

Case study 49. Hesketh Out Marsh Managed Realignment

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Main driver: Improved defences, habitat creation (Biodiversity 2020 targets)

Project stage: Phase 1 Hesketh Out Marsh West complete in 2008, phase 2 Hesketh Out Marsh East due to complete July 2017



Photo 1: Aerial view of Hesketh Out Marsh (HOME in the foreground)

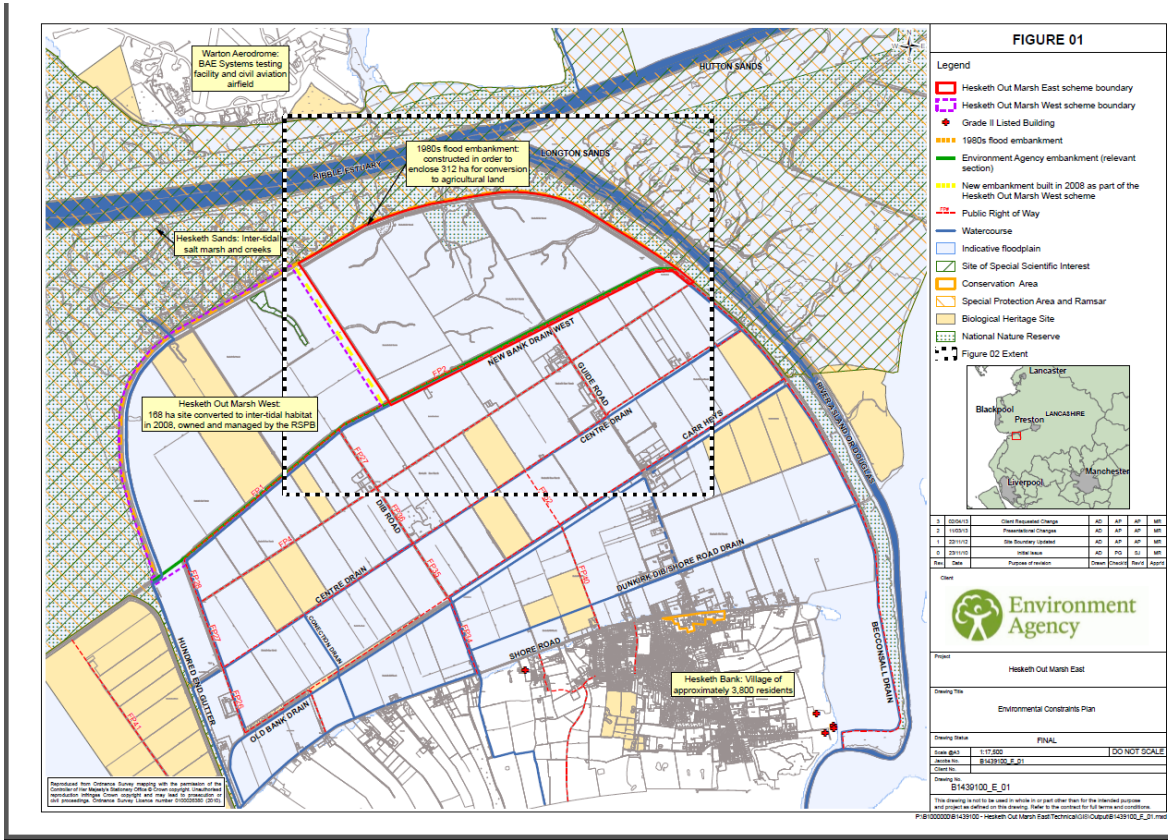
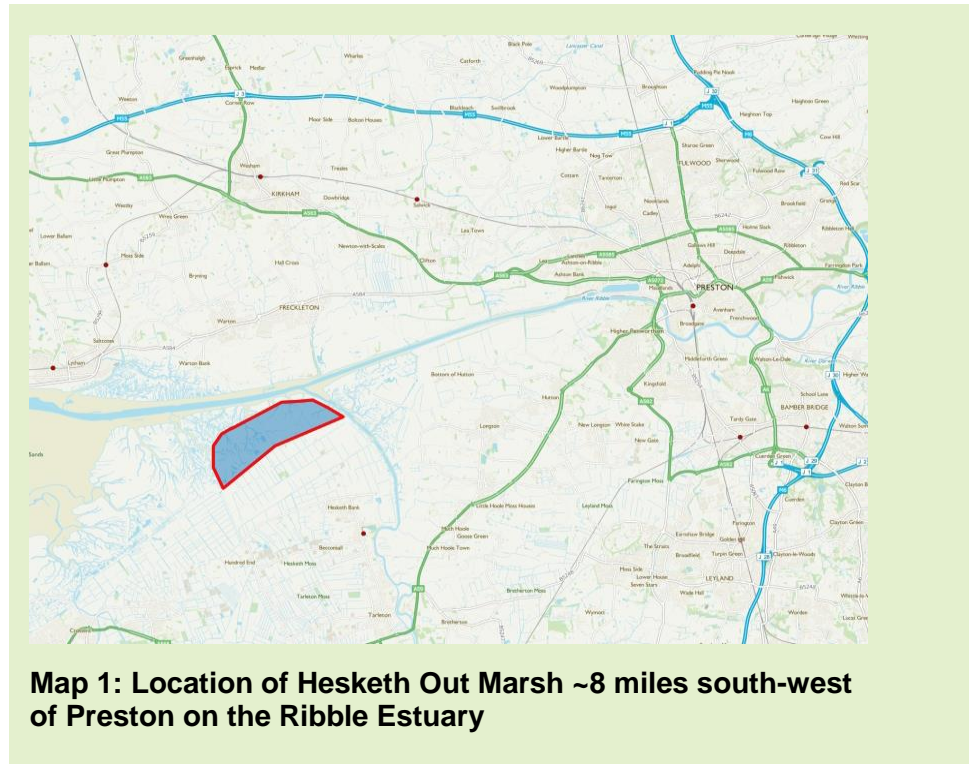
Project summary:

In the early 1980s, the intertidal saltmarsh habitat of Hesketh Out Marsh (Photo 1) was reclaimed from the Ribble Estuary for use as farmland (Map 1). Ownership of the land within Hesketh Out Marsh divided this enclosure into two parcels of land: Hesketh Out Marsh West (HOMW) and Hesketh Out Marsh East (HOME) (Map 2).

In 2008, HOMW was reverted to intertidal saltmarsh when the Royal Society for the Protection of Birds (RSPB), in partnership with the Environment Agency, breached the outer flood embankment of this western half (HOMW). This breaching was possible by building a north–south cross-embankment separating the two parcels of land. Those works not only created 168ha of habitat – a nature reserve, owned and managed since by the RSPB – but also realigned the coastal margin for a more natural, robust and sustainable line of coastal flood defence. The challenge was then to do the same on the east

Key facts:

The Hesketh Out Marsh realignment creates a total of 322ha of priority saltmarsh habitat which contributes to a more robust flood defence system, providing a 1 in 200 year standard of flood protection to 143 residential properties, 3 commercial buildings and 300ha of prime agricultural land.



Map 2: Plan of Hesketh Out Marsh showing the west and east compartments

1. Contact details

Contact details	
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2. Location and coastal/estuarine water body description

Coastal/estuarine water body summary	
National Grid Reference:	SD 42135 25754
Town, County, Country:	Hesketh Bank, Lancashire, UK
Regional Flood and Coastal Committee (RFCC) region:	North West
Transitional and coastal water body size (km²):	44km ²
Transitional and coastal water body and location:	Transitional water body, Ribble Estuary
Water Framework Directive water body reference:	GB112070064820, River Douglas
Land use, geology, substrate, tidal range:	Agriculture, arable, salad crops, sheep and cattle pasture. Tidal flat deposits, clay and silt. The Ribble Estuary and adjoining parts of Liverpool Bay are macrotidal, with a mean spring tidal range of approximately 8 metres

3. Background summary of the coastal/estuarine water body

Socioeconomic/historic context

The Ribble Estuary consists of extensive sandflats and mudflats and large areas of saltmarsh. There are also areas of coastal grazing marsh located behind the sea embankments. The intertidal flats are rich in invertebrates on which waders and some of the wildfowl feed. Improved navigation of the estuary began in the early 19th century and there are numerous modifications. Land claim for farmland has occurred progressively since 1854, particularly on the southern shoreline. Mitigation measures include developing large areas of saltmarsh.

Flood and coastal erosion risk management problem(s)

The communities in this area are at risk of flooding from both the Ribble and Douglas rivers and the sea. Defences in the tidal Douglas area (principally earth embankments) reduce risk in these villages. These include defences on the River Douglas next to Tarleton, sea defences at Hesketh Marsh and Hesketh Bank, and defences on the tributaries of Hall Brook and Longton Brook. The flat topography means that the number of properties at risk could increase substantially with more extreme flood events, now more likely under climate change. A total of 143 properties are affected by a 1 in 200 year event, with 300ha of prime agricultural land also affected. Ongoing maintenance of the sea defences is required to maintain the current standard of protection, which is further challenged by future sea level rise predictions.

Other environmental problems

Other issues include water quality, industry, navigation and climate change adaptation.

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood and coastal erosion risk management problem(s) and solution(s)

Consideration of managed realignment at HOME began before 2000. In 2004, this led to Halcrow being commissioned by the Environment Agency to carry out a review of the feasibility of managed realignment in the Ribble Estuary. The resulting report, 'Ribble Estuary Managed Realignment Study Stage 1: Initial Review of Feasibility of Managed Realignment at Various Sites', identified 11 potential sites around the estuary suitable for managed realignment. HOMW and HOME were ranked as the top 2 sites for managed realignment. By this time, RSPB was already in negotiation with the landowners at Hesketh Out Marsh with a long-term aspiration to purchase and manage the site as a nature reserve. This was further developed and checked by modelling carried out by the Halcrow group (now CH2MHill) for both HOMW in 2005 and for HOME in 2015.

What was the design rationale?

As far as possible, the design of the realignments at Hesketh Out Marsh has attempted to recreate the creeks and saltmarsh habitat as they were prior to their reclamation around 1980. The breaches have been positioned and excavated to fit the location and size of the former creek pattern onto the existing outmarsh. The excavated creek pattern within the recreated marsh area follows the relic creek network as far as is practical given the constraints of the new reserve (such as accommodating access tracks, remnant banks and additional lagoons). It was recognised that the volume of the excavated creeks constituted a major portion of the tidal exchange volume. In the case of HOME, the aggregate of the breach aperture widths took account of the former secondary creeks between aperture locations. This would also serve to maximise tidal exchange in the formative post breaching stage.

The addition of shallow lagoons (a feature not present on the original 1960s saltmarsh), limited to 1ha, was a design decision based on the eventual end use of the land as an RSPB nature reserve. For HOME, these lagoons were not connected to the creek network. The saline lagoon features provide additional habitat value for waders and wildfowl, with potential for benefits to serve as fish nursery habitat.

Creeks/lagoons were not excavated within 50m of the defence embankment (shown as a solid green line in Photo 2) to reduce the risk of erosion from future evolving creeks and lagoon edges developing towards the Environment Agency's sea defence embankment and threatening the defence integrity.



Photo 2: 1960s aerial survey used to plan the reinstatement of creek patterns

Project summary

Area of transitional and coastal water body or length benefiting from project:	322ha
Types of measures/interventions used (Working with Natural Processes and traditional):	Managed realignment Creation of new saltmarsh alongside the improvement of earth bank sea defences
Numbers of measures/interventions used (Working with Natural Processes and traditional):	2
Standard of protection for project as a whole:	1 in 200 year protection
Estimated number of properties protected:	143 properties and 3 commercial buildings

How effective has the project been?

Managed realignment at HOMW in 2008 (Phase 1) was a success, with priority saltmarsh vegetation establishing within 3 years across the entire site, much quicker than the 7 years predicted by the original model. This area is now a fully functioning RSPB reserve, with improved footpath access, signage, car park and bird hide, providing a recreational and educational asset to the local community. The site is already supporting good numbers of birds including avocets, redshank, Bewick's swan, black-tailed godwit, lapwing and marsh harrier.

Phase 2 at HOME is an equivalent extension to the reserve. The site elevation is almost the same as at HOMW and so the project team is confident that saltmarsh vegetation will establish successfully once breach works are complete in 2017. Lessons learnt from HOMW on the design of creeks and lagoons have been applied to HOME, so it is expected that the saltmarsh habitat that forms will provide even greater benefits to the reserve. HOME landscaping works also sought to take account of recent studies emphasising the importance of variation of the microtopography, or 'rugosity', for optimal biodiversity.

Fine sediment delivery to the site has been greater than anticipated so there has been a readily available substrate available for the establishment of saltmarsh pioneer species. Rates of accretion on HOMW have exceeded 1cm per year and may be expected to do so for several decades at least.

5. Project construction

How were individual measures constructed?

The same basic principle of construction applied across both HOMW and HOME. First the adopted line of defence (the Environment Agency embankment), ~1km inland from the estuary, was strengthened, widened and raised to a 1 in 200 year standard. Material needed for these embankment improvements was excavated from the proposed realignment area to create creeks and lagoon features. Once the new embankment was stable, vegetated breaches were constructed in the private outer earth embankment to reinstate tidal inundation across the site.

For HOMW construction in 2008, in-house Environment Agency Operations Delivery teams were used to carry out all construction works and bank improvements. In contrast, during the recent construction of HOME between 2014 and 2017 a combination of in-house Operations Delivery and external framework contractors have been used due to the resource demands of such a large-scale project. However, the mid-stage landscaping and creek excavation works overseen by the in-house Operations Delivery team were deemed particularly successful owing to the flexibility and ready attention to detail, which achieved efficiencies on site.

How long were measures designed to last?

The reversion of farmland back to saltmarsh has been designed as a permanent change. The entire landholding is now in the ownership of the RSPB and will be managed in perpetuity as a nature reserve. Given the projected accretion rates, the likely sea level rise due to climate change within the 21st century and isostatic land change, the saltmarsh habitat could be expected to be sustainable into the 22nd century.

Were there any landowner or legal requirements which needed consideration?

- Appropriate assessment under the Habitats Directive was required for designated sites (Special Protection Area/ Site of Special Scientific Interest) in the Ribble Estuary.
- Landowner negotiations and land purchase by RSPB
- Negotiations were required with the adjacent Warton Aerodrome due to the risk of bird strike to aircraft. These resulted in the drawing up of a best practice bird control management plan.
- Monitoring requirements to satisfy the Canal and River Trust
- Requirement for a Marine Management Organisation licence to carry out the breaches in the outer earth embankment to reinstate tidal inundation; this required a detailed Environmental Statement.
- Planning permission required to create features such as creeks, lagoons and embankment breaches in the proposed saltmarsh area prior to the return of tidal inundation.
- Agreements with landowners and tenant farmers regarding livestock access across the newly created saltmarsh – needed to maintain access to grazing areas on the outer existing saltmarsh (Ribble Estuary)
- Permission from the local authority required for temporary footpath closure for the duration of the construction works.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures

Year project was undertaken/completed:	HOMW: completed 2008 HOME: due to be completed 2017
How was the project funded:	For HOME, the Environment Agency's forecast out-turn project costs of £3.8 million are funded by Flood Defence Grant-in-Aid. RSPB costs (including land acquisition) are ~£3.4 million and have been funded by RSPB and grants from external sources such as WREN and Natural England.
Total cash cost of project (£):	The forecast total out-turn cost of the HOME project is £7.2 million including both Environment Agency and RSPB expenditure.
Overall cost and cost breakdown for WWNP/NFM measures (£):	HOME project cost is broken down as follows: <ul style="list-style-type: none"> planning and design (by Environment Agency with partners) = £0.45 million* construction and consultancy (by Environment Agency) = £3.3 million* RSPB costs including land purchase = £3.4 million Environmental monitoring (over 5 years) = £60,000 * Environment Agency costs include consultant, contractor and staff costs
WWNP/NFM costs as a % of overall project costs:	83% of total costs
Unit breakdown of costs for WWNP/NFM measures:	Maximum cost to the Environment Agency of saltmarsh created for the HOME project is £25,000 per hectare.
Cost-benefit ratio (and timescale in years over which it has been estimated):	2.3 to 1 Calculated over a 99 year time period

7. Wider benefits

What wider benefits has the project achieved?

Sustainable shoreline management and flood defence

- The reconstructed flood defence will provide a 1 in 200 year standard of protection for 143 residential properties and 3 commercial buildings.
- The scheme delivers specific Annex C actions of the North West River Basin Management Plan for the Environment Agency's Flood and Coastal Risk Management (FCRM) function.
- The scheme supports policy and actions under the 2010 Shoreline Management Plan.
- The scheme meets a key aspiration of the Environment Agency corporate plan for sustainable flood risk management.

Biodiversity and habitat

- The creation of 322ha of saltmarsh (Priority habitat) brings important biodiversity benefits and

delivers important national priority habitat creation under Defra's Biodiversity 2020 strategy.

- The scheme helps the UK comply with both the Habitats Directive (to restore saltmarsh) and the Wild Birds Directive (aimed at essential conservation). Key target species for this habitat include redshank, avocet and lapwing – all of which are supported by Hesketh Out Marsh.
- The scale of habitat creation is important in the context of Lancashire's Local Nature Partnership and developing Lancashire's ecological networks (habitat linkages).

Water Framework Directive and water quality

- HOME is an important target action for the Ribble catchment in the North West River Basin Management Plan and the achievement of Water Framework Directive objectives.
- Ribble Estuary saltmarsh creation contributes to meeting water quality objectives.

River Estuary morphology and landscape amenity

- The significant re-naturalisation of the Estuary achieved (river morphology improvements) also aids navigational interests due to the saltmarsh forming a substantial sediment sink.
- An important contribution to the subregional landscape character is regained.
- On completion of HOME in 2017, the RSPB reserve will double in size (to 322ha), providing a valuable local and regional asset and recreational amenity – one of the largest of its kind in the UK.
- A valuable elevated visitors' observation station over the saltmarsh is now possible.
- The far more generous crest width (1 > 5m) of the reconstructed Environment Agency embankment will allow full recreational use by pedestrians and enable efficient maintenance of the bank.

Climate change adaptation and mitigation

- Setting back the sea defence line is a much needed climate change adaptation in face of sea level rise. New saltmarsh forming in front of the flood defence embankment will serve to dissipate tidal energy and achieve a defence of greater resilience.
- The scheme contributes to climate change mitigation through its carbon sequestration.
- The carbon footprint of the scheme is minimised due to earth moving during construction being confined within the site.

How much habitat has been created, improved or restored?

A total of 322ha of intertidal habitat will be created to help meet Water Framework Directive mitigation measures, comply with requirements under the Birds Directive and make a significant contribution to Defra's habitat creation target (Defra 2012).

In the case of HOME, some further 48ha of saltmarsh on the seaward frontage to Hesketh Out Marsh will be improved by a change to conservation grazing and management by RSPB as part of this project.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

Maintenance of the primary sea defence (a 3.9km earth embankment unusually owned by the Environment Agency) is planned and being carried out as part of the annual routine maintenance programme by Environment Agency Operations Delivery teams. The bank itself requires vegetation management to allow asset inspection; this is currently achieved through sheep grazing by agreement with a local farmer.

Light conservation grazing by cattle is required to maintain the vegetation sward on the saltmarsh itself. This is organised out by the RSPB using tenant farmers and/or grazing agreements.

Some maintenance of fencing and gates will be required in the future by the RSPB to manage the level of grazing pressure across the site.

Is the project being monitored?

Yes, the first phase of the project at HOMW has been monitored since the breaches were created in 2009. A full monitoring plan was implemented by a team from Edge Hill University (based at Ormskirk) for 5 years, with a report produced annually during this period of early change at the site. Monitoring included National Vegetation Classification quadrats, sedimentation rates and depths, and assessment of erosion and scour, sampling for invertebrates and fish. RSPB carried out annual monitoring of breeding and wintering birds for the same time period; bird surveys of the site have continued beyond the 5 year monitoring period as part of RSPB's management of the reserve. In addition, the Environment Agency arranged regular LiDAR (light detection and ranging) and aerial photography monitoring of the site as it developed over the first 5 years.

A monitoring plan is currently in development for the adjacent realignment site at HOME, with breaching planned for 2017. It is likely that a similar monitoring regime will be adopted with the addition of some additional bird monitoring to satisfy the bird control management plan (needed due to the close proximity of Warton Aerodrome) and some monitoring of training walls in the Ribble Estuary (required following consultation with the Canal and River Trust which has navigation interests on the Ribble Estuary).

Links with universities are being established with the aim of developing a long-term monitoring framework for academic and other stakeholders to be in place by early summer 2017. The potential for contribution from a 'citizen science' approach will be explored. Funding and contractual arrangements are under consideration.

Has adaptive management been needed?

The design of HOMW included a number of lagoons connected to saltmarsh creeks. It was intended that these shallow bowl features (up to 1ha each) would fill with saltwater from the higher tides and be retained following the ebb tide, providing habitat for waders and waterfowl. However, monitoring identified that sedimentation rates across the new saltmarsh were more rapid than the design model had earlier suggested. This meant that some of the lagoon features rapidly silted up. These areas readily formed saltmarsh vegetation and therefore are still valuable to the reserve. However, they no longer provide the intended lagoon areas for waders and waterfowl. RSPB may require some adaptive management in future years to re-excavate lagoons if these features are still required.

As a result, the design of the second phase of managed realignment at HOME still incorporated lagoon features but these have been created as standalone features, unconnected to the creeks, with the intention that this will slow down the rate of infill by sedimentation. Any future recreation of lagoons at HOMW to replace those that have silted up is likely to be unconnected to creeks so as to increase the longevity of these features on the reserve.

Areas of sedimentation, erosion and scour have occurred across the site as the saltmarsh has formed (particularly around the breaches). However, this was anticipated when designing the scheme and this has been allowed to occur unhindered, so that as much as possible a naturalised saltmarsh can be recreated. No adaptive management is planned.

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

- Ideally, long-term strategic planning is needed to identify, prioritise and capitalise on opportunities for achieving managed realignment. From conception to delivery, this realignment work has taken almost 20 years while, for north-west England, the 2011 Shoreline Management Plan calls for a further 122km before 2030!
- Check any site proposed for managed realignment is between the level for highest astronomical tide and the mean high water neap tide. The importance of the availability of sea level gauge data cannot be understated. This is one of the first considerations of strategic planning for managed realignment sites.

- Check whether you have an eroding or an accreting estuary system. The methodology described above is based on an accreting system, from which a sediment supply will be readily fed into the site following breaching.
- Consider the long-term management of the site at the start of the project. Is the current landowner willing to carry out a permanent change to saltmarsh? Is land purchase necessary?
- Significant quantities of spoil are created from creek excavation and breach works. Plan carefully in advance the order of construction works and the location of spoil disposal, and wherever possible, reuse and relocate spoil within the site appropriately. For example, spoil at Hesketh Out Marsh has been used to: raise and widen the sea defence embankment; create ridge features for redshank nesting areas; fill in remnant field drainage; and create an elevated location for an observation hide.
- Studies have shown that many recent managed realignment sites suffer from low variability in elevation at the small scale; consideration of the microtopography (that is, rugosity) will be beneficial to the eventual biodiversity across the managed realignment site.
- Modelling is advisable during the planning/design of managed realignment. HOME used the InfoWorks RS river modelling software package, supported by LiDAR information to provide the surface area/level information.
- Where a project site was formally saltmarsh and has been reclaimed, the use of old maps and/or aerial photography (which pre-date the reclamation) is valuable, allowing the former saltmarsh creek layout to be understood and where possible recreated. These resources also provide the best evidence for the number, location and size of breaches required for a site.
- Breach openings should be carefully designed so as to not unduly constrain tidal exchange in the formative early years post breaching. Where aerial photographs allow, attention should be given to assessing the historical tidal exchange from aggregate creek widths.
- Multiple breach openings require careful design and planning to enable construction to be carried out simultaneously, with safety being paramount in any methodology, with well-defined staging, for breaching.
- It is possible to create saltmarsh by realignment simply by creating breaches and allowing tidal inundation to gradually erode creeks over time. However, this can be a very long process, as only the highest tides of the year will inundate the site, which may take many decades to attain habitat optimal. The process of habitat creation can be accelerated by the recreation of a sufficient creek network to feed tidal flows onto the site during the majority of the high tide cycles. This allowed the creation of a full saltmarsh vegetation community in 3–5 years following breaching on the Ribble Estuary.
- Any set back line of defence (earth embankment) should be fully vegetated before breaching defences seaward of the new defence line. The inner embankments at Hesketh were seeded with a grass mix rich in fescue species which are tolerant of saline influence and allowed to establish a vegetation mat for a full year before being exposed to the tide. British Seed Houses – A21 Coastal/Saline Amenity mix was used.
- Excavation of the creeks should be modelled in terms of the length, width and depth required for the site, although experience has shown that if these parameters are met accurately, the profile itself can be roughly cut to save time and cost. This is because the tidal inundation following breaching creates a smooth profile as the excavations become exposed to the tidal exchange flows.
- To encourage the formation of lateral creek divisions from the main excavated creek pattern, it is advisable to create notches, or 'grips' (~15m long) at intervals along the banks of the creeks. This can potentially speed up the formation of a naturalised creek pattern on the developing saltmarsh.
- Saline lagoons are a relatively rare feature on saltmarsh and it is not necessary to create them on all managed realignment sites. However, if these are a desirable feature for your intended site it is advisable that they are separate features unconnected to the saltmarsh creek system.
- Where low ground pressure construction plant is not used and compaction is suspected, selected areas of ploughing within a 40m buffer of the creeks may assist with the restoration of diverse saltmarsh flora.

10. Bibliography

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Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's [Joint Flood and Coastal Erosion Risk Management Research and Development Programme](#).