed in most years thereafter until 1987.

The saltmarsh became enclosed by the Pilling-Cockerham sea defence embankment in 1981. The site became re-notified in 1985, with the adjacent length of embankment and Delph ditch being included because it was thought that the colony might expand into these areas (although this did not occur).

Since enclosure, the former upper saltmarsh area has developed into marshy grassland following the decrease in salinity levels. No natterjack toads have been recorded breeding at the site since 1987 and the last record of adult presence (two females) at the site was in 1990. This is despite efforts at habitat restoration in several years since 1997 and (unsuccessful) translocation of spawn in 2000 - 2005.

The pattern of a declining population of natterjack toads at Cockerham Marsh SSSI is presented in Figure 41 (from Buckley & Beebee, 2004).

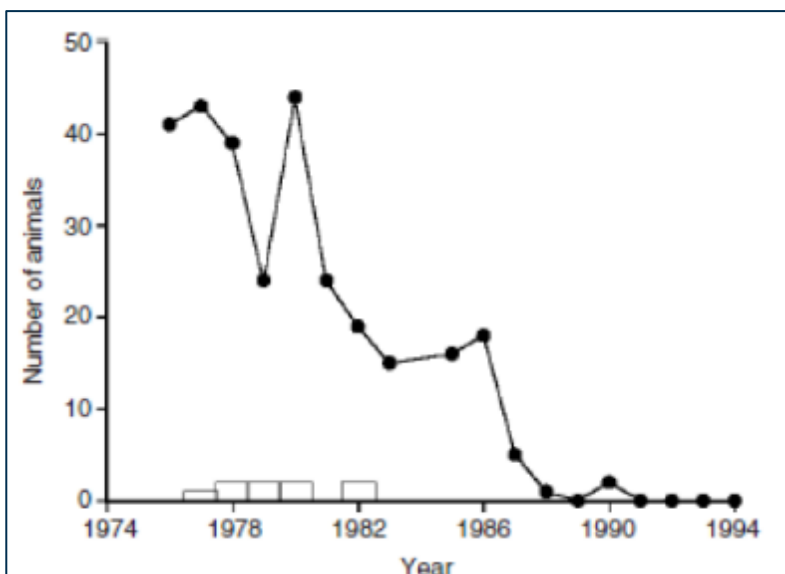


Figure 41 Pattern of a declining population of natterjack toads at Cockerham Marsh SSSI (from Buckley & Beebee, 2004)

2.11.14 Natterjack Toad Guidance

The Natterjack Toad Conservation Handbook (Beebee & Denton, 1996) has been superseded by Chapter 11 Natterjack Toad and Chapter 12 Translocation and Reintroduction of the Amphibian Habitat Management Handbook (Baker, Beebee, Buckley, Gent & Orchard, 2011). Other relevant information does exist and has largely been incorporated into the latest guidance. Box B provides a synopsis of the key aspects of the guidance that may influence optioneering (Task 2a) or design (Task 2c) as part of the present study.

Box B – Background and Design Considerations from Natterjack Toad Guidance

Background

- Natterjack toads are a European Protected Species (EPS) and a UK Biodiversity Action Plan (BAP) species.
- There are around 15,000 – 20,000 adults in the UK
- They are a habitat specialist, using warm, unshaded (open) habitats on: (i) coastal dune; (ii) upper saltmarsh; and (iii) lowland heath.
- The (shallow) ponds, pools, scrapes and ditches used for breeding are likely to be ephemeral, so sensitive habitat to flooding/drought
- If ponds are permanently salty, they will be toxic to spawn and tadpoles
- If ponds are permanently fresh, there will be too many (earlier breeding) competitors/predators
- They prefer extensive areas of unvegetated or minimally vegetated (sward <1cm) terrestrial vegetation and minimal aquatic vegetation in breeding ponds
- They need nearby substrate in which to burrow, as they shelter in burrows (or drystone walls, under refugia, etc) during day
- They actively hunt prey at night
- [Toadlets newly emerged from tadpole stage are active by day].
- Their habitat sensitivity makes reproduction 'boom or bust'
- They are a relatively long-lived species

Design of Breeding Ponds

- Shallow ponds, pools, scrapes or ditches, so likely to be ephemeral
- Unshaded
- Water depth 50-70 cm, but spawning is in shallower areas at edges (5-10cm water)
- Gradually sloping sides
- Free of predators/competitors (such as common frog, common toad, great crested newts, water beetles and larvae, water boatmen, fish* – which can all eat eggs and tadpoles)

* There is some research that some fish species can be beneficial to natterjack toad as they predate the invertebrates and (earlier spawning) common frog / common toad tadpoles

- Little or no vegetation (encourage livestock grazing of surrounding terrestrial vegetation)

Upper Saltmarsh Habitat

- Nearby embankments or dry-stone walls (or debris such as corrugated tiles) for burrowing and shelter
- Breed in shallow pools at upper edge of saltmarsh that is inundated during only the highest tides in spring and autumn, but then 'freshen-up' due to runoff or rainwater in late spring/summer
- Seasonal (only) seawater inundation removes predators and competitors (ideal pond salinity <15% seawater, 0.5% NaCl – sodium chloride)

Box B – Background and Design Considerations from Natterjack Toad Guidance

Habitat Management

- Increase number of suitable ponds / pools / ditches
- Increase extent of suitable surrounding terrestrial habitat as breeding success improves
- Free from surrounding reeds / rushes / scrub and minimally vegetated (grazing by sheep, cattle, ponies, horses or cutting)
- 'Scrape away' deposited sediment from pond basin and clear aquatic vegetation

Habitat Restoration

- Terrestrial:
 - Mowing and collecting cuttings
 - Foliar spraying (saplings)
 - Weed wiping
 - Grubbing-out scrub > burn > deeply bury or dispose off-site

Pond Creation

- 1:10 or gentler gradient on sides
- Max water depth 50 – 70 cm (spawning in 5-10 cm depths)
- Could be asymmetrical to have deeper areas and shallower areas
- Could be symmetrical 'saucer' design
- Dry-out late summer (desiccation)
- 'Trial and error' approach (manual intervention to slightly deepen or slightly infill over time)
- Construct late summer/early autumn (water table is low)
- 10m diameter of water at start of breeding season (~80m²)
- Spread soil from scrape on ground away from pond edges in low piles (<50cm high) and do not compact – allows areas for burrowing
- Range of ponds of different depths so at least some will be successful in any one year
- Lined or artificial ponds

Translocation

- Prefer natural colonisation but translocation is a last resort (it is in the Natterjack Toad Species Action Plan)
- Must have suitable habitat in place first
- EPS licence required
- 3 successive years of translocation should be undertaken to establish a mixed age structure within the population
- Cut and relocate spawn strings

3 Updated Assessment of Historic and Recent Changes

3.1 Historic Maps

Historic maps from the years 1845, 1910, 1951, 1970 and a contemporary map from 2023 have been used to define changes in position of the saltmarsh edge and alignment of the Cocker Tidal Channel.

3.1.1 Saltmarsh Extent

In the earliest map, from 1845, the saltmarsh edge was aligned roughly along the position of the present Pilling-Cockerham sea defence embankment. By the time of the 1910 mapping, this had prograded seawards within much of the study area; a process which continued to the time of the 1951 mapping.

The new cut of the Cocker Tidal Channel was made in the 1960s and the first available mapping after that date shows continued seaward saltmarsh growth. The upper saltmarsh was reclaimed by construction of the Pilling-Cockerham sea defence embankment and saltmarsh growth appears to have continued between the 1970 mapping and the contemporary mapping from 2023. These changes can be seen in Figure 42.

However, the Environment Agency has undertaken mapping, downloaded from the Defra data portal, which provides a more refined timeline of change in the years between 2009 and 2012 (Figure 43). This suggests that whilst most areas of marsh were stable, there were some zones of marsh-edge erosion, in the vicinity of Bank End Farm and at a few other places along Pilling-Cockerham Marshes, despite a greater extent of marsh growth at the seaward margin along the Pilling-Cockerham Marshes.

Although there is no evidence of what conditions were like prior to the first historic map of 1848, it does appear that there was no saltmarsh in front of Bank End Farm prior to the Cocker Channel straightening in the 1960s, with it being created since that time.

Noting the changes in the vicinity of Bank End Farm (which prompted the Environment Agency's previous Geomorphological Assessment (Swift, 2013)), further analysis of aerial photographs from 1948, 2000, 2012, 2017 and 2023 has been undertaken for this study. It can be seen from Figure 44 that the marsh width has progressively reduced over time in front of Bank End Farm. Whilst the urgency of the issue appears to have lessened (due to an apparent reduction in the annual average rate of erosion) the trend does appear to remain ongoing.

Between 2000 and 2012, some 9.4m width of marsh was lost (an annual average rate of 0.78m/year – in keeping with the findings of Swift (2013) who estimated 0.8m/year erosion). Between 2012 and 2017, a further 4.2m of erosion occurred (an annual average rate of 0.84m/year). This continued to 2023 with a further 3.7m erosion (an annual average rate of 0.61m/year).

Project related

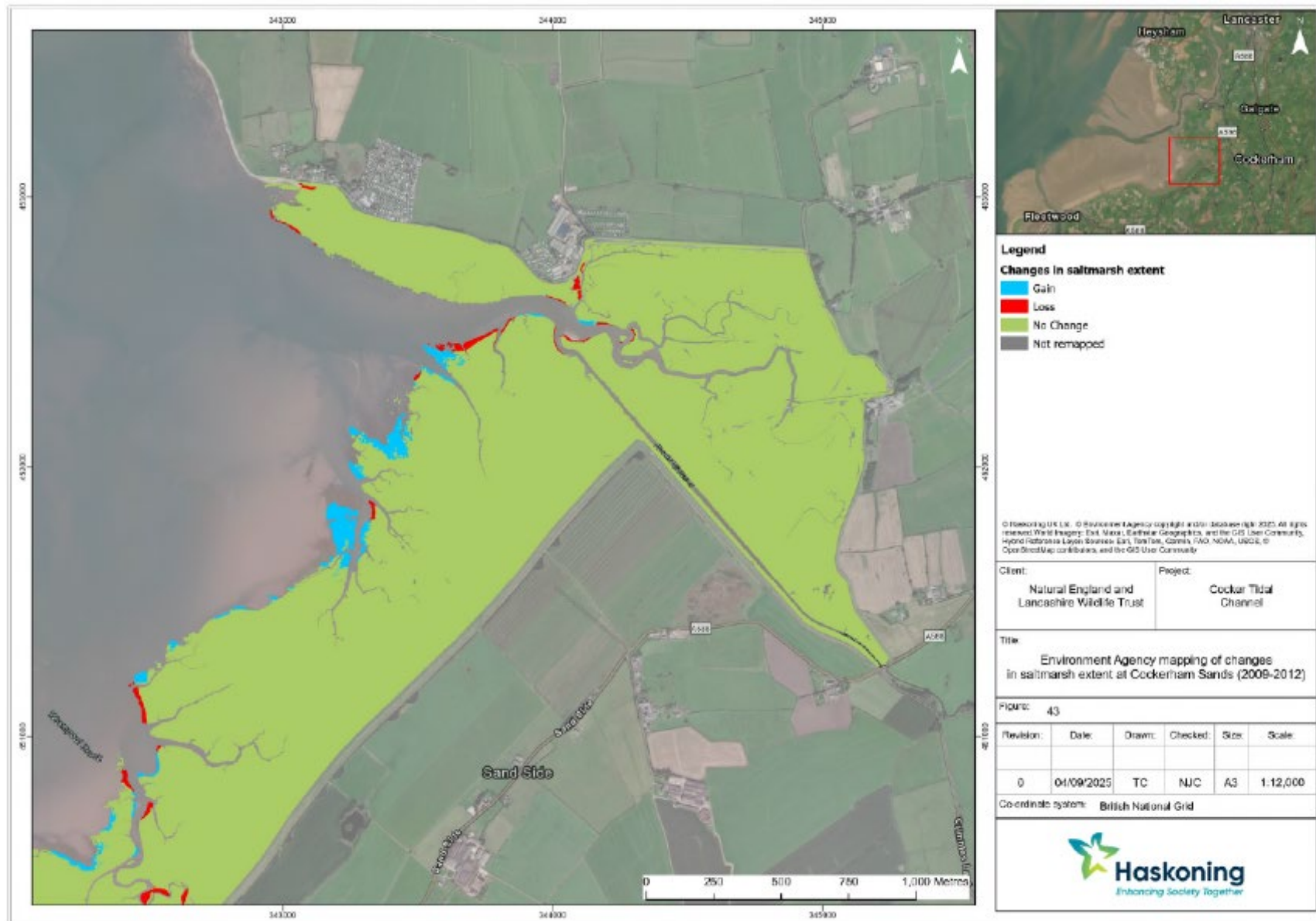


Figure 43 Environment Agency mapping of changes in saltmarsh extent at Cockerham Sands (2009-2012)

3.1.2 Channel Alignment

Changes in channel alignment from 1845, 1910, 1951, 1970 and 2023 are shown in Figure 45.

The earliest map, from 1845, shows the natural alignment of the Cocker Tidal Channel, meandering west of the present cut channel alignment before switching north towards Patty's Farm and then combining with the naturally meandering Patty's Farm Creek and then both channels jointly heading west towards the Outer Cocker Channel. Such patterns were also observed in the 1910 and 1951 mapping, which both also pre-date the new channel cut.

The first mapping after the channel was artificially cut in the 1960s shows linear alignments to both the Cocker Tidal Channel and the Patty's Farm Creek. Even after this relatively short time, the remnant (former naturally meandering) creeks appear far less distinct features. It is not known what was done with the sediment cut from the linear channels, but it is possible it was either side-cast and naturally infilled the original channels and creeks or was placed within those areas to infill them and ensure flow was preferentially directed through the new cuts.

Figure 46 shows the envelope of change in channel alignment across all mapped dates. This shows that the changes just seaward of Bank End Farm are not greater than changes along other reaches but are caused by increased incision caused by the meander just downstream of the confluence of the Cocker Tidal Channel and Patty's Farm Creek. The three pre-cut maps show the channel alignment at this location being notably further away from the shoreline at Bank End Farm.

Project related

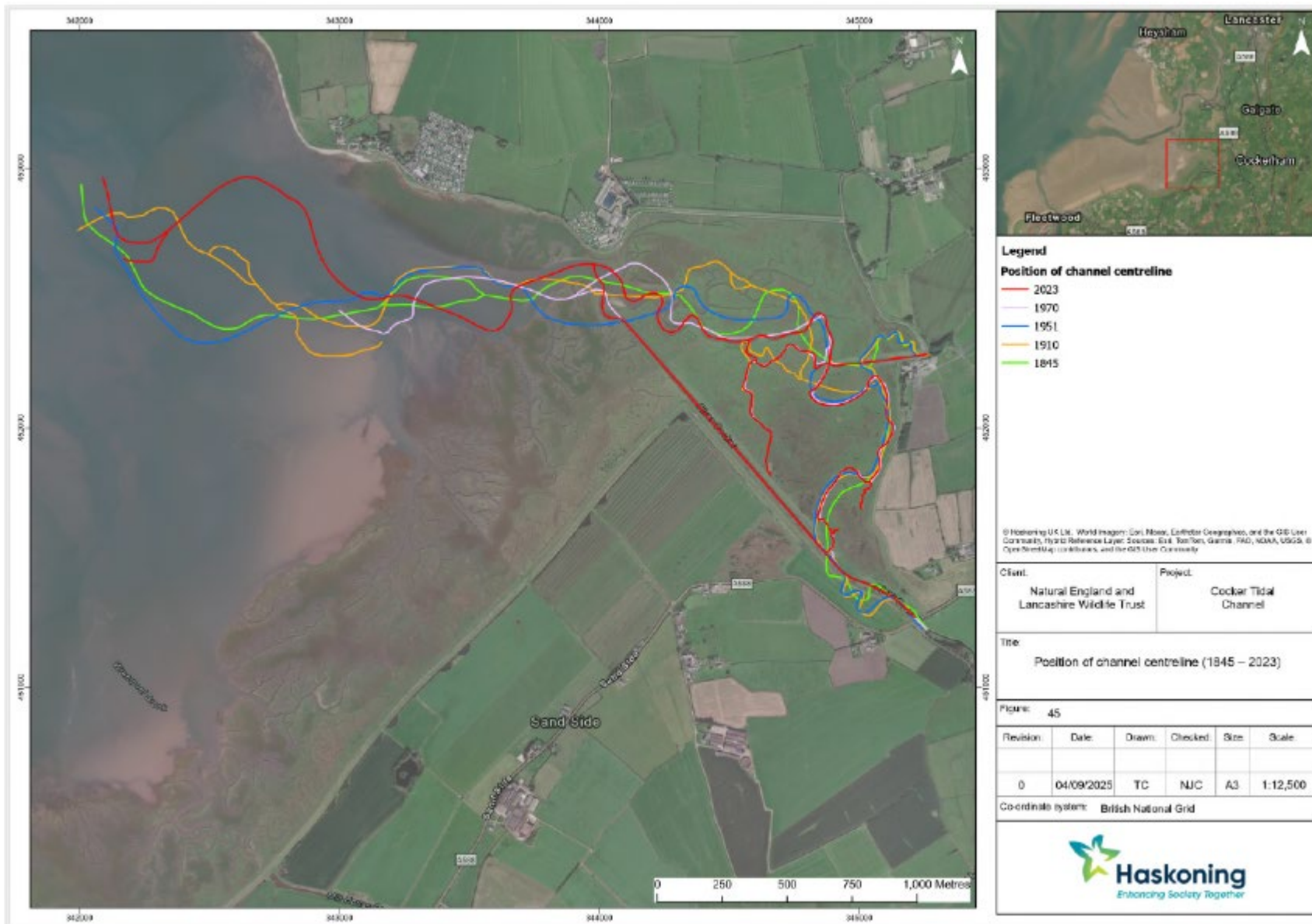


Figure 45 Position of channel centreline (1845 – 2023)

Project related

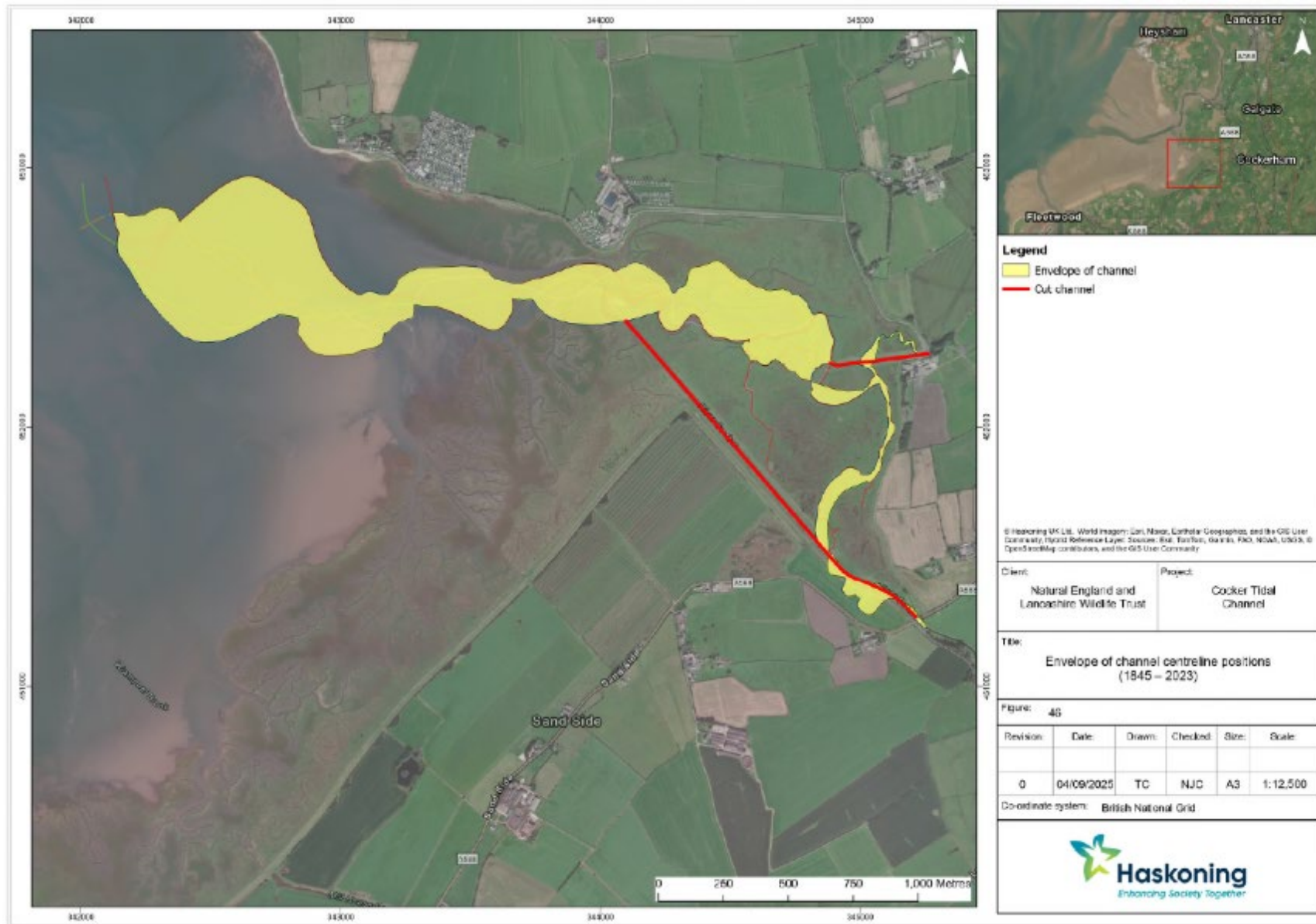


Figure 46 Envelope of channel centreline positions (1845 – 2023)

3.2 Beach Transect Surveys

3.2.1 Background

The North West Coastal Monitoring Programme's beach surveys from between 2007 and 2024 were obtained for profile transects CC01 to CC06 (for locations see Figure 47) and plotted as cross-sections (see Figure 48 to Figure 53).

Upon inspection, there appears to be a lateral shift in the data after the September 2015 survey. Rather than attempt to manually correct this shift, the data have been interpreted in two 'batches', namely:

- First batch - from November 2007 to September 2015
- Second batch - from April 2016 to September 2024⁸

Principal findings have been presented in following sections relating to the saltmarsh and channel alignment.



Figure 47 Location of profile transects available from North West Coastal Monitoring Programme

⁸ This being the most recent available survey at the time of writing.

3.2.2 Saltmarsh

At transect CC01, which crosses the Cocker cut channel towards its head, the changes in level of saltmarsh are minor. There is up to only 0.1m accretion in level over the 17-year monitoring period. Similarly, the saltmarsh at CC02 is relatively stable, with the main creeks remaining in position and changes in level being only around 0.15m over this period. Accretion along CC03 is similar, at up to 0.15m over the monitoring period.

CC04 extends seaward from Bank End Farm. Around 0.1m of accretion occurred on the marsh surface between 2007 and 2015, with a further 0.1m (approximately) between 2016 and 2024. However, the distinct low cliff at the seaward edge of the marsh distinctly retreated landwards over the monitoring record. In total, over 13 m of saltmarsh edge erosion has occurred between 2007 and 2024 (this would represent an annual average rate of 0.8m/year over this period). This has measurably reduced the width of saltmarsh available in front of the flood embankment at this location. However, the rate of change has not been constant over this period. Initially around 4.15m was eroded between 2007 and 2012 (corroborating the findings of Swift (2013) who observed 0.8m/year between 2006 and 2012), accelerating to retreat a further 3.9m in the three years between 2012 and 2015. A further 5.7m of retreat occurred between 2016 and 2024 (which corresponds to a slightly lower annual average rate of around 0.6m/year over this most recent period).

CC05 represents a wide tidal flat, extending down to the low water mark of the Outer Cocker Channel. The tidal flat is more variable in level, generally accreting by up to 0.4m between 2007 and 2015 and by up to 0.2m further between 2016 and 2024. However, in the latter period, changes can be in excess of 0.5m nearer the low water channel as the bank margins migrate towards the shore.

CC06 also crosses a wide tidal flat over which there has been relatively little change between 2007 and 2015, except for at the seaward end of the transect (around 300m chainage from shore) where accretion of up to 0.5m was recorded. Between 2016 and 2024, accretion has been more prominent over the entire profile, with around 0.3 – 0.4m increase in elevation recorded.

3.2.3 Channel Alignment

At transects CC01 and CC02, the alignment of the Cocker Channel is stable, being within the cut section. Along CC03, the alignment of the cut Cocker Channel also remains stable, but where this transect crosses Patty's Farm Creek, there can be up to 10m change in position of the creek.

At CC04 the channel just downstream of the confluence of the Cocker Channel and Patty's Farm Creek is a very pronounced and considerably dynamic feature of the survey. The retreat of the saltmarsh edge noted at this location is associated with the meander of the channel just downstream of the confluence of Cocker Channel and Patty's Farm Creek incising more sharply towards the shore. The movement of the channel centreline over the monitoring record has been of the order of 30m.

At CC05, the Outer Cocker Channel appears to have migrated towards shore in recent years, causing shoaling along its northern bank margins. Transect CC06 does not cross the Outer Cocker Channel.

Project related

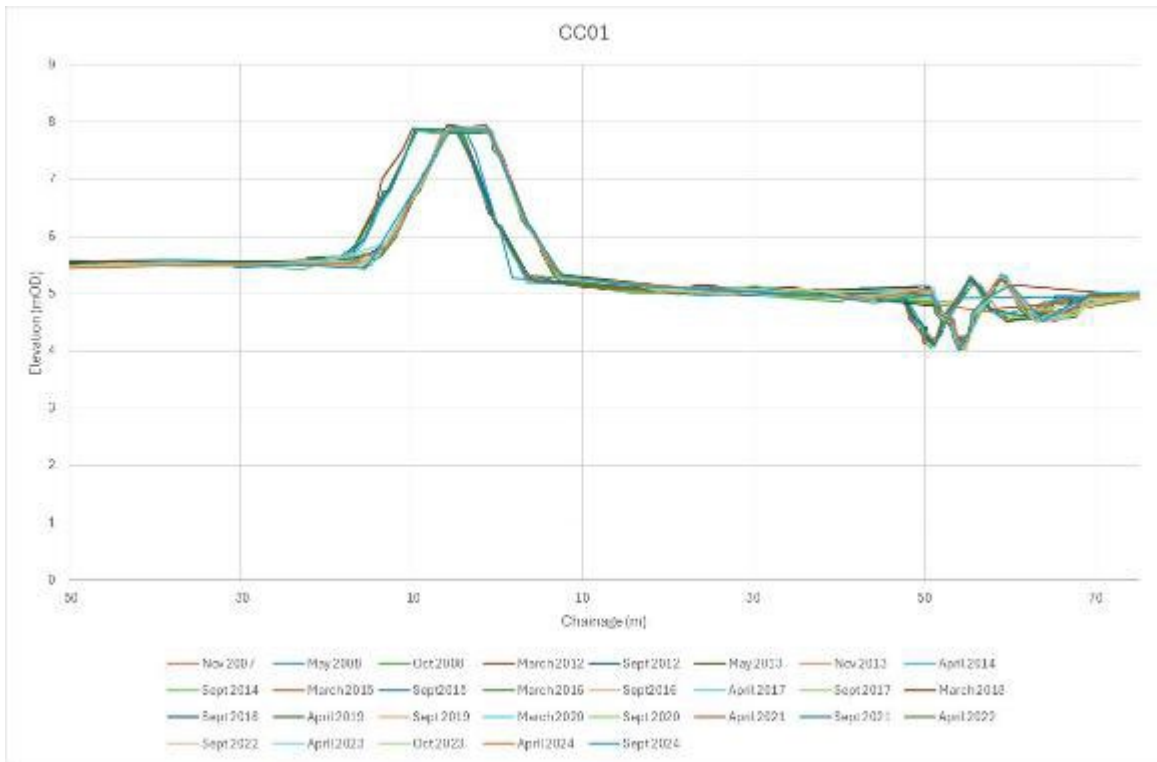


Figure 48 Profile transect CC01 (2007 – 2024)



Figure 49 Profile transect CC02 (2007 – 2024)

Project related

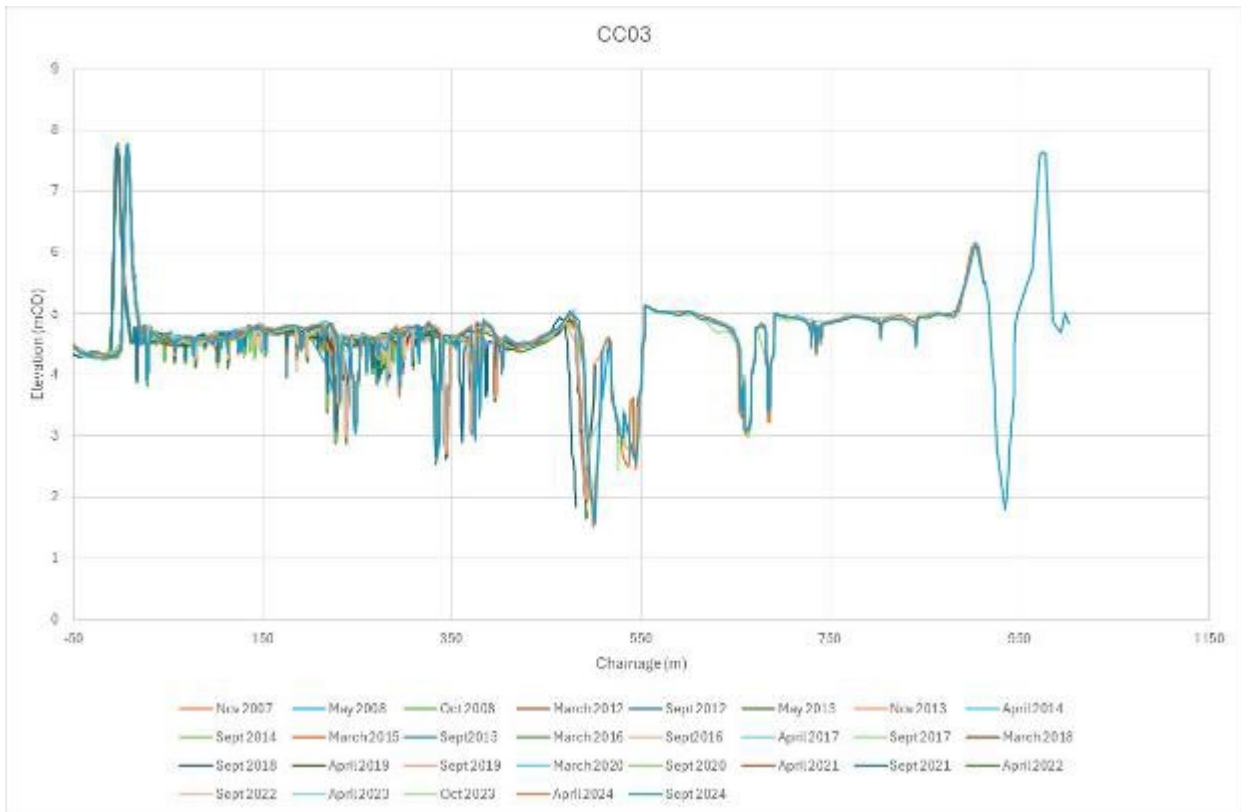


Figure 50 Profile transect CC03 (2007 – 2024)

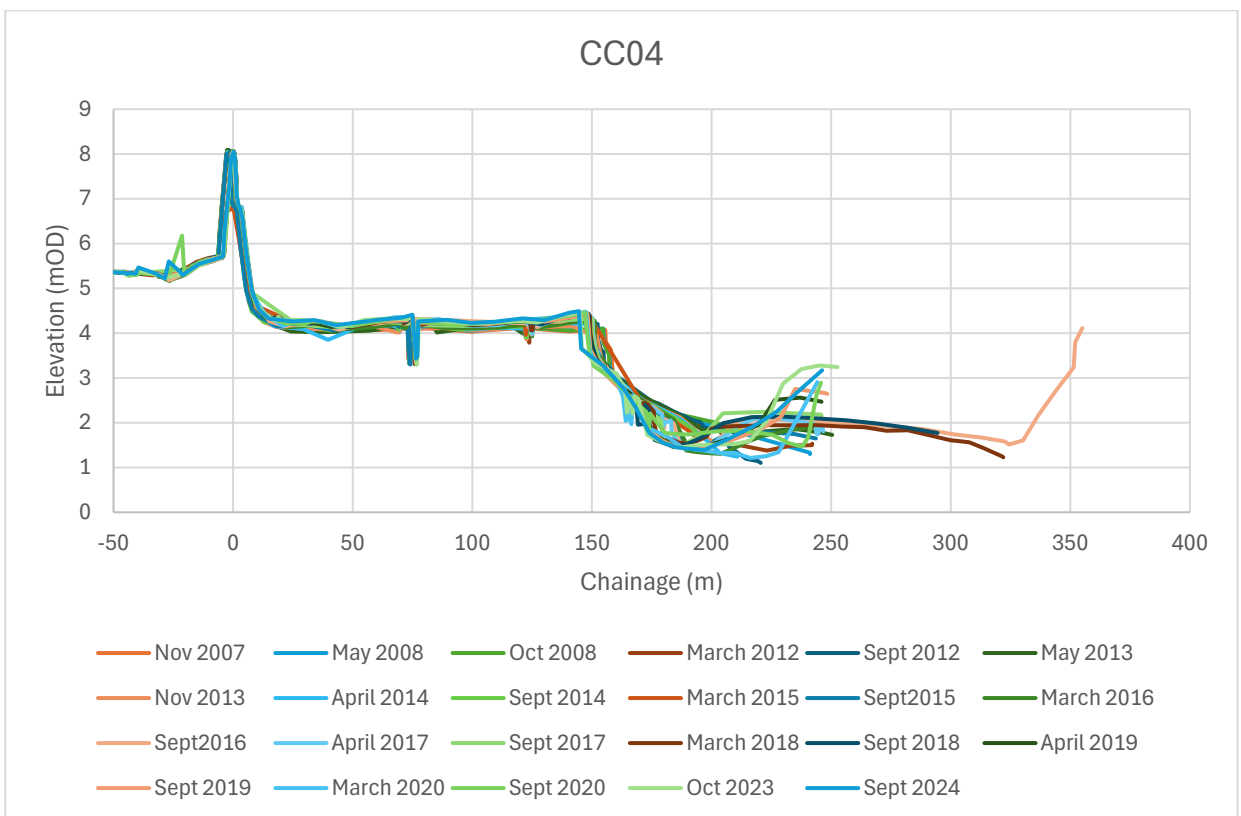


Figure 51 Profile transect CC04 (2007 – 2024)

Project related

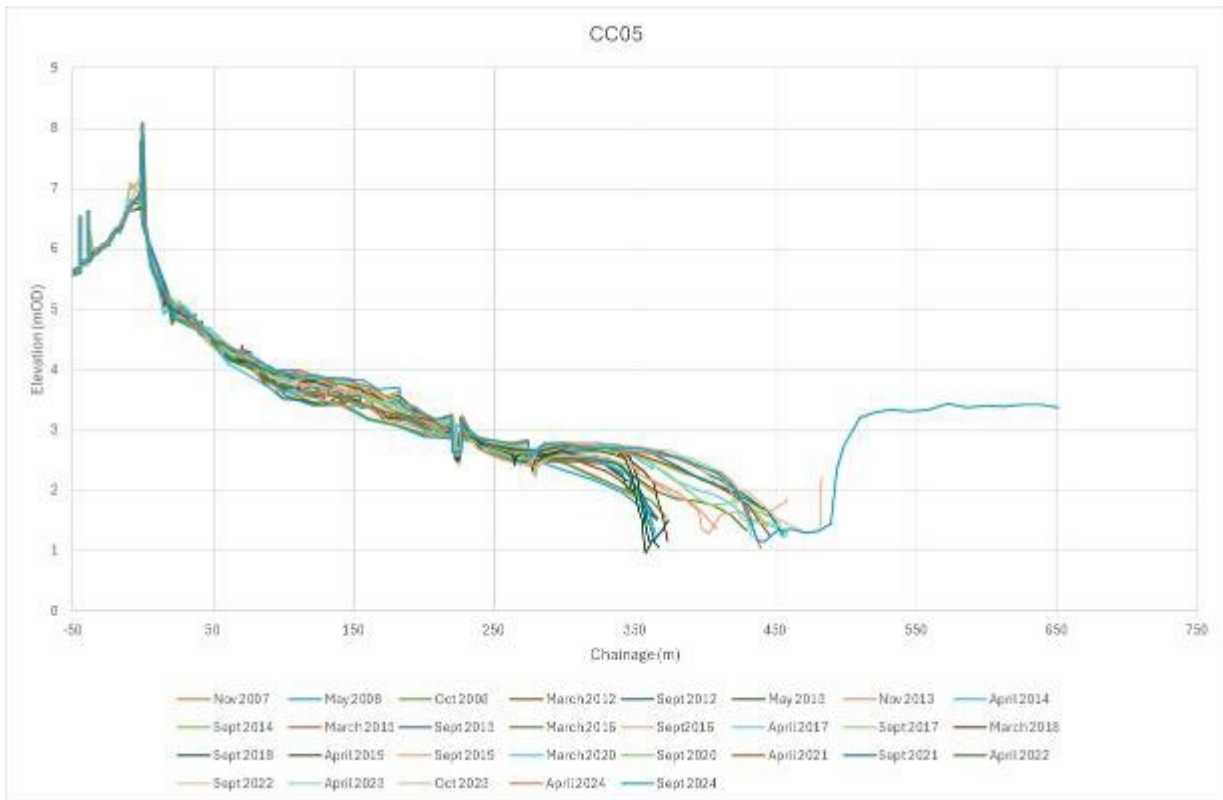


Figure 52 Profile transect CC05 (2007 – 2024)

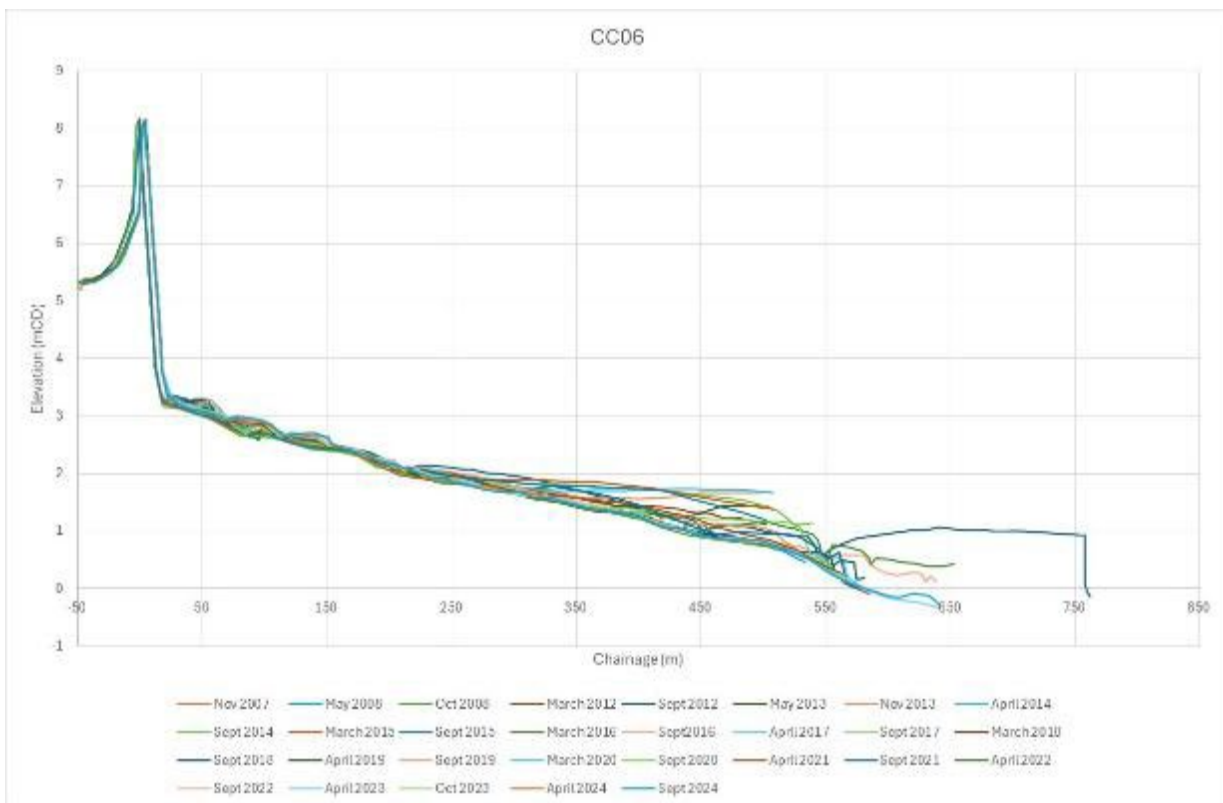


Figure 53 Profile transect CC06 (2007 – 2024)

4 Task 1b – Site Visit

A site visit was made on 2nd September 2025 to view the site from Cockerham Marsh SSSI round to Bank End Farm. In attendance were Mandy Knott from Natural England, Kim Wisdom from Lancashire Wildlife Trust, Nick Cooper and Tom Ward (engineers from Haskoning) and Beth Millwater and Amelia Parvin-Graham (ecologists from Haskoning). A photographic record from the visit is provided in **Appendix A** and key observations are summarised in **Box C**.

Box C - Key Observations from Site Visit on 2nd September 2025

Cockerham Marsh SSSI

- Cockerham Marsh SSSI appears high in elevation relative to the envisaged tidal levels and the levels in topography of adjacent fields. Whilst the vegetation and scrub on the site may be misleading (giving perception of an apparently higher elevation than true ground level) it will be important in Task 2 to investigate: (i) whether tidal waters can be brought onto the site; and, if so (ii) how this can be achieved without undue increase in flood risk to adjacent fields or the backing road.
- Regarding the latter point, adjoining fields ‘appeared’ lower in level than the SSSI, but this can be checked using LiDAR data. Also, the Delph ditch backing the embankment is a large ditch that ultimately connects with the sluice at the drainage channel from Mill House Farm to discharge seaward. Unless there are earthworks and pipework installed, tidal water brought through the embankment will initially preferentially flow towards the Mill House sluice via the Delph ditch and only extend across the SSSI once that ditch is full and overflowing. At the southern boundary of the SSSI, the Delph ditch terminates and transitions to a pipe. The source of the pipe is unknown but would require a similar control structure to prevent flooding upstream. [Note: It is understood that the Environment Agency is imminently undertaking improvement works to Mill House sluice].
- The SSSI appears somewhat isolated since reclamation by agricultural fields to either side. Whilst there are no known historic sightings of natterjack toads in these fields, they would formerly (pre-reclamation) have been upper saltmarsh and so have contained suitable habitat – potentially containing prey and providing connectivity with other areas. The reclamation has therefore not only removed saline influence from the SSSI but also isolated the site from its former wider context and setting.
- No natterjack toads were found on Cockerham Marsh SSSI during the visit and the vegetation was terrestrial and the pools dry.
- Plant species present in the SSSI and their abundance (DAFOR scale⁹):
 - Heath rush (F)
 - *Phragmites sp.* (F)
 - Yorkshire fog (A)
 - Creeping buttercup (O)
 - Creeping Thistle (O)
 - Common Nettle (A)
 - Cocksfoot (A)
 - Silverweed (F)
 - Curly dock (O)
 - Hogweed (R)
 - False oat grass (F)
 - Tufted vetch (O)
 - Rosebay willow herb (O)
 - Sea rush (O)

⁹ D = Dominant (51-100% species coverage); A = Abundant (31-50%); F = Frequent (16-30%); O = Occasional (6-15%); R = Rare (1-5%); X = Not present (0%).

- Ragwort sp. (R)
 - Common birds foot trefoil (O)
 - Soft rush (A)
 - Common bent (A)
 - Marsh pennywort (R)
- Vegetation species present in the mixed scrub of Cockerham Marsh SSSI included: Gorse (A), Hawthorn (F), Bramble (F) and Goat willow (O).

Cocker Tidal Channel and Surrounding Area of Cockerham Sands

- The 'new' cut channel belongs to the Wildfowlers (with whom Mandy Knott met separately on the same day). It is anticipated that siltation within the channel would have continued since the last known Environment Agency dredging and it is unknown whether the natural flushing of the gates has been undertaken as planned or with what level of success.
- The side-slopes of the cut channel are dominated by saltmarsh species, but the adjacent land is rank, being ungrazed and dominated by tall, tussocky, coarse species of grass. Despite this, there are still saltmarsh species rarely evident suggesting some occasional tidal inundation of this area.
- The cut section of the channel is initially deep and narrow, but towards its seaward end beyond the man-made cut, it widens considerably. It is the Outer Cocker Channel (downstream of the confluence of the cut Cocker Channel and Patty's Farm Creek) that has incised to around 30 m of the shore at Bank End Farm – the issue which prompted earlier investigations in 2013.
- The flood embankment to the rear of the tidal road approaching Bank End Farm is high, wide and protects an extensive low-lying hinterland (which was cattle-grazed at the time of the visit). It is armoured with concrete blocks on its seaward face and appears in good condition.
- Seaward of the flood embankment is sheep-grazed saltmarsh with several tidal pools (saltpans) and creeks. There is evidence of Glasswort (*Salicornia europaea agg.*) on the flanks of some creeks and saltmarsh species adjacent to the creeks.
- Whilst on site we met with Mr Lawson, the landowner of Bank End Farm and considerable areas of sheep-grazed saltmarsh and backing terrestrial farmland. He expressed a number of views to be taken into consideration in Task 2 of the study, including that:
 - To re-naturalise the old tidal Cocker Channel would involve extensive earthworks and require a new network of stock fences and creek bridges so he could continue sheep grazing;
 - He had concerns about the potential loss of stock or loss of grazable areas due to an increase in the areas of fluid mud (or 'quicksand' as he referred to it);
 - The flood embankment last breached on 11th November 1977 causing flooding of the farmhouse and extensive areas of the Thurnham peninsula;
 - Since erection of a stock fence on saltmarsh immediately fronting Bank End Farm around 5 years ago, his view was that the saltmarsh width has not changed since (although this seems contradicted by evidence elsewhere within this Task 1 report and signs of ongoing erosion were clearly observed on the day of the visit, with areas adjacent to the pinch point showing signs of slumping and detachment from the main marsh); and
 - To bring tidal water into upper areas of saltmarsh south of Patty's Farm, it was suggested that a new channel could be dug to connect an existing natural creek to the Patty's Farm Creek 'new' cut.

Project related

- Plant species present on the banks of the canalised channel and their abundance (DAFOR scale):
 - Fat hen (D)
 - Sea couch grass (R)
 - Sea aster (F)
 - Salt marsh sand spurrey (O)
- Plant species present in the marsh adjacent to the canalised channel (nearest the road) and their abundance (DAFOR scale):
 - Perennial rye grass (D)
 - Sea rush (O)
 - Sea plantain (O)
 - Ragwort sp.(O)
 - *Phragmites* sp. (O)
 - False oat grass (O)
 - Curly dock (R)
 - Silverweed (A)
 - Sea thrift (R)
- Plant species present on the grazed northern marshland their abundance (DAFOR scale):
 - Sea rush (D)
 - Sea milkwort (D)
 - Perennial rye grass (A)
 - Sea aster (F)
 - Cuckooflower (R)
 - Glasswort (F)
 - 2 desiccated pieces of bladder wrack - remnants of tidal influence
- Plant species present in the PRoW Track and their abundance (DAFOR scale):
 - Perennial rye grass (D)
 - Silverweed (D)
 - Saltmarsh sand spurrey (O)
 - Yorkshire fog (O)
 - Yarrow (O) (on flood embankment next to path)
 - Patches of bare ground from vehicle tracks

Other

- It is understood that house recently built at Nateby has diverted water towards Pilling.
- Whilst the reclamation of Pilling to Cockerham saltmarsh was undertaken in 1981, further reclamation south of Pilling was in the late 1980s following flooding of that area.
- There has been flooding of the fields and path between Hillam Farm and Patty's Farm, thought to be caused by waters backing up from the flap valve sluice at Patty's Farm (named Hasty Beck Tidal Flap).

5 Summary

Box D summarises the key issues and opportunities arising from Task 1 of the study.

Box D - Key Issues and Opportunities

Historic Changes

- There has been recent historic (1960s) straightening of the Cocker Tidal Channel from its natural meandering alignment to an artificial 'cut'.
- Where this 'new' cut meets the natural Patty's Farm Creek, the larger joint natural channel meanders across Cockerham Sands.
- Where the combined channel incises closely towards shore (notably at Bank End Farm), ongoing erosion of saltmarsh margins has caused some past local concerns about flood risk.
- There has been extensive recent historic (1981) reclamation of saltmarsh at Cockerham Sands through land claim at Pilling to Cockerham Marsh.
- Cockerham Marsh SSSI (designated solely for natterjack toads) is now in an 'unfavourable declining' status as a consequence of this reclamation.
- Natural sediment deposition in Morecambe Bay can cause siltation and blockage of land drainage sluice gates and outfalls and backing-up of water.

Management Approaches

- The Shoreline Management Plan (SMP) policy is 'managed realignment' for 11C2.3 (Fluke Hall to Cocker Bridge) and 'hold the line' for 11C2.4 (Cocker Bridge to Glasson Dock).
- A perceived lack of engagement with the local community during SMP development, caused frustration and anger at the initial managed realignment policy for 11C2.4 (Cocker Bridge to Glasson Dock) and as such there is now emphasis on improved engagement.
- The Environment Agency recently stated it will no longer maintain defences in 11C2.4 (Cocker Bridge to Glasson Dock).

Opportunities

- There is opportunity for restoration of natural processes, morphology and habitat.
- This could deliver other benefits to the estuary and catchment (reduced flood risk, improved land drainage).

Based upon the findings from Task 1, recommendations for the remaining study tasks are:

- **Task 2** – Consideration of re-naturalisation of the original Cocker tidal channel should include potential benefits of alleviating pressure at its confluence with Patty's Farm creek as well as the potential to increase or ameliorate flood risk or siltation elsewhere, particularly at the Cocker Bridge tidal gates where siltation causes backed up water and flooding to farmland behind the flood embankment.
- **Task 3** - Opportunities for NBS in the wider catchment should be identified to help flood risk in these areas.
- **Task 4** - Opportunities should be considered for improving the 'unfavourable declining' status of the interest feature within Cockerham Marsh SSSI through measures to re-introduce (controlled) occasional tidal inundation.

6 References

Baker, Beebee, Buckley, Gent & Orchard, 2011. The Amphibian Habitat Management Handbook [see Chapter 11 Natterjack Toad and Chapter 12 Translocation and Reintroduction].

Beebee & Denton, 1996. The Natterjack Toad Conservation Handbook.

Buckley, J. and Beebee, TJC, 2004. Monitoring the conservation status of an endangered amphibian: the natterjack toad *Bufo calamita* in Britain. *Animal Conservation* (2004) 7, 221–228

Halcrow, 2010. North West England and North Wales Shoreline Management Plan SMP2. 2010. Report to North West and North Wales Coastal Group.

Halcrow, 2002. Futurecoast. CD produced as part of the Futurecoast project for Defra.

Robinson, N.A. & Pringle, A.W., 1987. Morecambe Bay: An Assessment of Present Ecological Knowledge. Published as a Resource Paper of the Centre for North West Regional Studies in conjunction with the Morecambe Bay Study Group, 1987.

Steers, J.A., 1946. *The coastline of England and Wales*. Cambridge University Press.

Swift, L., 2013. Tidal Cocker Channel Geomorphological Appraisal. Environment Agency Note dated January 2013, revised May 2013.

Appendix A

Photographic Record from Site Visit on 2nd September 2025

Project related



Cocker channel looking upstream from Cocker Bridge sluice gates

Project related



Cocker Bridge sluice gates – upstream side

Project related



Cocker channel looking downstream from Cocker Bridge sluice gates

Project related



Cocker Bridge sluice gates – upstream side

Project related



Cocker Tidal Channel – ‘new’ cut reach immediately downstream from Cocker Bridge sluice gates

Project related



Cocker Tidal Channel – ‘new’ cut reach slightly further downstream from Cocker Bridge sluice gates

Project related



Cocker Tidal Channel – outer reach in vicinity of channel meander near to Bank End Farm

Project related



Cocker Tidal Channel - Slumping at saltmarsh margin at outer reach in vicinity of channel meander near to Bank End Farm

Project related



Saltmarsh between Cocker Bridge and Patty's Farm

Project related



Flood embankment between Cocker Bridge and Patty's Farm

Project related



Saltmarsh between Cocker Bridge and Patty's Farm

Project related



Saltmarsh between Cocker Bridge and Patty's Farm

Project related



Hasty Beck Tidal Flap at Patty's Farm



Project related



Saltmarsh (left) and flood embankment (right) between Patty's Farm and Bank End Farm

Project related



Saltmarsh between Patty's Farm and Bank End Farm

Project related



Flood embankment between Patty's Farm and Bank End Farm

Project related



Land to rear of flood embankment between Patty's Farm and Bank End Farm

Project related



Saltmarsh fronting flood embankment between Patty's Farm and Bank End Farm

Project related



Bank End Tidal Flap and Cut Channel



Project related



Intersection between Cut and Natural Channel from Bank End Tidal Flap

Project related



Saltmarsh fronting Bank End Farm

Project related



Cockerham Marsh SSSI – general view of site from field gate entrance

Project related



Cockerham Marsh SSSI –view of Delph ditch and flood embankment

Project related



Cockerham Marsh SSSI – view from east of site looking towards the west