Gauging the tide

A critical review of the current level of methods used to assess and manage flood risk in the Upper Severn Estuary

Advance the Line

CONTENTS

Key words and abbreviations

Above Ordnance Datum - AOD

Accretion - *the process of growth or enlargement by a gradual build-up of sediment.*

Advance the Line - *a term used in coastal flood risk strategies which means reclaiming land from the sea by building new defences further seaward.*

Arable Reversion - *the reversion of arable land to permanent grassland to deliver environmental benefits.*

Below Ordnance Datum - BOD

Biodiversity - *the variety of life in a particular habitat or ecosystem.*

Bore - *a steep-fronted wave caused by the constriction of the tide rushing up an estuary of a particular shape and proportion, both in plan and in the shape of its bed.*

British Waterways (BW) - *replaced by the Canal and River Trust during 2012*

Canal and River Trust - CRT

Coastal Setback - *an early term for managed realignment in a landward direction.*

Coastal Squeeze - *the process by which coastal habitats and natural features are progressively lost or drowned, caught between coastal defences and rising sea levels.*

Countryside Stewardship - *a scheme administered by Natural England (and predecessors) aimed at improving the environmental value of farmland.*

Crib - *a breakwater; often a simple wooden framework incorporating stones or a sunken barge filled with stone, but can describe a more substantial construction such as Hock Crib, known locally as 'the great bulwark' which was built of formed stonework.*

Environment Agency - EA

Flood and Coastal Erosion Risk Management Strategy for England - *FCERM*

Frampton Court Estate - FCE

Higher Level Stewardship - *an agri-environment scheme administered by Natural England which aims to deliver significant environmental benefits in priority areas over a long period of time. Agreements are tailored to local circumstances.*

Hold the Line - *a term used in coastal flood risk strategies to provide some level of defence, keeping the position of the defence where it is now. This does not automatically mean that the defence will be improved to counteract climate change.*

Integrated Local Delivery - *a process whereby all partner organisations with an interest in a particular area work collectively with local landowners and communities, thereby integrating national and international strategic policy with local skills and environmental land management knowledge in order to achieve the best possible outcome.*

Intertidal Zone - *the area that is exposed to the air at low tide and underwater at high tide (also known as the foreshore and seashore, and sometimes referred to as the littoral zone).*

Lead Local Flood Authority (LLFA) - *a body with responsibility for local sources of flood risk, in particular surface runoff, groundwater and ordinary watercourses. Gloucestershire County Council is the LLFA for the study area.*

Littoral Zone - *the part of a sea, lake or river that is close to the shore. In coastal environments the littoral zone extends from the high water mark, which is rarely inundated, to shoreline areas that are permanently submerged. It always includes the intertidal zone and is often used to mean the same as the intertidal zone. However, the meaning of littoral zone can extend well beyond the intertidal zone.*

Lower Severn Internal Drainage Board - LSIDB

Managed Realignment - *the creation of new intertidal habitat through the realignment of primary sea defences in either a landward direction to a new, shorter sea defence at the back of the site or to naturally occurring higher ground, or in a seaward direction where the existing intertidal habitat is extended in width by sediment recharge.*

Managed Retreat - *an early term for managed realignment in a landward direction.*

Mudflat - *a coastal wetland formed when mud is deposited by tides or rivers.*

Natura 2000 - *The EC Birds Directive requires the establishment of Special Protection Areas (SPAs) for birds and the EC Habitats Directive similarly requires Special Areas of Conservation (SACs) to be designated for species other than birds, and for habitats. Together, SPAs and SACs make up the Natura 2000 network of protected areas.*

Natural England - NE

Outfall - *the place where a river, drain or sewer empties into the sea, a river or a lake.*

Ramsar Site - *Ramsar sites are designated under the Convention on Wetlands of International Importance. The broad objective of Ramsar*

designation is to stem the loss and progressive encroachment on wetlands now and in the future.

Regional Flood and Coastal Committee (RFCC) - *an RFCC is a committee established by the Environment Agency under the Flood and Water Management Act 2010 that brings together members appointed by the Lead Local Flood Authorities and independent members with relevant experience to provide a better understanding within that membership of the flood and coastal erosion risks within its area. RFCCs ensure coherent plans for identifying, communicating and managing flood and coastal erosion risks and promote cost-effective management. The English Severn and Wye RFCC covers the study area.*

Saltmarsh - *a type of wetland subject to frequent or continuous flooding with salt water and dominated by salt tolerant plants.*

Severn Estuary Coastal Habitat Management Plan - *CHaMP*

Severn Estuary Flood Risk Management Strategy **(draft)** - *SEFRMS*

Severn Estuary Shoreline Management Plan Review **(draft)** - *SMP2*

Site of Special Scientific Interest (SSSI) - *an area of land which is considered to be of special interest by virtue of its fauna, flora, geological or physiographical/geomorphological features.*

Southwest Strategic Regional Coastal Monitoring Programme - SSRCMP

Special Area of Conservation (SAC) - *SACs are strictly protected sites designated under the EC Habitats Directive in recognition of the significant contribution they make to conserving habitat types and species in most need at European level (excluding birds).*

Special Protection Area (SPA) - *SPAs are classified under the EC Birds Directive to help protect and manage areas that are important for rare and vulnerable birds because they use them for breeding, feeding, wintering or migration. SPAs require specifically that the extent of saltmarsh within the designated boundary is maintained.*

The Severn Lands - the *area owned by Frampton Court Estate bordered by Hock Ditch (north), Frampton Pill (south), Gloucester and Sharpness Canal (east) and the River Severn (west).*

The Shoots - *a deep rocky channel in the vicinity of the Second Severn Crossing.*

Tidal Frame - *the elevation range between the lowest and highest tides.*

Tidal Prism - *the volume of water between mean low tide and mean high tide.*

Tide Locking - *the time during which watercourses and drainage channels cannot discharge into the estuary due to the tide being in.*

Transitional Waters - *are bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows.*

UK Biodiversity Action Plan (UK BAP) - *The UK BAP is the UK Government's response to the Convention on Biological Diversity. It describes the UK's biological resources (species and habitats) and commits to a detailed plan for the protection of these resources.*

Waling - *a horizontal timber or beam used to brace or support an upright member such as sheeting.*

Warth - *an old or dialect word for a river bank or a flat meadow beside a river or estuary, especially used to describe the lands along the Severn estuary. It is interesting to note the similarity of the word 'warth' to 'wharf', which can mean to strengthen or make firm the bank of a river with a wall of timber or stone.*

Water Framework Directive (WFD) - *helps to protect and enhance the quality of surface freshwater, groundwaters and their dependent ecosystems, estuaries and coastal waters out to one mile from low water.*

Wildfowl and Wetlands Trust - WWT

Wrack - a colloquial term for flotsam and jetsam stranded on the shoreline by the tides.

Advance the Line was formed by local professionals with relevant expertise interested in the development of the Environment Agency's *Severn Estuary Flood Risk Management Strategy* in the parishes of Fretherne-with-Saul and Frampton on Severn. This report (*Gauging the tide*)[1] intends to look at managing flood risk within a very specific section of the Upper Severn Estuary between Hock Cliff (Fretherne) and Frampton Pill (the boundary between Frampton on Severn and Slimbridge); although due to the complex dynamics of the Severn Estuary its consideration is at times broader.

Gauging the tide (which is effectively a summary of our work to January 2013 and may be updated from time-to-time) investigates historic, current and proposed methods of managing flood risk and their attendant environmental and social implications. Additionally it serves as a critical review of policy developed by organisations currently tasked with managing flood risk, and considers risks to natural and anthropogenic interests arising. One of its key conclusions is that policy is not based on a robust evidence base and its effects are poorly understood. This may adversely affect environmental and social sustainability and in the medium-term lead to unintended consequences. We hope that our work will ensure the establishment of monitoring protocols to increase the understanding of current conditions, trends in environmental change and the results of policy decisions along this section of the Severn Estuary.

It is interesting to note the emergence of '*integrated local delivery*' which has been used successfully within Gloucestershire on other projects.[2] This concept highlights the need for such organisations as the Environment Agency, Natural England, Lower Severn Internal Drainage Board and Canal and River Trust to work together with the Severnside communities, parish councils, landowners, farmers, local conservationists and the Wildfowl and Wetlands Trust to collectively understand and respond to the consequences of rising sea levels, increased storminess and reduced funding for flood defence.

There is much to learn from the '*managed realignment*' scheme that has operated within the area for almost 20 years, particularly in the light of suggestions that other, similar schemes might be considered nearby in the future to provide compensatory habitat for that lost through coastal squeeze elsewhere. However, in common with most other managed realignment schemes throughout the country, the results of this policy have largely gone unmonitored. This is contrary to widely accepted norms where scientific decisions are based on a strong evidence base supported by monitoring to evaluate the implications of that decision. As such it is unclear as to whether current and suggested future management strategies have, or will, achieve the best possible outcome in terms of biodiversity and flood risk management, and ultimately whether they represent sustainable solutions.

[1] Cover photographs: front - taken from the sea wall at Fretherne looking towards Saul and Frampton Warths, 25th February 2012; back - the bore from Fretherne Warth, 5th August 2012

[2] The Countryside and Community Research Institute, *Inspiring and Enabling Local Communities: An integrated delivery model for Localism and the Environment,* (2011)

Additionally it became clear during the compilation of this report that weaknesses in the research undertaken by those charged with developing the *Severn Estuary Flood Risk Management Strategy* had much wider implications throughout the entire Gloucestershire section of the estuary; some 53 miles of coastline.[1] This area is largely under-monitored by comparison with its counterparts, the sections covering South Gloucestershire to Hinckley Point in Somerset (60 miles) and South East Wales to Lavernock Point (42 miles). A key conclusion is that there is an acute need to feed local monitoring information into the existing minimal data set, both to act as a baseline and to understand future trends.

We hope to assist in identifying means to obtain data relating to the Upper Severn Estuary to address this current deficiency. Both the draft *Severn Estuary Shoreline Management Plan Review* and *Severn Estuary Flood Risk Management Strategy* extend to Gloucester, and there does not appear to be any good reason to omit almost the whole of this coastline from the Southwest Strategic Regional Coastal Monitoring Programme.[2]

Ultimately we hope to ensure that future revisions to both strategies are better-informed and that they benefit from the same standard of data available throughout the entire area covered by these strategies; a more holistic approach will lead to a much-improved understanding of this complex system.

Gauging the tide will be sent to organisations and individuals[3] with an interest in the future management of the Upper Severn Estuary in anticipation that they will work together to develop a strategy to establish terrestrial and fluvial baseline conditions and how flood management practices are influencing them.

It is hoped that the recommendations made in this report are noted within the *Severn Estuary Flood Risk Management Strategy* documentation and that by the time the next iteration is produced, the *Severn Estuary Shoreline Management Plan Review* will have been updated to provide more accurate and meaningful guidance not only for the study area, but for the whole of the Gloucestershire coastline.

[1] Sharpness Dock to Gloucester Weirs, Gloucester Weirs to Lydney Dock

[2] A multi-disciplinal programme which is designed to inform those managing tidal flood risk throughout those areas covered by the over-arching shoreline management plans and their more detailed flood risk strategies.

[3] See Appendix F for List of Recipients

1 INTRODUCTION

1.1 TERMS OF REFERENCE

This report has been prepared because local residents and naturalists interested in the unique environs of the littoral zone along the eastern bank of the River Severn between Hock Cliff and Frampton Pill have raised concerns regarding the scientific rigour of the flood risk management policies being developed by the Severn Estuary Coastal Group (SECG) and the Environment Agency (EA).

It investigates historic and current methods of managing tidal flood risk and their environmental and social implications. It has been prepared by local professionals with relevant technical specialisations and draws on a range of recorded material, historical data, on site monitoring and anecdotal evidence. In acknowledgement of the complexity of the study area it is very much an iterative document and will be further developed.

Additionally it serves as a critical review of policy developed by organisations currently tasked with managing tidal flood risk for the study area, and considers risks to natural and anthropogenic interests arising. A key aspect of this review investigates how successful the policy of managed realignment in this locale has been in achieving objectives related to the Severn Estuary Natura 2000 and Ramsar sites and in effectively managing flood risk. The report identifies a range of future scenarios that may arise from historic and proposed measures to open up dialogue on whether the current and proposed policies really represent sustainable solutions.

It concludes by making a series of wide-ranging recommendations that relate to both the study area and the Gloucestershire section of the estuary from Sharpness/Lydney to Gloucester.

1.1.1 The research team and their experience

The report has been prepared by a group of individuals with both detailed understanding of the unique environs of the study area and a range of complementary technical expertise.

Table 1.1 The research team

Roger Bagley	Engineer
Paul Burnside	Civil Engineer (Rivers and Canals)
Julie Ellison	Social and Environmental Enterprise Consultant
Roderick Ellison	Chartered Environmental Consultant
Phill Harvey	Project Manager
Rose Hewlett	Local Historian and Secretary to Frampton Court Estate
Mike Ounsted	Wetlands Conservationist

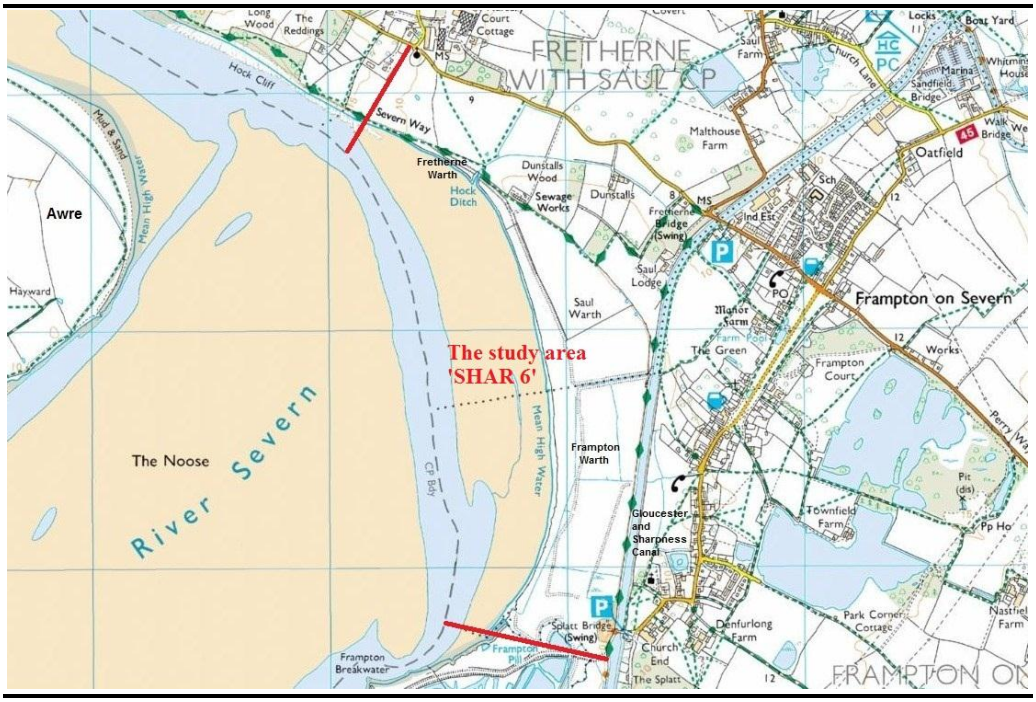
1.2 SCOPE OF THE REPORT

1.2.1 The study area

This report has been prepared on the study area of the littoral zone of the eastern bank of the River Severn between Hock Cliff and Frampton Pill referred to within the Severn Estuary Coastal Group's (SECG) over-arching draft *Severn Estuary Shoreline Management Plan Review* (*SMP2*) as policy unit '*SHAR 6 Gloucester to Sharpness – downstream of Hock Cliff to Frampton Pill*'.

The northern section from Hock Cliff to Hock Ditch comprises a high-cliffed shoreline of lower lias clay and bands of limestone[1] which gives way to the lower-lying unstructured alluvium of Fretherne Warth on the approach to Hock Ditch. This topography continues southwards throughout the rest of the policy unit where Saul and Frampton Warths are collectively known as '*The Severn Lands*'. The southern extent is marked by Frampton Pill which forms the boundary with neighbouring Slimbridge Warth.

Figure 1.1 The study area



Patterns of erosion and accretion of these reclaimed warthlands, which lie on the outside of a large meander, have been influenced by both natural processes and anthropogenic intervention. The powerful, relatively short flood tide and long ebb, which often carries additional fluvial flow, both play an important part in shaping the shoreline and the river's ephemeral mudflats and midstream sandbanks.

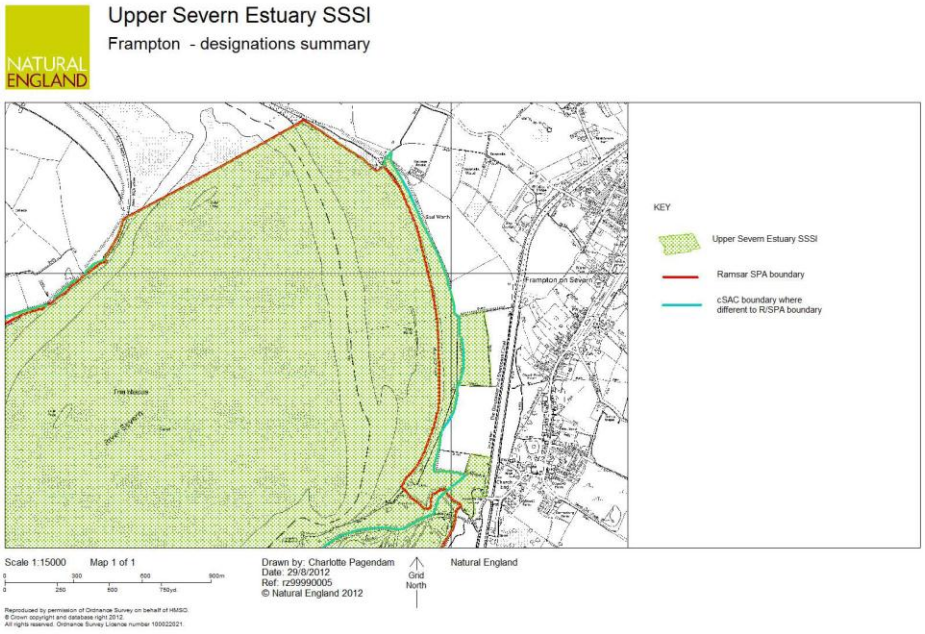
[1] Dreghorn, William, *Geology Explained in the Severn Vale and Cotswolds*, (1973)

1.2.2 Statutory designations

The land between Hock Cliff and Frampton Pill and the associated Upper Severn Estuary are recognised as areas of exceptional wildlife value. The Upper Severn is designated as a Ramsar Site, a Special Protection Area (SPA), Special Area of Conservation (SAC) and a Site of Special Scientific Interest (SSSI). See Figure 1.2 below for the extent of these designations.

Ramsar sites are designated under the Convention on Wetlands of International Importance. The broad objective of Ramsar designation is to stem the loss and progressive encroachment on wetlands now and in the future.[1]

Figure 1.2 Habitat designations within the study area



SPAs are classified under the EC Birds Directive to help protect and manage areas that are important for rare and vulnerable birds due to their use for breeding, feeding, wintering or migration. SPAs require specifically that the extent of saltmarsh is maintained.

SACs are strictly protected sites designated under the EC Habitats Directive in recognition of the significant contribution they make to conserving habitat types and species in most need at European level (excluding birds).

The Upper Severn Estuary, including parts of the land between the high tide line and the Gloucester and Sharpness Canal, is also a SSSI.

[1] Joint Nature Conservation Committee - jncc.defra.gov.uk

1.2.3 Trends

Although surveys of the Upper Severn Estuary as a whole undertaken during the past 40 years have resulted in the establishment of this protected status, detailed wildlife information on the warths themselves has largely been recorded informally and is uncoordinated. This is despite the fact that many birdwatchers visit the area and part of the land is leased for wildfowling. As a result, historical changes in the ecology of the warths remain largely anecdotal, and therefore it is difficult to predict future trends.

Despite the lack of firm data, there is general agreement that the last 50 years (i.e. within the lifetimes of several local amateur naturalists) have seen a dramatic decline in passerine birds (e.g. Skylarks), wildfowl (e.g. Wigeon) and mammals (e.g. Brown Hares). Whilst much of this decline is likely to be a result of wider habitat loss and changes in agricultural practice, some of the decline is also thought to be a direct result of local loss of habitat associated with the erosion on the warth itself. Paradoxically, erosion of the high saltmarsh also leads to the development of low and mid-level saltmarsh and mudflat that also have a benefit for wildlife, although given the narrow band covered by the saltmarsh, the effects are on a much smaller scale than elsewhere in the estuary.

Figure 1.3 Narrow band of saltmarsh on Saul Warth, 8th August 2012

In 2006 and 2012, with optimum conditions, natural flooding of the marshland between an abandoned sea wall and the Gloucester and Sharpness Canal and between the higher ground and the sea wall south of Hock Ditch created a wetland of exceptional biodiversity importance. This is significant as this habitat is important not only in winter but specifically for breeding birds in

spring and summer. It is one of only three regular breeding sites for Garganey in Gloucestershire.[1]

1.2.4 Recent data

Severn Estuary Coastal Habitat Management Plan

The *Severn Estuary Coastal Habitat Management Plan* (*CHaMP*)[2] was developed to guide the *SMP2* by providing advice to inform strategic flood risk and coastal management decisions in order to avoid damage to sites designated under the Ramsar Convention and Habitats and Birds Directives. Its purpose is to predict long-term deterioration in the integrity of sites, enabling the EA to meet Government obligations. It is unclear how the findings of *CHaMP* are being incorporated into the developing *Severn Estuary Flood Risk Management Strategy* (*SEFRMS*) as no specific mention is made of habitat within the drafts supplied so far by the EA.

Natural England, Upper Severn Estuary SSSI assessment

In monitoring the Upper Severn SSSI, Natural England (NE) records (2010) that '*Unit 3*' (the study area) continues to suffer from active erosion at the saltmarsh edge.[3] The habitat is described as '*unfavourable no change*' which is interpreted as being in '*adverse condition*' and not meeting the Government's Public Service Agreement target of being in favourable or recovering condition by 2010.

WWT Consulting study of The Severn Lands

As part of Frampton Court Estate's (FCE) Higher Level Stewardship agreement WWT (Consulting) Ltd produced a detailed study of The Severn Lands.[4] This provides an ecological baseline for the study area which could be used as a starting point in mapping and understanding baseline conditions.

1.2.5 Tidal flood defences

Tidal flood defences protecting the village of Fretherne-with-Saul include stone revetments and earth embankments around the Hock Ditch outfall, which itself incorporates tidal flaps and a tide gate. The Frampton on Severn section was formerly protected by an earthen sea wall which was abandoned almost 20 years ago when The Severn Lands went into the then novel concept of *'coastal setback'* (managed realignment). As a result, the sea defences along Frampton Warth have been realigned to the Gloucester and Sharpness Canal embankments.

The *SMP2* predicts that *'the shoreline defence fails in the 20 to 50 year epoch, although residential properties become at risk from flooding between 50 and 100 years'*. The shoreline defence along the study area may indeed come under pressure given the current rate of erosion to the outer warths. Additionally as the Gloucester and Sharpness Canal currently supplies more

[1] Wildfowl and Wetlands Trust, *Breeding Wader Survey, The Severn Lands*, 21st April 2010
[2] ABPmer, Royal Haskoning, *Severn Estuary Coastal Habitat Management Plan*, (2006)
[3] Natural England, *Upper Severn Estuary SSSI Assessment,* 29th September 2010
[4] Wildfowl and Wetlands Trust (Consulting) Ltd, *Frampton Estate Intertidal Zone Feasibility Study*, (2011)

than 50% of Bristol's water[1] the implications are, in fact, much broader than this.

1.3 REPORT OBJECTIVES AND BACKGROUND

1.3.1 Purpose

This report reviews the implications of managed realignment within the study area, what monitoring regimes have been established to verify this process and ultimately whether both historic and proposed policies are the most sustainable long-term options. It will also examine whether those organisations charged with managing tidal flood risk currently have sufficient information on which to base their short, medium and long-term strategies.

The report also considers the management of surface water inasmuch as it relates to the *SEFRMS*. Successful discharge of surface water from the villages of Fretherne-with-Saul and Frampton on Severn is inextricably linked to the mechanisms at the main outfalls of Hock Ditch and Frampton Pill (which works in conjunction with those relating to the Gloucester and Sharpness Canal).

Figure 1.4 Frampton Pill, 17th November 2012

The report highlights the need for these outfalls to be effectively maintained and monitored to ensure that the management of pluvial, fluvial and tidal dynamics are integrated.

[1] www.bristolwater.co.uk

The key purposes of the report are summarised as:

- To consider statutory habitat designations and the effects of managed realignment on their qualifying criteria;
- The efficacy of the *SMP2* and *SEFRMS* considering their limited data set, almost non-existent monitoring regime and generic understanding of the study area;
- To investigate the management of flood risk in the historical context from Medieval times to the present day;
- To review contemporary topographic and hydrological evidence to provide a current baseline to assist with understanding the trends and effects of erosion and accretion;
- The effects of managed realignment on fluvial, tidal and pluvial flood risk and the consequent potential difficulties associated with the management of the western bank of the Gloucester and Sharpness Canal which could potentially be adversely impacted by regular tidal inundation within ten years; and
- To make recommendations to assist with improving understanding of the study area.

1.4 LIMITATIONS

The report data set has been developed from historical records, site visits and anecdotal evidence. We recognise that our work has not been informed by a detailed computer model of the sediment dynamics of this particularly complex section of the estuary. Unfortunately, such a study has never been undertaken and those developing the *SMP2* and *SEFRMS* have seemingly been content to accept this significant gap in knowledge.

This report seeks to partly redress the lack of data through detailed historic research and information drawn from local people and engineers who have watched and worked along the river at this location for centuries.

It is noted that the mapping of the precise edge of the warths by Ordnance Survey is subject to the interpretation of their cartographers. Anecdotal evidence, particularly from 17th century court records and 19th century engineers' reports and correspondence, does not contain accurate measurements. However, these deficiencies do not significantly detract from the results of analysing general trends of erosion and accretion.

1.5 REPORT STRUCTURE

This report adopts the following structure:

- Section 2 Critical Review of Applicable Policy;
- Section 3 Historical Context and Map Regression;
- Section 4 Consideration of the Sustainability of Managed Realignment;
- Section 5 Surface Water Management;
- Section 6 Third Party Assets - The Gloucester and Sharpness Canal
- Section 7 Possible Future Scenarios; and
- Section 8 Recommendations and Conclusions.

2 CRITICAL REVIEW OF APPLICABLE POLICY

2.1 INTRODUCTION

The National Flood and Coastal Erosion Risk Management Strategy for England[1] (*FCERM*) sets out the EA's strategic overview role as it builds on existing approaches to flood and coastal risk management.

Flooding and coastal erosion cannot be entirely prevented and the relevant legislation is largely permissive. This means that there is no general right to be protected from flooding and coastal erosion, and no right to be protected to any particular standard where risk management action is taken. Instead, Government promotes nationally consistent approaches to assessing and managing flood and coastal erosion risk.[2]

The Southwest Strategic Regional Coastal Monitoring Programme (SSRCMP) provides a consistent regional approach to coastal process monitoring, providing information for the development of strategic shoreline management plans, coastal defence strategies and operational management of coastal protection and flood defence.[3]

The programme, which provides regular topographic and bathymetric survey data, LiDAR, aerial photography and ecological mapping, is managed on behalf of various coastal groups and is funded by Defra in partnership with the maritime local authorities and the EA Southwest Region.

It does not, however, include the shoreline north of Sharpness/Lydney which lies within the EA Midlands Region. This accounts for almost the whole of Gloucestershire which in itself comprises over one third of the area covered by the *SMP2* and *SEFRMS*.

This exclusion from the SSRCMP has led to a lack of understanding of the processes at work in the Upper Severn Estuary and how they influence/are influenced by changes elsewhere in the system. The consistent approach promoted by both the *FCERM* and SSRCMP can only be achieved if the estuary is managed holistically and that will require comparative data sets throughout the whole area covered by the *SMP2* and *SEFRMS*.

2.2 POLICY AND ITS IMPLEMENTATION

The *SMP2* sets out in a general way how the shoreline in each policy unit should be managed during epochs of 0-20 years, 20-50 years and 50-100 years. The detail of implementation (e.g. what defences should be built of, their precise location and line, or the standard of protection to which they should be built) is provided within the *SEFRMS*. The *SEFRMS* has adopted a policy of adaptive management and once this document is accepted there will

[1] Defra and the Environment Agency, *The National Flood and Coastal Erosion Risk Management Strategy for England*, (2011)
[2] Defra and the Environment Agency, *The National Flood and Coastal Erosion Risk Management Strategy for England*, (2011), 35
[3] http://www.channelcoast.org/southwest/

be a need for the *SMP2* to be revised to ensure that the two strategies are not contrary or divergent.

The Government charges the EA with the responsibility for the management of flood risk from main rivers. In developing flood risk and management strategies it is necessary to:

- Establish a clear knowledge of the nature of the flood risk;
- Identify a methodology for managing the risk at an acceptable level; and
- Establish a management structure to implement a plan in an affordable way over the short, medium and long-term.

In describing and implementing the *SEFRMS*, it is incumbent on the EA to be fully transparent, particularly to the populace directly affected by the risks. In doing this it is important to identify all agencies and organisations that have a role in developing and implementing the strategy, stating clearly their relative roles, responsibilities and communication mechanisms.

Gloucestershire County Council as Lead Local Flood Authority has responsibility for managing flood risk from surface water, groundwater and ordinary watercourses (but not main rivers). The Lower Severn Internal Drainage Board (LSIDB) maintains the drainage ditches from the 10 metre contour line to the EA's outfalls.

2.3 CRITICAL REVIEW OF THE SMP2 AND SEFRMS

The EA's original draft *Severn Estuary Flood Risk Management Strategy* was withdrawn in 2011 on the direction of the Rt. Hon. Richard Benyon, MP, Minister for the Natural Environment, Water and Rural Affairs, following separate representation from the Gloucestershire Severnside parishes between Slimbridge and Elmore, and the North Somerset coastal parishes of Wick St. Lawrence and Kingston Seymour. Those communities and others had not been consulted during its preparation and the EA were told to reject their original draft strategy and start again, this time with full community and stakeholder engagement.

The lack of engagement that blighted the first draft *SEFRMS* had its roots in the committee rooms of the SECG who underestimated the need for stakeholder engagement at community level during the preparation of the *SMP2*.[1] The requirement for such engagement had been made clear in Defra's *Shoreline Management Plan Guidance*, which even provided examples of the letters that should have been sent.[2]

The exceptionally limited baseline data and monitoring in the Upper Severn Estuary has exposed a lack of understanding with regard to the physical processes at work and how to best manage flood risk; for instance the *SMP2* states that:

- *'There is little sediment data available upstream of The Shoots'* (the site of the Second Severn Crossing)*; and*

[1] Severn Estuary Coastal Group, *Severn Estuary Shoreline Management Plan Review: Appendix B, Stakeholder Engagement and Consultation*, *Annex A, List of Key Stakeholders,* (2010)
[2] Defra, *Shoreline Management Plan Guidance, Appendix A: Stakeholder Engagement Strategies*, (2006)

- *'The increased tidal flood risk, nor in addition to fluvial flood risk, caused by the tidal bore is not documented, and therefore has not been included in the baseline scenario flood risk mapping.'*

It could be successfully argued that these are some of the most important aspects to take into consideration. With the second highest tidal range in the world, the Severn carries an enormous sediment budget with an estimated 30 million tonnes of sediments suspended on a spring tide.[1] The main channel between Frampton and Awre is prone to migration, although the reasons for this are not fully understood. In the absence of a study of the sediment dynamics the characteristic midstream sandbanks and shoreline mudflats and the part they play in the evolution of the upper estuary are unexplained. This knowledge gap is also noted by the Wildfowl and Wetlands Trust (WWT) who would welcome a long-term study of the area.[2]

The action of the bore and its following waters as they race up the river, cutting into the shoreline mudflats and warths, are a strong component of the system along this section of the estuary. It is those tides that shape the coastline of the study area. Frampton and Saul Warths are particularly susceptible to erosion; something which past flood risk management has recognised and, on occasions, successfully mitigated.

In developing a clear flood risk management strategy for the medium to long-term, the first step is to analyse and describe the nature of the flood risk to be managed. The *SEFRMS* makes no attempt to do this other than to state in broad terms that the risk is tidal in nature and that in the long-term there may be some impact from sea level rise. Even then the sea level rise data estimates provided relate to datum points along the open coast of the lower estuary without consideration of how such tidal changes will impact in the more confined upper reaches where fluvial flow is also relevant.

Fluvial flooding is outside the scope of the *SEFRMS*. However, the need to ensure that the flood defences are maintained so as not to impede fluvial drainage into the estuary is within its scope. The EA currently have responsibility for the clearance of Hock Ditch and Frampton Pill under their permissive powers. The clearance and maintenance of these fluvial channels is fundamental to any flood risk strategy, yet the *SEFRMS* is silent in this regard. Furthermore, there is no consideration of the issues of '*tide locking*', sediment blockage or the effects of erosion and accretion on these channels.

The *SEFRMS* for Frampton (see Appendix A) does define the existing flood defences and states that they will be maintained. However the strategy is vague about the level of maintenance. Furthermore, some of the defences are in the third party ownership of the Canal and River Trust (CRT) and will be maintained, at least in part, by them. Whilst the EA and CRT have exchanged letters of understanding (see Appendix E) regarding the role of the western canal bank as a primary flood defence, these letters have no contractual or statutory effect. Without a more precise agreement it is difficult to see how budgetary responsibility will be divided between the two organisations.

[1] Kirby, Robert, *Managing the Shores of the Severn Estuary*, Presentation to Gloucestershire NFU Severn Estuary Stakeholders, 10th July 2012

[2] Correspondence with the Wildfowl and Wetlands Trust, September 2012

There is a clear mismatch in the maintenance philosophies of the EA and CRT.

Figure 2.1 The Environment Agency's embankment on Saul Warth is kept clear to aid inspection and discourage mammals and vegetation from weakening the defences, 25th February 2012

Figure 2.2 The overgrown western canal bank at Frampton, 17th October 2012

Given that the canal bank is almost 200 years old, and that it has only been subject to a visual inspection (which must have been hampered by undergrowth), it is difficult to make any estimate of its suitability as a primary flood defence.

In defining the canal bank as a primary flood defence, no mention has been made of the fact that a primary drainage channel runs at the foot of its western bank. This ditch is owned by the CRT and maintained under contract by the LSIDB, yet no mention of this is made in the *SEFRMS*, nor is it apparent that any discussions have taken place with the LSIDB on the impact of the *SEFRMS*.

Figure 2.3 The primary drainage channel beside the western canal bank at Frampton, 13th January 2013

In the Fretherne-with-Saul section (see Appendix B) there is a lack of clarity in segregating the flood defences and the associated statistical risks between those at Saul/Framilode (to the north of the Arlingham peninsula) and those to the south at Hock Ditch. The defences to the north have a higher statistical risk of failure, but this is not made sufficiently clear in the strategy which also fails to note that Hock Ditch is the main fluvial drainage channel for Fretherne-with-Saul and the north of Frampton.

Whilst the *SEFRMS* mentions statistical flood risk levels there is no indication of how these figures are derived. For Frampton the defences are stated as giving better than 1:200 protection. Whilst this is good news if the statistical analysis is valid, no mention is made as to how this will be reflected in the EA flood risk maps.

2.4 MONITORING UNDERTAKEN BY REGULATORY BODIES

Modelling is only as good as the data on which it is based. Successful engineering solutions have, for centuries, only been achieved where careful, meticulous planning and design has taken place informing decisions. In the past, generations working on and alongside the river depended on their observations and the knowledge of their forebears to keep them safe and minimise the risk of flooding. The river is still intrinsically linked to the villages and habitats that lie along its banks which are now reliant on external organisations to manage flood risk. It is incumbent upon those organisations to obtain sufficient information, including detailed surveys and reference to the historic model, in order to inform decisions.

It is apparent from discussions with the EA and NE that for many decades few, if any, coastal or river bank surveys have been undertaken in the study area. Furthermore it is evident that a strategy or framework was not, and is not currently in place to steer such surveys. For Natura 2000 sites and SSSIs there is a requirement to understand whether the created/restored habitats have achieved the desired aim. Such monitoring, which is limited in the study area, would usually focus on mudflat benthos, marsh vegetation and overwintering birds. It is beyond the scope of this report to quantify the sum of changes, although on the basis that the SSSI is in adverse condition, it is reasonable to conclude that the changes have not been positive in terms of achievement of the objectives related to the Severn Estuary Natura 2000 site.

The *SMP2* ambiguously states: '*The mud bank adjacent to Frampton has either eroded or remained relatively stable*.'

Figure 2.4 The ephemeral high-cliffed mudflat adjacent to Saul and Frampton Warths in a phase of rapid erosion, 23rd June 2012

It is surprising that preparation for the *SEFRMS* has not included physical monitoring of the shoreline and hydrology. Nor has the need to understand the sediment dynamics of this part of the estuary been recognised. The large, high-cliffed mudflat plays an important part in protecting the outer warths. It is ephemeral and, in additional to normal tidal action, it is affected by the backwash from the flood tides hitting the harder shoreline at Fretherne.

Whilst this report does not doubt that there is a potential for the shoreline defences, which include the western bank of the Gloucester and Sharpness Canal, to fail in the medium-term due to the erosive actions of the tides,[1] there is no obvious data set within the *SMP2* to support this conclusion.

2.5 RELATIVE SEA LEVEL RISE

It is noted that the four main monitoring points used to measure sea level rise (currently 2.4 mm/pa) in the Severn Estuary are located at Mumbles, Newport, Ilfracombe and Hinckley Point; all well south of the study area.[2] Findings from these monitoring points note a change in the tidal frame with maximum extreme sea level trends at all four locations showing reducing trends whilst minimum extreme sea levels show rising trends. However, none of these monitoring points reflect the unique nature of the estuary north of Sharpness where the mean neap tides are lower than the mean spring tides,[3] and fluvial flow plays an important part in the height of the river. With a predicted increase in storminess, fluvial flow may become a more dominant factor. In addition, it is expected that any relative sea level rise in the broad reaches of the outer estuary will be magnified within the confines of the inner estuary through tidal propagation.

[1] Severn Estuary Coastal Group, *Severn Estuary Shoreline Management Plan Review: Appendix F, Policy Development and Appraisal*, 200, (2010)

[2] Williams, Allan, *Coastal Erosion and Sea Level Rise*, Severn Estuary Climate Change Research Advisory Group workshop, 26th February 2010. The study covered the years 1993-2007. This short presentation made no mention of the 18.6 year lunar cycle which will see the highest tidal predictions peak in 2015.

[3] Arrowsmith, Bristol Channel Tide Table 2012 (information from the UK Hydrographic Office); the actual point of change is Shepperdine (Harbourmaster, Gloucester Harbour Trustees)

3 HISTORICAL CONTEXT AND MAP REGRESSION

3.1 HISTORIC TIDAL AND FLUVIAL FLOOD MANAGEMENT

Effective management practices have aided the accretion of land on Fretherne, Saul, Frampton and Slimbridge Warths since Medieval times. This conferred numerous benefits; social, environmental and economic.[1] However, left unchecked, the natural process is mostly one of erosion, the unstructured rich alluvium formed on the outside of one of the Severn's great meanders offering little resistance to the forces of the river.

The earliest surviving signs of agricultural activity along the Frampton and Saul Warths are provided by the abundant cattle and sheep footprints in the pink estuarine silts which date between Roman times and the Medieval ridge-and-furrow buried beneath these marginal lands that are often washed by the tides. These traces suggest that the saltmarsh was used merely for seasonal grazing until land reclamation was initiated during the Medieval period.

The use of cribs, breakwaters and earth embankments can be traced through documentation from the 16th to 20th centuries.[2] In the late 16th century it was possible to walk in a straight line on dry ground between Frampton Pill and the hedge delineating the parish boundary of Fretherne and Arlingham. Of particular note was Hock Crib, a magnificent stone structure rebuilt in 1739 at this point to protect Fretherne, Saul, Frampton and Slimbridge Warths from the long ebb tide. It started to decay at the beginning of the 19th century.

These warths underwent extensive erosion between 1820 and 1870. During this period the earth embankments at Frampton and Slimbridge were often repaired and small cribs and breakwaters were built. The repair or rebuilding of Hock Crib was considered several times but there was disagreement amongst engineers about the most effective position of the breakwater.[3]

The building of the Severn Railway Bridge between Lydney and Sharpness (1875-79) changed the river's dynamics significantly and land began to accrete again on Frampton and Saul Warths, presumably because the bridge's supporting piers had the effect of slowing down the flow thereby allowing sediment to drop out as it went around the outside of the meander. The need to repair or rebuild Hock Crib became less urgent and discussions appear to have ceased.

According to Ordnance Survey mapping and anecdotal evidence the warths were very extensive by the early 20th century and remained so until 1960 when the Severn Railway Bridge was severely damaged by two tankers, with one of the bridge piers being swept away in the collision.[4] This led to the river's dynamics changing again, and the present pattern of erosion appears to have

[1] Allen, J R L, *A Medieval Waterside Settlement overlooking Severn-estuary alluvium, Hock Cliff, Fretherne and Saul, Gloucestershire*, from Archaeology in the Severn Estuary, 12, (2001); Allen, J R L, *A short history of salt-marsh reclamation at Slimbridge Warth and neighbouring areas*, Gloucestershire, from Transactions of the Bristol and Gloucestershire Archaeological Society, vol. 104, (1986)

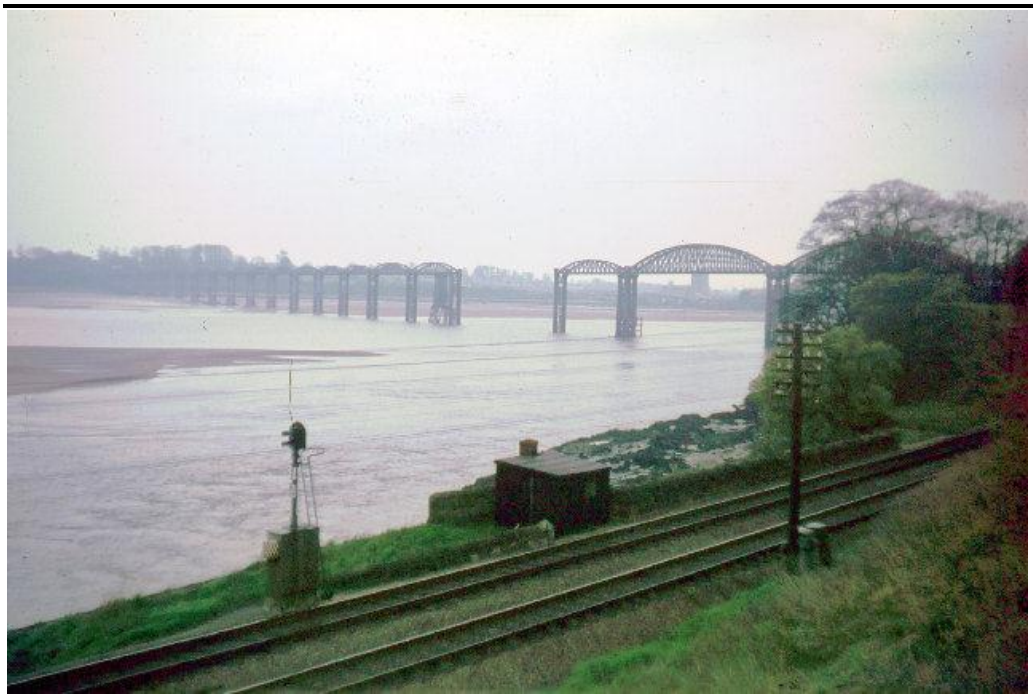
[2] Hewlett, Rose, *Hock Crib, near Fretherne, Gloucestershire*, (2012)

[3] Hewlett, Rose, *Hock Crib, near Fretherne, Gloucestershire*, (2012)

[4] Vivian, Andy, *Remembering the Severn Rail Bridge Disaster*, BBC Radio Gloucestershire, (2010), *http://news.bbc.co.uk/local/gloucestershire/hi/people_and_places/history/newsid_9111000/9111421.stm*

started around this time. The bridge was demolished between 1967 and 1970, although the foundations of some of the piers and the wrecks of the two tankers which collided still remain. These presumably continue to have some effect on the sediment dynamics of the area.

Figure 3.1 Severn Railway Bridge from the western bank after the disaster in 1960[1]



The main channel closed in on the eastern bank and by the summer of 1972 the shoreline mudflat adjacent to Saul Warth had eroded completely for a considerable part of its length.

In the past Frampton Breakwater (to the south of Frampton Pill in the parish of Slimbridge) was effective in pushing the main channel towards the middle of the river during the short, but powerful flood tide. For the last 50 years, through lack of maintenance, it has gradually lost parts of its integrity, most particularly during the storm associated with the 'hurricane' of 1987. The enhancement to the earth embankment along Slimbridge Warth in the early 1990s may have constricted the river's natural floodplain and further contributed towards the erosion processes in the study area.

A severe storm on 8th June 2012 also appears to have given the estuary a new dynamic having ripped away large areas of the shoreline mudflat adjacent to Frampton and Saul Warths. Note the position of the church at Frampton (marked with a red arrow) in Figures 3.2 and 3.3. The photograph of 10th April 2012 was chosen as it was taken at a similar state of tide; the extent of the mudflat was the same until the storm of 8th June.

[1] Photograph taken in April 1966, http://en.wikipedia.org/wiki/Severn_Railway_Bridge

Figure 3.2 Mudflat looking from Fretherne Warth, 10th April 2012

Figure 3.3 Mudflat from the same position immediately after the storm, 8th June 2012

The present positions of the main channel hard against the eastern river bank, and that of the remaining mudflat, appears to mirror those of the 1970s. Air photographs from the Cambridge University Collection of 1973 and 1977[1] are particularly helpful and give a good indication of the amount of erosion that the warths might expect during the next few years having now lost their cover.

[1] Cambridge University Collection of Air Photographs K17AC069, K17AC071, K17AC099, K17AC100 and RC8CI204

The pattern of maintenance and decay of the large breakwater at Tites Point, Purton needs studying to see if there is any connection with the sudden migration of the main channel approximately two years ago towards the eastern bank at Slimbridge, Frampton and Saul. The area around Tites Point is inaccessible to the public, making it difficult to undertake any monitoring. However, just as Frampton and Saul have lost their warths and covering mudflat a large area of new mudflat and saltmarsh has been forming to the south along the Slimbridge shore in the embayment between the New Grounds and Tites Point.

3.2 AVAILABLE BASELINE INFORMATION

3.2.1 Intertidal Zone Feasibility Study

The WWT Consulting study[1] provides an ecological baseline and will prove a valuable resource as a starting point in understanding baseline conditions.

The study included the following elements:

- A review of relevant desk study material;
- An extended Phase 1 Habitat Survey;
- A basic topographic survey of field height levels in relation to tidal inundation levels;
- A basic soil survey to determine water retention capacity; and
- A basic hydrological survey to determine water input and outputs.

Many UK Biodiversity Action Plan (UK BAP) priority habitats are found on The Severn Lands which are currently rich in biodiversity. Of particular note is the ancient boundary hedge between the parishes of Saul and Frampton with its double-embankment and central ditch, signifying that its origins probably date to before the Norman Conquest. It serves as the only substantial refuge of its type for a significant length of the eastern shoreline and is of particular value to birds, invertebrates and mammals in times of storm and severe weather. It is also an important habitat for passerine migrant birds during both their autumn and spring passage.

Excluding saltmarsh, a total of 72 ha of grassland habitat was mapped of which 1 ha comprised improved grassland, 56 ha of semi-improved and 15 ha of lowland marshy grassland. Much of this habitat is inundated on high spring tides and water retention (both tidal and pluvial) is helped by the alluvial clay substrate. This ensures the viability of potentially important feeding and breeding areas for a range of waders (particularly Lapwing and Curlew) and gulls. However, rapid erosion of the abandoned sea wall means that tidal lagoons are likely to form within the lower-lying adjacent fields leading to a possibility that the nests of breeding waders in this area will become flooded.

The saltmarsh habitat of just 1.15 ha is limited to a narrow strip immediately adjacent to the mean high water line, which tapers towards its northern extent. The relatively high, almost-'cliffed', river bank (8.75 m Above Ordnance Datum (AOD)) working in conjunction with the pressure from the adjacent tidal waters effectively concentrates the pioneer, low, mid and high saltmarsh into an

[1] Wildfowl and Wetlands Trust (Consulting) Ltd, *Frampton Estate Intertidal Zone Feasibility Study*, (2011)

almost impossibly narrow band which is not replicated anywhere else within the estuary.[1] As a consequence it has generally been erroneously thought that the different ground levels within this band have indicated previous extents of erosion.

Figure 3.4 Narrow band of saltmarsh on Saul Warth, 24th October 2012

Anecdotal evidence from local landowners, farmers, birdwatchers, conservationists, fishermen, boatmen and wildfowlers tells a different story. The warths have, during their memory, always topographically been a gentle sloping progression from terrestrial to intertidal habitat with a sharp drop at the edge to the adjoining ephemeral mudflat and/or river. Anecdotally it is said that much land has been lost during that time, almost certainly in excess of 100 metres.

A variety of wet ditches and old earth embankments traversing the site, and an extending reed bed provide additional biodiversity.

The low stocking rate of cattle on The Severn Lands from 1st May to 30th November forms an intrinsic part of FCE's Higher Level Stewardship agreement as small numbers of animals reduce the likelihood of damage to the nests of ground-nesting birds. Whilst the cattle prove beneficial in terms of ensuring the sustainability of the UK BAP Priority Habitat of coastal and floodplain grazing, they add to the erosion of the abandoned sea wall and outer warth by poaching and tracking. Additionally, their encroachment into the reed bed and the ancient boundary hedge between Saul and Frampton can be partly destructive.

[1] Natural England site visit, 31st October 2012

3.3 FURTHER DEVELOPING AN ENVIRONMENTAL BASELINE

3.3.1 Introduction

As previously discussed, data is limited within the study area and current and proposed flood risk management policies are seemingly not based on a robust database or any form of monitoring protocol. As such as practical we have endeavoured to ensure this report is founded on the best available data within the constraints of a community organisation.

To inform our understanding of the estuary we have undertaken an in-depth review of historical data (including map regression) and established a protocol for field surveys. The purpose of this work has been to determine the variations in the line of the eastern bank of the Severn and the extent of terrestrial and intertidal habitats.

The work of this study is on-going and the English Heritage Archive has been contacted in an effort to locate air photographs taken in 1969 which were used by Ordnance Survey to remap the coastline, together with any that may have been taken by the RAF and Luftwaffe in the 1940s.

3.3.2 Data certainty

Measurements taken using air photographs, satellite imagery and maps have as accurately as possible followed the same angles from the monitoring points to the edge of the warth. It is noted that the air photographs and satellite imagery have differing resolutions and have been assessed using a standard computer system. Ordnance Survey mapping of the edge of the coastline is only an interpretation of the facts available to their cartographers.

The edge of the warth is defined as the seaward edge of the upper level of the outer warth, excluding any unstable land which is seen to be in the process of becoming separated by apparent fissures. It is accepted that field study measurements have been undertaken without the benefit of scientific instruments and may therefore be subject to a small degree of variation in terms of the angle taken from the monitoring point to the edge of the warth. The measurements were originally taken to satisfy the needs of FCE.

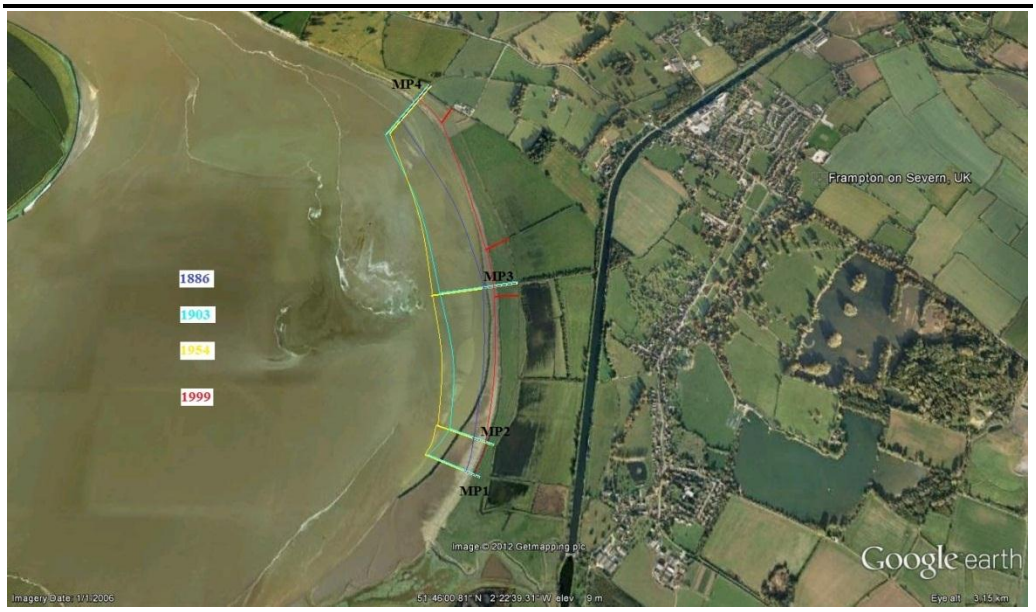
Despite the above limitations, the results shown by the field study measurements and those taken from air photographs, satellite imagery and maps are sufficient to provide overall trends in erosion and accretion.

3.3.3 Monitoring of the eastern bank

Four Monitoring Points (MPs) were chosen for the purposes of this study and these are shown in Figure 3.5, together with the approximate edge of the warth in 1886, 1903, 1954 and 1999.[1]

[1] Ordnance Survey 6 inch to one mile maps 1886, 1903 and 1954; Google Earth 1999. The image date is 1st January 2006, although it is suspected that the actual date of the imagery was during 2005 as there are leaves on the trees.

Figure 3.5 Monitoring Point locations



A description of the MPs and their locations (National Grid Reference) is provided in Appendix C.

3.3.4 The derived position of the eastern bank

Using the data for each MP (see Appendix D) it has been possible to draw the following graph (Figure 3.6) which shows the general pattern of accretion and erosion from 1886 to the present day.[1] There is a lack of information for the period covering the second quarter of the 20th century and further investigation is required to see whether Ordnance Survey undertook any detailed field studies during this time. Their 6 inch to the mile 1924 edition appears to merely repeat the 1903 Second Edition mapping. A naval chart of the River Severn compiled in 1926-27 with revisions in 1949[2] has not been used owing to its scale and its reliance on Ordnance Survey for topographical information.

Anecdotal evidence covering the second quarter of the 20th century suggests that the extent of the warths was gradually increasing and no particular concerns regarding erosion have been found within FCE records or the Fred Rowbotham[3] archive.[4]

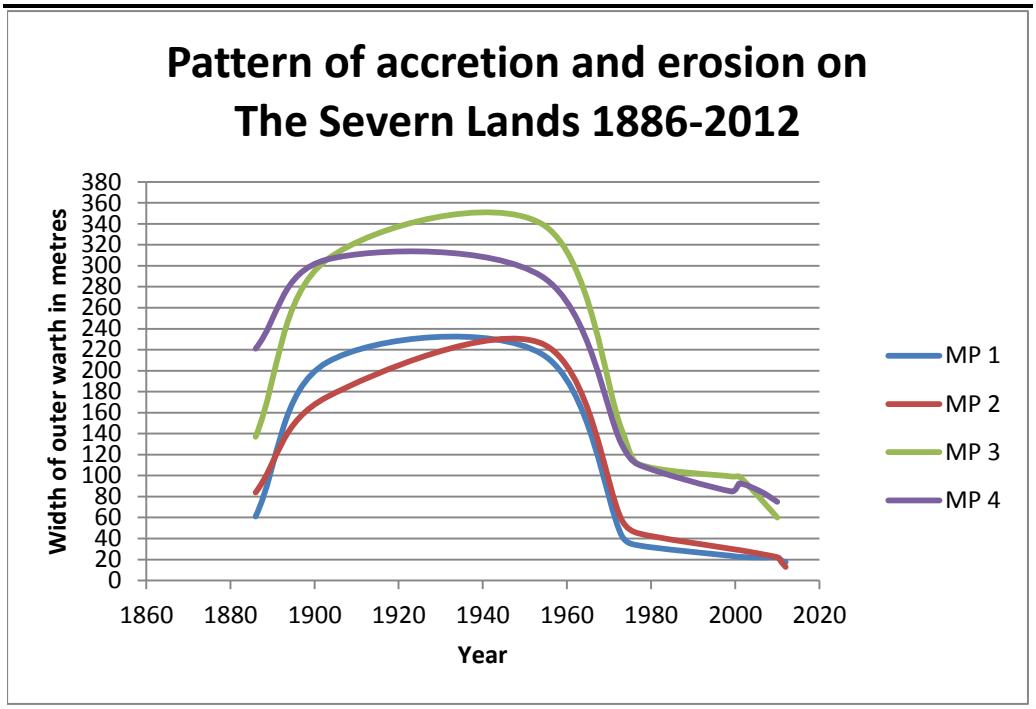
[1] Data was taken from the following sources: Ordnance Survey 6 inch to one mile maps 1886, 1903 and 1954; Cambridge University Collection of Air Photographs 1973 and 1977; Google Earth 1999 and 2006; Satellite image supplied by Natural England 2001; on site measuring 3rd November 2011 and 5th November 2012

[2] Gloucestershire Archives D3921.IV.28

[3] District Engineer for the Severn River Authority 1932-74

[4] Gloucester Archives D3489

Figure 3.6 The derived position of the eastern bank[1]

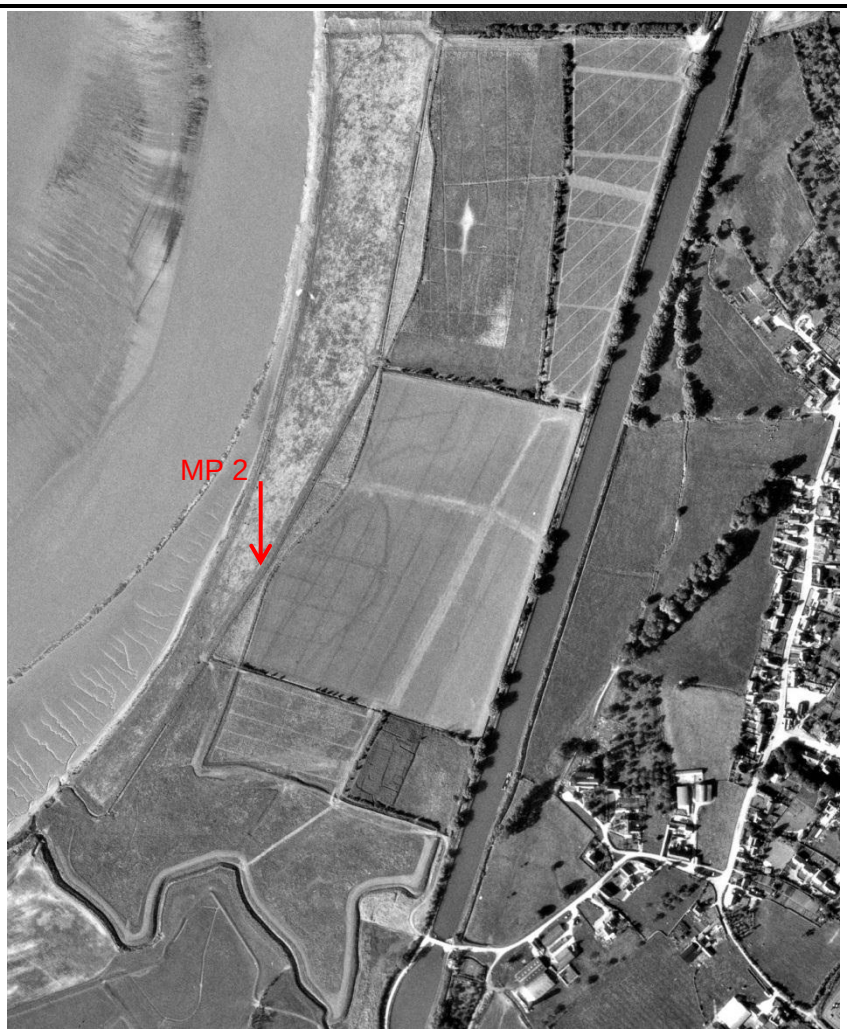


Prior to the building of the Severn Railway Bridge between Sharpness and Lydney (1875-79), the warths had undergone a prolonged period of erosion. Evidence is found within the Berkeley Estate muniments and the Clifford and Rowbotham archives in the form of maps, engineers' reports and correspondence.[2] This information has not been extrapolated into the above graph as it does not contain many actual measurements. It is, however, interesting to note the concerns of the Gloucester and Berkeley Canal[3] Company engineers, William Clegram and his son, William B. Clegram, during the 1840s and 1860s regarding the erosion of the outer warth and destruction of the earthen sea wall at Frampton, and their input into effecting repairs. They clearly viewed the erosion process with interest as the land was being eaten away towards their newly-built canal, opened in 1827.[4]

It is apparent that the building of the Severn Railway Bridge greatly influenced the processes at work within the study area. Its supporting piers appear to have slowed the flow on the flood tide to such an extent that the suspended sediments were able to drop out along the edge of the large meander around the Slimbridge, Frampton and Saul Warths. It is noticeable that this trend reverses somewhat abruptly following the demolition of the bridge and its piers (between 1967 and 1970) and the subsequent rapid erosion can be partly followed by comparing the air photographs of 1973 and 1977. The 1969 air photographs taken for Ordnance Survey would greatly enhance our understanding of this period and confirm whether or not the destruction of the 17th pier when the vessels collided in 1960, and the wrecks of the two tankers, also had a significant effect on the processes at work on the warths at Frampton and Saul.

[1] Data was taken from the following sources: Ordnance Survey 6 inch to one mile maps 1886, 1903 and 1954; Cambridge University Collection of Air Photographs 1973 and 1977; Google Earth 1999 and 2006; Satellite image supplied by Natural England 2001; on site measuring 3rd November 2011 and 5th November 2012.
[2] Hewlett, Rose, *Hock Crib, near Fretherne, Gloucestershire*, (2012)
[3] Later re-named the Gloucester and Sharpness Canal
[4] Gloucestershire Archives, D149/E100 and E101

Figure 3.7 Frampton Warth, September 1977[1]



[1] Cambridge University Collection of Air Photographs, RC8CI204

Figure 3.8 Frampton Warth, July 2011[1]

Measurements taken on site in November 2011 and November 2012 give rise for concern, particularly at MP 2 which is only 4.00 m away from a large breach in the old sea wall and interestingly the area most at risk during the erosion cycle of the mid-19th century. At this point the outer warth (currently 12.90 m in width)[2] is eroding at more than 2.00 m per annum. A few metres north of MP 2 the outer warth is just 10.40 m wide.

[1] www.apple.com/uk/ios/maps
[2] 5th November 2012

Figure 3.9 Monitoring Point 2 at high tide, 15th November 2012 (arrow marks the breach in the old sea wall).

The height of the outer warth increases over time as layers of silt are deposited by the tides. At MP 2 the outer warth is 8.75 m AOD, some 0.75 m above Great Narles, the adjacent field between the old sea wall and the Gloucester and Sharpness Canal. The study undertaken in 2010 by WWT Consulting incorporates a LiDAR survey (see Figure 7.1) which illustrates that a water level of 8.25 m AOD would flood much of the site if there was open connection with the river. Based on the current pattern of erosion this could happen within the next 5-10 years.

4 CONSIDERATION OF THE SUSTAINABILITY OF MANAGED REALIGNMENT

4.1 THE CONCEPT OF MANAGED REALIGNMENT

Following the EC Habitats Directive 1992 it was understood that rising sea levels and manmade sea defences were gradually squeezing out intertidal habitat such as mudflats and saltmarsh. In certain coastal and estuarine locations it was accepted that the best and most sustainable and cost effective way to enhance flood protection was to realign the primary sea defences in a landward direction, either to a new, shorter sea wall at the back of the site or to naturally occurring higher ground. Known originally as '*coastal setback*', and later by the name '*managed retreat*', '*managed realignment*' is now practiced throughout the world. Managed realignment can also occur in a seaward direction where it extends the width of existing intertidal habitats through sediment recharge.[1]

Managed realignment is seen as a means for delivering on the demands of the Water Framework Directive (WFD) to improve the ecological status of transitional (estuarine) water bodies.[2] The *Managed Realignment Moving Towards Water Framework Objectives* project was funded by the EU via the LIFE Environment Programme and aimed to provide information on the benefits of the managed realignment of flood defences, particularly, but not exclusively, in relation to EC Directives. It set out to identify the link between managed realignment and the emerging WFD objectives for estuaries and coastlines.

One of the primary outputs of this project was intended to be an analysis of how managed realignment sites around Europe were monitored. The project stumbled at this point as the anticipated level of information on monitoring was not available. Some sites had not been monitored at all, whilst at others the monitoring had been very short-term. There was no standardisation in monitoring and no procedure for sharing information.

This lack of data should not have been unexpected for Atkinson et al. had identified in 2001 that nationally there were no agreed protocols for the monitoring of managed realignment sites.[3] Due to low levels of monitoring there is little evidence on which to base future managed realignment projects. ABPmer are currently compiling a database of managed realignment sites throughout Northern Europe[4] in an attempt to communicate the lessons learned in the past and thus to improve the quality of similar projects in the future; nonetheless it is quite limited and it would appear not definitive with only one study along the Severn Estuary (at Cone Pill), for which there is no monitoring information available.

[1] Defra, *Shoreline Management Plan Guidance for England and Wales*, (2006)
[2] Environment Agency, *EU LIFE Environment Managed Realignment Moving Towards Water Framework Objectives Final Report,* (2010)
[3] Atkinson, P.W., Crooks, S., Grant, A. and Rehfisch, M. M., *The success of creation and restoration schemes in producing intertidal habitat suitable for waterbirds*, English Nature Research Report 425, (2001)
[4] ABPmer *Online Managed Realignment Guide* - http://www.abpmer.net/omreg/

A lack of long-term monitoring at sites means that as yet there is no understanding of when a managed realignment policy ceases to be of benefit to biodiversity and managing flood risk, i.e. when erosion of the site means that the biodiversity goes into decline and the flood risk increases. Most sites are only monitored for up to 5 years.[1]

Of those sites that have been monitored, the main focus has been on birds, food sources for birds or particular interest features of the designations. Less work has been done on the physical changes which take place within and outside of the sites and other ecological groups such as fish.[2] The '*Managed Realignment Moving Towards Water Framework Objectives Final Report*' recommended that the following key parameters should feature in all future managed realignment monitoring programmes:

- Original ground levels;
- Frequency of tidal inundation on all parts of the new intertidal area;
- Sedimentation at fixed monitoring points;
- Changes in ground level across the site;
- The nature of sediments in terms of particle size, organic content and moisture content;
- Invertebrate colonisation of the intertidal sediments and water column;
- Use of the site by birds; and
- Colonisation of bare substrates by vegetation including both algae and higher plants.

Designing and assessing managed realignment projects is a complex process, and can vary greatly in scope between projects. Two issues are crucial to the success:

- The hydrology and hydraulics within the site have to be designed to support the target habitats; and
- The physical changes which occur along adjacent estuaries or coasts following the introduction of a new inundation area need to be assessed, particularly as these can in turn affect other interests, such as designated habitats or flood protection.

Understanding such changes often requires detailed hydrodynamic, sediment and wave modelling/assessment exercises. These are absent in the case of the study area.

However, it is important to briefly reflect on what should be the focus and what should be three of the best-understood and most accurately-quantifiable aspects of the physical changes which occur. These are:

- The amount by which a scheme increases an estuary's tidal prism which in turn provides a simple indication of potential effects in proximity to the project and secondary effects which may be generated elsewhere by these primary changes;
- The channel formations that occur in front of a site as an indication of its primary effects; and

[1] Environment Agency, *EU LIFE Environment Managed Realignment Moving Towards Water Framework Objectives Final Report*, (2010)

[2] Environment Agency, *EU LIFE Environment Managed Realignment Moving Towards Water Framework Objectives Final Report*, (2010)

- The anticipated rate of accretion of sediments within a site, which influence how a site functions and also the rate at which the tidal prism effect reduces over time as a result.

4.2 MANAGED REALIGNMENT - THE SEVERN LANDS

4.2.1 Coastal Setback, a novel approach

In the early 1990s the National Rivers Authority put forward plans to enhance the earthen sea wall along Slimbridge, Frampton, Saul and Fretherne Warths. These works went ahead to the south at Slimbridge and the north at Fretherne. However, the old sea wall along Frampton Warth and part of Saul Warth was left untouched because MAFF eventually withdrew their offer of funding. This decision appears to have been greatly influenced by a feasibility study for coastal setback undertaken in 1992.[1] The Severn Lands were thought by English Nature, the Countryside Commission and National Rivers Authority to be an ideal location to pilot such a scheme.

English Nature and the National Rivers Authority recommended a detailed physical and biological investigation of the site and a prediction of the physical and ecological consequences of managed retreat. They also required advice on the design and implementation of managed retreat and on ways of monitoring its performance. The overall objectives were:

- A detailed design for a managed retreat scheme over land on FCE;
- An assessment of the physical, ecological and economic consequences of implementing such a scheme;
- Baseline information against which to measure the performance of the scheme if implemented; and
- A methodology for measuring the performance of the scheme if implemented.

Had the scheme gone ahead, a protocol would have been developed in respect of the following:

- The development of vegetation;
- The drainage of adjacent land;
- Future erosion;
- Stability and maintenance of a new flood defence line;
- Siltation rates; and
- Usefulness of the land for grazing or other forms of income generation compatible with its nature conservation interest.

Agreement to enter into the pilot scheme was not reached partly because FCE were unable to agree to the deliberate removal of a section of the existing sea wall.

Once it became clear that works to enhance the sea wall were not going to proceed FCE was forced to look at things from an economic perspective. Arable farming would not be possible in the long-term unless FCE took on the enhancement of the sea wall itself. The cost of such works was prohibitive

[1] Radley, G. P., Coastal Ecologist, English Nature, *Feasibility Study for Coastal Setback on the Frampton Court Estate, Upper Severn Estuary SSSI, Gloucestershire*, (1992)

and the idea of managed retreat proved more appealing so FCE entered into Countryside Stewardship in the autumn of 1993, albeit without the benefit of any of the above baseline surveys or monitoring protocols. Following the abandonment of the sea wall by MAFF and FCE, the sea defences for Frampton were effectively realigned to the Gloucester and Sharpness Canal.

As part of the Countryside Stewardship agreement the Long Ditch (which runs for a considerable length along The Severn Lands) and a grid system in one of the fields were gradually deepened to assist with water retention.

The Severn Lands remained in arable production until 2002 after which time it became clear that the crops would be lost to the tides too regularly to be viable. In 2003 part of The Severn Lands went into Countryside Stewardship Arable Reversion. These schemes were replaced by a Higher Level Stewardship agreement in 2010.

The creation of 39.50 ha of intertidal habitat was achieved during the period between the introduction of the Habitats Directive and *CHaMP*. This is acknowledged by NE[1] which, with its predecessors, has overseen the management activities of the site since 1993 via various stewardship schemes. It is remarkable that the EA takes a contrary stance and considers the intertidal habitat now found on The Severn Lands to have been created naturally and without management intervention, this despite reference to NE and FCE providing detailed information for the period in question.

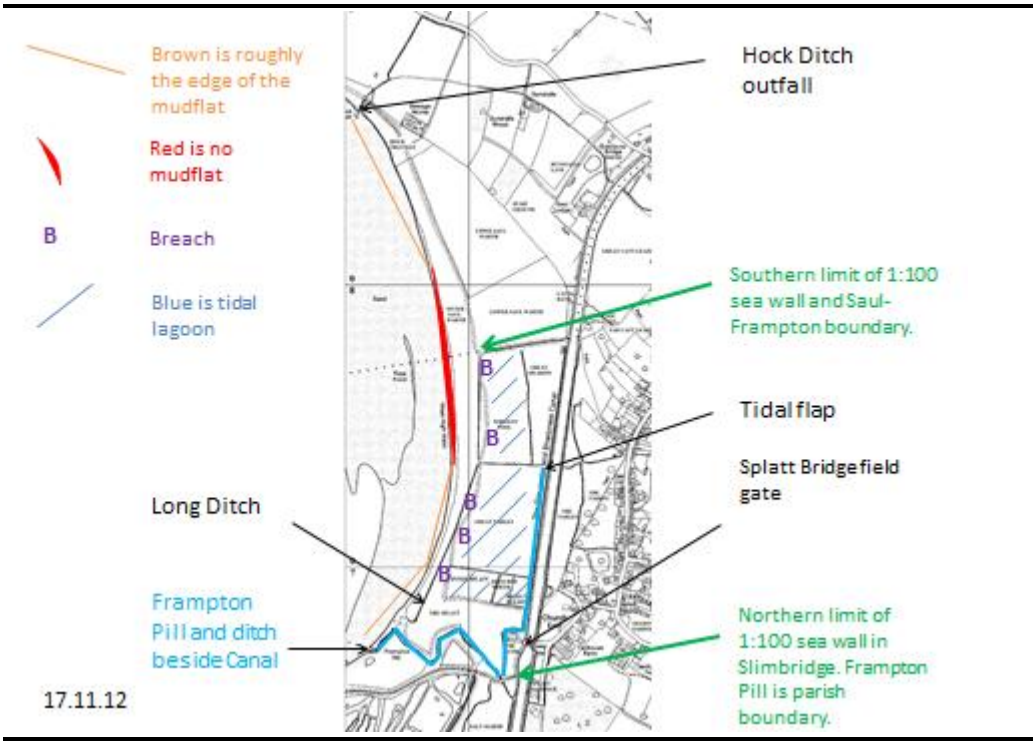
It is clear from the Biodiversity Action Reporting System that accurate records of saltmarsh habitat gains and losses were not kept during this period. This has led perversely to the Severn Estuary having an accepted '*pre-CHaMP*' deficit of 40 ha,[2] an almost identical area to that created on The Severn Lands within the same time frame.

4.2.2 The current situation

A graphical representation of the implementation of policy is shown in Figure 4.1 for the study area.

[1] Natural England site visit, 22nd August 2012
[2] Environment Agency and Severn Voice, *The Future of Flood Defences in the Severn Voice Parishes*, March 2012

Figure 4.1 The current situation



5 SURFACE WATER MANAGEMENT

5.1 DISCHARGE OF SURFACE WATER FROM FRAMPTON ON SEVERN

The fluvial drainage from Frampton can be segregated into three broad areas; north, south and central. The north and south areas discharge into the River Frome and Wicksters Brook respectively and are beyond the scope of this report.

The fluvial flows from the central parish areas, within the village boundary, flow from east to west and discharge through siphon culverts under the canal. The culverts are the responsibility of the CRT and were originally of wood construction though in recent years they have been repaired, relined and strengthened with synthetic/cement linings. There are three such culverts at:

Saul Lodge: This culvert takes the discharge from the B4071 (Perryway) and the northern end of the village. It discharges into the Severn via Hock Ditch. Hock Ditch has a high level tidal flap that controls fluvial and sewage works discharge. This tidal mechanism is the responsibility of the EA;

Buckle Brook (Buckholdt): This culvert takes the discharge from central village areas and is the only one to have a tidal flap at the western end. The tidal flap is the responsibility of the EA; and

Brick Pit: This culvert is to the south of Splatt Bridge and takes the discharge from Church End and the surrounding area.

Fluvial flow is beyond the scope of this report except to the extent that fluvial discharge is impeded by the tidal mechanisms referred to above. Discharge is impeded by high tide events of varying duration (tide locking), or by mechanical blockage caused by flotsam and jetsam debris.

Adequate fluvial storage is available to cope with current routine discharge blocking events, but the further erosion of Frampton Warth may expose the Buckholdt culvert to increased periods of tide locking and blockages caused by debris and silt.

5.2 HOCK DITCH OUTFALL

The EA's draft proposal in respect of the *SEFRMS* for Fretherne-with-Saul (see Appendix B) confirms that the current 1:100 earth embankment to each side of the Hock Ditch outfall on Saul and Fretherne Warths will continue to be maintained, and also improved in the light of rising sea levels; and that it will not be allowed to fall below 1:75. The proposal does not indicate the extent of the increase in relative sea level required to reach the 1:75 scenario.

The village of Saul lies below the Severn and an effective surface water drainage system is vital to its existence. No mention is made in the *SEFRMS* of the tidal flaps and tide gate at the Hock Ditch outfall which form a vital part of the sea defence for the parish of Fretherne-with-Saul. Their operational effectiveness will need to be monitored against rising sea and fluvial levels,

and in the light of erosion. The height of the tidal flaps will need to be regularly assessed in relation to tide locking to ensure that action is taken before unacceptable surface water levels are reached. The timing of this may be different to the requirement to improve the earth embankments.

5.3 MAINTENANCE OF ENVIRONMENT AGENCY ASSETS

The EA are under no legal obligation to protect against flood risk, but use their permissive powers to maintain outfalls and other flood risk assets (such as earth embankments) within budgetary constraints. Within the study area the large number of properties at Fretherne-with-Saul and Frampton on Severn ensure that it is cost-beneficial to continue to maintain the outfalls and assets into the medium and long-term.[1]

The EA's MEICA (Mechanical, Engineering, Instrumentation, Control and Automation) and Asset Performance teams work within an inspection programme to assess the structures for operational efficacy and overall condition and signal any future work that may be required on a structure.[2] The EA's Operations Delivery team visit more frequently to ensure correct function, taking particular account of the effects of high spring tides and severe storms.

The build-up of flotsam and jetsam (known colloquially as '*wrack*') around the Hock Ditch and Frampton Pill outfalls has, in the past, been cleared by the EA to ensure the unimpeded drainage of surface water and reduce the likelihood of a tidal flap becoming jammed open or shut by a piece of debris. Much of the wrack (shown in Figure 5.1) deposited during a particularly high set of tides in October 2012 is still in place at the time of this report, January 2013.

[1] Environment Agency, draft *SEFRMS* wordings for Fretherne-with-Saul, November 2012 and Frampton on Severn, December 2012

[2] Environment Agency emails to Fretherne-with-Saul Parish Council, July 2012

Figure 5.1 Hock Ditch outfall, 21st October 2012 with wrack from recent high tides

6 THIRD PARTY ASSETS - THE GLOUCESTER AND SHARPNESS CANAL

6.1 INTRODUCTION

The Gloucester and Sharpness Canal is currently owned by the CRT who maintain it to a standard fit for the purpose of keeping slow moving water within its banks. When the canal was built in 1827 its design was based on this principle.

6.1.1 Responsibility for maintenance of the Gloucester and Sharpness Canal and its associated mechanisms as a tidal flood defence

Responsibilities for the maintenance of the Gloucester and Sharpness Canal and its associated mechanisms have recently been agreed between the EA and CRT and are outlined in a briefing from the EA[1] (see Appendix E). It should be noted that the EA's letter of 20th January 2012 to the CRT's predecessor, British Waterways (BW), implies that the EA is maintaining an earth defence with a protection of 1:100 which acts as a support to the protection provided by the Gloucester and Sharpness Canal at Frampton. This is not the case; the earth defence in question is some half mile further up the river along the upper part of Saul Warth and because of the topography and distances involved currently plays little or no part in protecting the village of Frampton.

The CRT has no experience of maintaining a canal embankment exposed to a tidal situation. There are two locations along the length of the Gloucester and Sharpness Canal where there is a possibility of exposure to tidal conditions, at Purton and Frampton. Although the Severn runs much closer to the canal at Purton, the harder shoreline of Silurian rocks consisting of calcareous shales and sandstones[2] (reinforced by sunken barges acting as sea defences) has kept the river waters from encroaching at this point.

The situation at Frampton is somewhat different and although the river appears to be a very distant threat some 300 metres away, the ground in between comprises unstructured alluvium which offers little resistance to the erosive action of the tides. The abandoned sea wall lies lower than the outer warth along parts of its length, and the breaches along this old earth embankment increase its instability and the likelihood of tidal inundation across the much lower-lying adjacent fields to the canal.

6.1.2 Current areas of weakness in the Gloucester and Sharpness Canal as a tidal flood defence

It is accepted that the Gloucester and Sharpness Canal embankment was never designed to be a flood defence against the River Severn.[3] Given the rate of erosion on the outer warth and the topography of the land between the river and the canal, the current proposal within the *SEFRMS* would see the

[1] Environment Agency Briefing for Gloucestershire NFU Severn Estuary Stakeholders Group, *The Gloucester & Sharpness Canal as a Sea Defence*, 24th October 2012

[2] Dreghorn, William, *Geology Explained in the Severn Vale and Cotswolds*, (1973)

[3] BWB Consulting, *Embankment Inspection Report, Gloucester and Sharpness Canal, Frampton on Severn, Gloucestershire*, (2006)

western canal embankment regularly subjected to scouring as waters flow along its base. In time this would become significant and it is easy to envisage a scenario when structural instability of the embankment would necessitate remedial action; e.g. some form of scour protection.

Although the *SEFRMS* makes no reference to the likelihood of the bank's failure it does confirm that the EA '*will regularly inspect the length of canal that acts as a formal tidal flood defence and liaise with the CRT if any problems are identified that may result in increased flood risk*'. The *SEFRMS* stops short of confirming the process for dealing with any problem, including the financial responsibility for any necessary works. The CRT's responsibilities lie with ensuring the '*on-going integrity of the embankment to maintain freshwater in the canal*' and to '*liaise with the EA if they* (CRT) *become aware of changes to the canal bank which may allow ingress of saltwater and/or increase flood risk*'.

BWB Consulting's *Embankment Inspection Report*[1] was prepared in 2006 for the EA as a preliminary assessment of the stability of the impounding embankment to the Gloucester and Sharpness Canal adjacent to Frampton. No intrusive survey was carried out and the results of the report comprise the assumptions made from visual inspection only.

Whilst the profile of the western embankment has been over-steepened at the toe due to continued maintenance/de-silting of the adjoining drainage ditch, it is not considered to be in imminent risk of significant failure. However, there is a risk of on-going small/shallow failures in the short to medium-term and it is likely that there would be an increased risk of similar failures during flood conditions. It is also anticipated that immediately after a tidal flood event increased pore water pressures associated with a rapidly reducing water level could further reduce the stability of the embankment.

In the light of the possibility of the drainage ditch and western canal embankment being directly exposed to tidal water and debris on a regular basis within the next 10 years, the EA should to undertake a full structural analysis to check its suitability as a flood defence structure. In order to carry this out correctly it must to include a topographical survey of the existing area, site investigation including boreholes and trial pits to confirm the construction materials within the embankment and its current condition along with a diving survey to confirm the length and condition of the sheet piles along the canal bank.

In addition, mature trees growing on the embankment are open to the prevailing winds and have the potential to be blown over taking a large root-ball from the embankment and exposing the slope to an increased risk of movement. So far, the report's recommendation to pollard these trees to help reduce this likelihood appears to have gone unheeded. The CRT should ensure that management of these trees is incorporated into their annual maintenance programme.

[1] BWB Consulting, *Gloucester and Sharpness Canal, Frampton on Severn, Gloucestershire: Embankment Inspection Report*, (2006)

The canal embankment has a number of leaks along it which are monitored by the CRT whose limited annual budget for maintenance works means that these leakages are often not addressed as other works on the canal network are given a higher priority. As the Gloucester and Sharpness Canal performs a flood defence function the CRT must ensure that this is given significant consideration when assessing the risks and prioritising maintenance works.

The drainage ditches which run along the base of the embankments, particularly on the western side, are regularly maintained to ensure the free flow of surface water from the village and as a result of this have encroached into the toe of the embankment. The risk posed by this will be increased as tidal water creates further erosion of the toe. This will eventually lead to structural instability of the embankment.

At Splatt Bridge field gate the existing embankment contours are low and in certain conditions where inclement weather coincides with high spring tides this area is compromised by tidal flood water spilling out of Frampton Pill. The effects of this have, in the past, been minimised by the deployment of sandbags, thought to have been put there by a well-meaning BW employee. At a site meeting on 6th December 2012 neither the CRT nor EA could see any reason to monitor the situation even though rising sea levels and increased storminess could lead to the possibility of ingress into the canal. Should this be identified as a potential problem in the future it could be easily rectified by a re-profiling of the slope which runs from Splatt Bridge into the adjoining field.

6.1.3 The Gloucester and Sharpness Canal's role in times of fluvial flood

In July 2007 many counties in the UK were hit by heavy rainfall which caused significant flooding across the country. Gloucestershire suffered widespread flooding with rivers and streams swelling to levels almost unheard of. Heavy rainfall on the 20th July 2007 resulted in a significant increase in water level in the Gloucester and Sharpness Canal as surrounding fields, housing estate stormwater outfalls and various swollen streams discharged unprecedented volumes of water into the canal.

As expected, BW reacted to this by fully opening all the control structures (sluices and weirs) available to them on the canal, initially achieving a 1 m reduction in water level at Sharpness Dock. However, given the length of the canal (16.3 miles) and the vast amounts of water adding to the system, this only resulted in a 500 mm drop in water level at Gloucester. Over the next 12 hours the situation became critical with levels in the canal continuing to rise as more water poured into the waterway than could be discharged through the various control structures. As a result the water level in the canal passing Frampton on Severn rose to within 40 mm of overtopping and in Hardwicke it did overtop, flooding a number of properties. During this time BW expressed concern that the ever increasing water level of the Severn at Gloucester Docks may result in the river overtopping into the canal.

2012 was the second wettest year on record[1] and the Gloucester and Sharpness Canal was again called upon to assist with the discharge of flood water. This, combined with the effects of saturated ground along the

[1] Met Office - http://www.metoffice.gov.uk/news/releases/archive/2013/2012-weather-statistics

embankments, has led to a number of failures along the canal banks where the integrity of the sheet piling and waling beams have been compromised under the load exerted.

Figure 6.1 Canal bank slippage near Saul Lodge, Fretherne, 8th January 2013

Four of the five wettest years since records began in the UK in 1910 have occurred since 2000 and analysis suggests that the frequency of extreme rainfall may be increasing.[1] Although the events of 2007 were taken to be unusual, it proves that heavy rainfall causes significant issues for the canal which are not always manageable. To put further pressure on this by expecting it to act as a flood defence therefore seems unrealistic.

[1] Met Office - http://www.metoffice.gov.uk/news/releases/archive/2013/2012-weather-statistics

7 POSSIBLE FUTURE SCENARIOS

7.1 INTRODUCTION

The LiDAR data supplied within the WWT Consulting study is of particular interest as it provides the most accurate indication available of the extent of likely tidal inundation. The southern half of the site is represented in Figure 7.1 which clearly shows the difference in height between the narrow outer warth (8.75 m AOD) and the adjoining low-lying field (variously 8.00 m and 8.25 m AOD).

Figure 7.1 LiDAR data for Frampton Warth

7.2 THE LIKELIHOOD OF DIRECT TIDAL INUNDATION UP TO THE GLOUCESTER AND SHARPNESS CANAL EMBANKMENT

Tide tables are a guide only. The actual height of the tide is increased by, amongst other things, low barometric pressure and a west or south-westerly wind. At present all tides over 9.00 m are considered to have the potential to top the outer warth given these conditions.[1] Conversely under high barometric pressure and still conditions a 10.00 m tide may currently stay just within the river banks.

Figure 7.2 Tide topping and breaching the abandoned sea wall on Frampton Warth, 2nd March 2006

Tide predictions for Sharpness Dock cill in 2012[2] (which is 1.33 m Below Ordnance Datum) have been used in Table 7.1 to show the current situation and the increase in risk of tidal inundation once the river has direct connection with the fields landward of the old sea wall which are variously at 8.00 m and 8.25 m AOD. For simplicity it has been assumed that there are no peculiar estuarial effects between Sharpness and Frampton.

[1] Observations during the last 40 years by members of Gloucestershire Wildfowlers Association (who lease the shooting rights over The Severn Lands) and those farming The Severn Lands.

[2] Arrowsmith, *Bristol Channel Tide Table 2012* (information from the UK Hydrographic Office)

Table 7.1 Predictions of tidal inundation

Model (based on 2012 tide predictions)	Number of tides predicted to inundate in benign conditions	Number of tides with potential to inundate part or all of the low-lying fields between the outer warth and the canal
8.75 m AOD	above 10.08 m - 0	9.00 m and above - 94
8.50 m AOD	above 9.83 m - 1	8.75 m and above - 129
8.25 m AOD	above 9.58 m - 22	8.50 m and above - 181
8.00 m AOD	above 9.33 m - 41	8.25 m and above - 216

Figure 7.3 Extent of inundation 6 hours after high tide, 17th October 2012

Boats moored on the Gloucester and Sharpness Canal can be seen adjacent to Frampton's church.

7.2.1 Tidal flood risk

The Gloucester and Sharpness Canal embankment as a tidal flood defence offers protection of 1:200 or better to the village of Frampton (see Appendix A). At present there is little likelihood of it being overtopped by tidal waters unless the estuary experiences the type of storm surge that was associated with the 'Greatest Storm' of 1703[1] or the flood of 1606/7,[2] both of which are considered to have been extreme events (perhaps likely to occur once in every 500-1,000 years) for which no reasonable protection would prove adequate.

The only realistic threat to Frampton from tidal flood risk would be as a result of the loss of integrity of both embankments of the canal. The eastern bank, being of sheet pile construction, is expected to act as a secondary defence

[1] Brayne, Martin, *The Greatest Storm*, (2003)
[2] Risk Management Solutions, *1607 Bristol Channel Floods: 400-Year Retrospective*, (2007)

should the western bank fail.[1] However, it is known that when the water in the canal is significantly lowered to accommodate stormwater peak flows, the sides of the canal become weakened by the lack of balancing forces on the embankment. This causes the sheet piling to slope inwards losing stability, potentially leading to a localised failure. It is therefore not at all certain that the eastern bank would stand in isolation.

The recent failure of the western canal bank just south of Saul Lodge appears to have been the result of saturated ground conditions combined with the drawing down of the canal water levels to accommodate increased stormwater through the system. This is currently being investigated by the CRT.

7.2.2 The discharge of surface water

Currently the drainage ditch adjacent to the western embankment of the canal receives tidal water via Frampton Pill. This is generally slow moving and by the time it has reached this point the majority of its associated flotsam and jetsam has been deposited.

An increase in the extent and duration of tidal inundation by direct connection with the river would have an effect on the discharge of surface water through the Buckholdt siphon, the drainage ditch beside the western embankment of the canal and Frampton Pill. The drainage system within Frampton would become tide locked for a greater period of time, and there is a likelihood that flotsam and jetsam would build up within the ditch and cause maintenance issues relating to the flow of water. There would also be an increased risk of debris becoming jammed in the tidal flap, either causing it to remain open or shut.

7.2.3 The integrity of the Gloucester and Sharpness Canal and its associated structures

It has already been stated that the western embankment of the canal is likely to be weakened by the scouring actions of flood water, and additional flotsam and jetsam are likely to add to the erosion process. Debris and silt brought in by the tides will need to be cleared on a more regular basis and this in turn will increase the pressure to the bank brought on by maintenance procedures.

7.3 THE BIODIVERSITY OF THE SEVERN LANDS

Prior to the introduction of managed realignment, The Severn Lands were rich in biodiversity with extensive terrestrial and intertidal habitats. Wildfowl flourished on the outer warths and mudflats and their presence was noted by those who designated the habitats which are such an intrinsic part of the estuary today.

The policy of managed realignment has produced both negative and positive effects for the study area. There has been a loss of terrestrial habitat and a consequent downturn in the number of farmland birds such as Skylarks and mammals such as Brown Hares. Productive farmland has reverted to

[1] BWB Consulting, *Gloucester and Sharpness Canal, Frampton on Severn, Gloucestershire: Embankment Inspection Report*, (2006)

grassland and the unchecked erosion of the outer warths has led to a loss of over 10 ha of land between 1994 and 2010.[1] Increased tidal inundation has seen the formation of tidal lagoons and other wetland areas which have been of benefit to wading birds especially as the site acts as an extension to the neighbouring WWT reserve at Slimbridge.

However, the saturation of the unstructured alluvium also creates a pattern of erosion from within the warths causing a certain degree of instability. This, combined with the erosion processes at work on the river's banks, mean that the land is currently disappearing at a rate of 2.00 m/year based on estimates contained within this report.

The EC Habitats Directive makes no reference to giving a priority to one type of habitat over another, and yet a policy of managed realignment seems in practice to promote intertidal habitat at the expense of terrestrial habitat. If the present trends continue much of the intertidal habitat will also be lost and the site will be largely flooded on most tides offering no refuge for mammals or breeding birds whatsoever. Furthermore, as baseline conditions have not been effectively recorded and monitoring protocols are not in place, informed decisions on whether such environmental changes are desirable cannot be scientifically made at present.

7.4 PROTECTION OF THE GLOUCESTER AND SHARPNESS CANAL

It is probable that under the '*Hold the Line*' policy adopted by the *SEFRMS* and *SMP2* some significant civil engineering works will be needed in order to provide tidal flood protection to the western embankment of the Gloucester and Sharpness Canal in the medium to long-term. This could be achieved through a variety of ways with gabion baskets, rock armouring, a secondary earth embankment or steel sheet piled retaining walls representing some of the more likely solutions.

All of these have significant economic and funding implications; for example a 4 m retained height steel sheet piled wall would currently cost in the region of £2,500 to £3,000 per linear metre. With nearly 1.5 km of embankment to protect within the study area such a solution could cost in excess of £4 million currently.

Other options have yet to be fully investigated. For instance, the establishment of a reed bed immediately landward of the abandoned sea wall would help to dissipate the tidal energy and trap silt, thereby building up the ground levels. However, this may not be a practical option for it would need to be protected against cattle and the power of the tides which, with their associated wrack, would cause maintenance issues to any fencing.

NE has suggested that drainage of the site could be improved to counteract the increased tidal inundation and that a possible way of achieving this might be through the use of poldering.[2] Such a scheme is outside the experience of those compiling this report and the only suggestion we have to make is that if

[1] Frampton Court Estate Farms, Rural Payment Agency (and predecessors) IACS mapping, (1994) and Rural Land Register mapping, (2010)

[2] Natural England site visit, 31st October 2012

poldering is considered to be a viable option then it is essential that the site is properly assessed and modelled before any decision is made.

It is interesting to note that current policies do not consider positive measures to manage the effects of tidal erosion upon the western canal embankment and its surrounding environs; surely fundamental to its successful utilisation as a flood defence? The importance of this aspect has been highlighted by this this report which has suggested (based on current erosion along the warth edge) that the western bank could within ten years be subject to regular tidal inundation. We acknowledge that the detail of implementation (e.g. what defences should be built of, their precise location and line, and the standard of protection to which they should be built) will be provided within the *SEFRMS* when published. We hope that any such strategy will, within its terms of reference, consider the secondary effects of the identified policies and how these matters needs to be managed, their sustainability and implications in terms of the achievement of wider policy objectives; for example those pertaining to the Severn Estuary Natura 2000 site.

7.5 ADVANCING THE LINE OF DEFENCE

In the past, breakwaters and cribs have been used to accrete and protect land along Fretherne, Saul, Frampton and Slimbridge Warths. It was suggested early in 2012 that by recreating this proven management it might be possible to build up a substantial amount (perhaps 100 ha) of new intertidal habitat seaward of the existing warths where there is a natural embayment.[1] As compensatory intertidal habitat this would have the potential to attract funding of up to £50,000/hectare.[2] The scheme seeks to:

- Extend the existing successful habitats found on the contiguous land managed by the WWT at Slimbridge;
- Arrest the loss of intertidal and terrestrial habitat on Saul and Frampton Warths thereby reversing the trend of '*adverse condition*' for the existing designated habitats; and
- Increase long-term flood protection to the villages of Fretherne-with-Saul and Frampton on Severn in the light of climate change.

This scheme was rejected by the EA[3] on the basis that it would impact on the natural erosion and accretion processes of the estuary and that the EA has no mandate to protect land from erosion unless an EA asset is at risk.

Whilst it is accepted that the reintroduction of hard points may indeed have far field effects elsewhere in the estuary's system, the lack of any data regarding the movement of sediment upstream of The Shoots means that modelling is currently impossible. However historic evidence does not necessarily identify significant far field effects arising from Hock Crib and Frampton Breakwater.[4]

[1] Hewlett, Rose, *Proposed intertidal habitat creation scheme at Frampton, Saul and Fretherne Warths*, January 2012
[2] Defra, *Flood and Coastal Resilience Partnership Funding Policy Statement*, OM 4b, 11 (2011)
[3] Environment Agency response to Rose Hewlett, email 1st June 2012
[4] Hewlett, Rose, *Hock Crib, near Fretherne, Gloucestershire*, (2012)

8 RECOMMENDATIONS AND CONCLUSIONS

8.1 RECOMMENDATIONS

During the preparation of this report it has become apparent that whilst some of the following recommendations are specific to the study area, others potentially apply to the whole of the Gloucestershire section of the *SEFRMS* from Sharpness/Lydney to Gloucester.

8.1.1 The Southwest Strategic Regional Coastal Monitoring Programme

The area from Sharpness/Lydney to Hock Cliff shares many of the same characteristics and consequently the same habitat designations as the adjoining section downstream to Aust/Beachley. From Hock Cliff to Gloucester the estuary becomes progressively more riverine in its character and the presence of willow (*salix sp.*) from Epney/Rodley onwards indicates the increasing dominance of fluvial flow. Nevertheless, the spring tides reach Gloucester where both the *SMP2* and *SEFRMS* have their northern limits.

It is surprising that the whole of the estuary from Sharpness/Lydney to Gloucester is excluded from the Southwest Strategic Regional Coastal Monitoring Programme given that its intention is to aid the development of strategic shoreline management plans, coastal defence strategies and operational management of coastal protection and flood defence. The *SMP2* notes there is little sediment data for the area and has taken no account of the effects of the incoming tide or fluvial flow, the two most dominant natural processes that shape this part of the estuary.

The implications of a lack of informed understanding and data are not confined to the *SMP2* and *SEFRMS*. For instance any proposal for national significant infrastructure in or alongside the Severn also highlights the need for baseline data upstream of Sharpness/Lydney. Tide locking in the event of artificially heightened water levels needs to be better understood. Concerns regarding this have been expressed in several of the recent submissions made to the Energy and Climate Change Committee.[1]

It is therefore essential that the area between Sharpness/Lydney and Gloucester is treated in identical fashion to the rest of the estuary in terms of regular topographic and bathymetric survey data, LiDAR, aerial photography and ecological mapping. Its inclusion in the Southwest Strategic Regional Coastal Monitoring Programme would ensure both a better understanding of the area in question, and of the estuary as a whole system; an holistic approach which is both desirable and logical. A long-term study of sediment dynamics could be undertaken by a university.

[1] Energy and Climate Change Committee: *A Severn Barrage?*, written evidence, December 2012 http://www.parliament.uk/business/committees/committees-a-z/commons-select/energy-and-climate-change-committee/inquiries/parliament-2010/a-severn-barrage/

8.1.2 Monitoring within the local community

Advance the Line welcome recognition of their work in relation to monitoring within the study area.[1] We also recognise that for monitoring to be effective and robust a protocol must be agreed and adhered to by all parties.

Our report/monitoring contains data that was recorded at precise locations at the same state of tide and we have tried to be as accurate as possible. Whilst this methodology has been sufficient to show general trends, it may lack the refinement required by the EA and other interested organisations. We would therefore recommend that the EA work with the local Severnside communities and landowners to establish what information should be recorded, how often it is recorded and exactly where and how it should be recorded. This information should then be used alongside scientific data.

8.1.3 Monitoring of relative sea level rise

Use of the EA's tidal monitoring data from their Sharpness, Epney, Minsterworth and Gloucester gauges, rather than a reliance on those of the outer estuary (where tidal and fluvial conditions bear no comparison), would ensure that the area from Sharpness/Lydney to Gloucester is more correctly modelled and monitored for relative water level changes in the river. This would achieve a better understanding of tide locking and direct tidal inundation as a result of sea level rise and increased fluvial flow due to climate change.

8.1.4 Monitoring and sustainability of managed realignment

Although the practice of managed realignment has been promoted throughout the EU since 1992, little monitoring of its effects in terms of flood risk management has been undertaken. This has been apparent for the study area where occasional visits by NE have been focussed on habitat management. The effects of the loss of 10 ha of land from the outer warth between 1994 and 2010 have not been specifically commented upon and although the consequences of the narrowing of the outer warth are noted in terms of habitat management in the WWT Consulting study, neither NE nor the EA have translated those findings into the management of flood risk.

Lessons can be derived from monitoring both within the study area and at other managed realignment sites, particularly those within the Severn Estuary, e.g. Cone Pill. Such sites should be regularly assessed in terms of whether the schemes are actually sustainable or just desirable in terms of CAPEX.

The abandonment of sea defences on a cost-benefit basis and the need to find compensatory intertidal habitat within the estuary has led to the EA suggesting locations between Sharpness/Lydney and Gloucester to be considered for managed realignment in the short and medium-term. It is recommended that a protocol is established to create a baseline assessment for each site, similar to that suggested in English Nature's *Feasibility Study for Coastal Setback on the Frampton Court Estate* (see Section 4.2.1). This would reveal whether the overall objectives are achievable. At present the

[1] Environment Agency, draft *SEFRMS* wording for Frampton on Severn, December 2012

method for site selection does not appear to be supported by such scientific analysis.

8.1.5 Severn Estuary Coastal Habitat Management Plan

Although the *Severn Estuary CHaMP* was developed to guide the *SMP2* by providing advice to inform strategic flood risk and coastal management decisions in order to avoid damage to sites designated under the Ramsar Convention and EC Habitats and Birds Directives, it is difficult to ascertain whether those developing the *SEFRMS* have taken account of its findings, particularly in relation to the study area which is currently known to be in adverse condition.

In order for the EA to be transparent in terms of whether or not it is meeting the Government's obligations, the *SEFRMS* should contain references to *CHaMP* and confirmation of the current status of each of the protected habitats throughout the estuary. Should any of these be in adverse condition, *SEFRMS* should note the steps being taken or requiring to be taken to ensure the best possible outcomes in terms of their designations under the Ramsar Convention and Natura 2000.

8.1.6 The integrity of the western embankment of the Gloucester and Sharpness Canal

The Gloucester and Sharpness Canal not only fulfils a function as a flood defence structure for Frampton, it also supplies over 50% of the water used by Bristol. From the perspective of Bristol Water and the CRT it is imperative that the integrity of the Gloucester and Sharpness Canal is not compromised by the risk of tidal flood.

It is perhaps surprising that so little notice has been taken of the *SMP2*'s prediction that '*the shoreline defence fails in the 20 to 50 year epoch*'. It is not clear how this prediction has been reached in the absence of a proper monitoring programme, nor whether the '*shoreline defence*' is the earth embankment either side of the Hock Ditch outfall, the Gloucester and Sharpness Canal embankment, or both. Nevertheless, given the current erosion rate of the outer warth, it is likely that the western embankment of the canal will become regularly exposed to the tides through direct connection via the adjoining low-lying field (Great Narles) within the next decade.

Although the EA and CRT have in place the basis of an inspection and maintenance agreement, there remains a lack of clarity regarding fiscal arrangements. Whilst this is undoubtedly a matter for the organisations involved, we would not wish to see necessary maintenance work delayed through funding uncertainty and potentially being identified subsequently as untenable.

It is disappointing to find that little or no heed has been taken of the recommendations and conclusions made in BWB Consulting's *Embankment Inspection Report* of 2006 which was compiled from a visual survey, likely to have been restricted by dense undergrowth. In particular, the report details the actions required to accurately assess the western embankment's stability and we recommend that these are followed up.

It is hoped that *Gauging the tide* will help to focus the attention of the EA and CRT as it would seem that until their site visit with **Advance the Line** in December 2012, both organisations had been unaware of the likelihood of the western canal bank becoming regularly scoured by direct tidal connection in the relatively short-term.

8.1.7 Compensatory habitat creation scheme

The compensatory habitat scheme adjacent to Fretherne, Saul and Frampton Warths proposed in January 2012 was not explored in any detail by the EA, partly because there was no scientific data available to understand the effects of advancing the line of defence by the re-introduction of breakwaters into the system.

It is recommended that as more monitoring data becomes available, the suggested scheme should be re-visited and thoroughly modelled. Should the results prove positive, there is much to be gained from replicating the proven flood risk management practices of the past and reversing the current loss of designated habitat. Funding for such schemes is currently available and should cover the provision of breakwaters. Increasing the height of the foreshore would improve the estuary's resilience within this natural embayment and offer a proven location for real compensatory habitat which would replicate exactly that currently being lost adjacent to the site.

8.1.8 Maintenance of outfalls and other assets

Whilst it is accepted that the removal of wrack from outfalls has fallen within the remit of the EA in the past, it could not confirm that this will continue to be the case in the future.[1] Where once wrack was removed and disposed of, these days to reduce costs it is often piled to one side only to wash back on another high tide.

The term '*managed neglect*' has been coined to describe this unstructured management approach and the lack of clear commitment to future management.[2] It raises the very serious issue of landowner liability in the event of a tidal flap becoming jammed open or shut, both scenarios having the potential to cause flooding to properties which would normally expect to be protected by a fully functioning mechanism.

So far the EA have been reluctant to admit the details of their reducing programme of maintenance to certain assets and works, instead preferring to confirm that those within catchment systems of the highest consequence would continue to receive priority over those of low consequence.[3] There is also in train a process to hand back the responsibility for some low consequence assets to landowners.[4] The associated protocol is designed to ensure that the impact on individual landowners and affected parties is minimised and that they have sufficient time to make alternative arrangements.

[1] Site meeting, 6th December 2012
[2] Gloucestershire NFU Severn Estuary Stakeholders meeting, 18th October 2012
[3] Gloucestershire NFU Severn Estuary Stakeholders meeting, 18th October 2012
[4] Environment Agency, *Protocol for the Maintenance of Flood and Coastal Risk Management Assets (England only)*, (2011)

We recommend that a more transparent approach be adopted by the EA and that they should have on open record a list of all assets and works, together with their inspection and maintenance schedules. This would assist parish councils, landowners and local communities to identify assets and works which are beginning to fall into the category of managed neglect, thereby potentially avoiding additional flood risk by enabling third parties to either alert the EA to a developing problem, or take the necessary action themselves.

8.1.9 Remaining life of EA assets at Fretherne-with-Saul

The draft *SEFRMS* wording supplied by the EA for Fretherne-with-Saul (see Appendix B) is silent in terms of the tidal flaps and tide gate at the Hock Ditch outfall, and neither has any attention been paid to the stone revetments along the shoreline. These should be separately monitored for the effects of relative sea level rise with particular attention being paid to the surface water levels encountered during tide locking to ensure that the flaps are being allowed to function to an acceptable standard which should be defined in an agreement with Fretherne-with-Saul Parish Council.

8.1.10 Relationship between the SMP2 and SEFRMS

The *SMP2* has not yet been signed off by Defra. The weaknesses in its data sets have been exposed during the engagement process by those developing the Gloucestershire section of the *SEFRMS*. The *SMP2* addresses future flood risk management in epochs of 0-20 years, 20-50 years and 50-100 years whereas the *SEFRMS* has adopted the more flexible policy of adaptive management. With varying sea level rise predictions this appears the most practical approach. The *SMP2* and *SEFRMS* are therefore no longer complementary. With its flaws in engagement and data sets, the *SMP2* does not currently meet the standards laid down in Defra's *Shoreline Management Plan Guidance* and should not be signed off in its current form.

It is therefore recommended that once the *SEFRMS* has been accepted the *SMP2* should be amended to reflect the adaptive management approach. It should also be updated to note the findings of the EA during the *SEFRMS* engagement process.

8.2 CONCLUSIONS

The consequences of the SECG's decision to overlook the need for community and landowner engagement have been far-reaching and it is now two years since the original *SEFRMS*, (which was produced in parallel with the *SMP2* and utilised much of the same information), was put out for public consultation and heavily criticised by the communities that it affected. The EA have seemingly taken on board that criticism and tried to redress the situation.

The *SEFRMS* engagement process has taken a year and has been guided, in part, by the Severn Voice Task Group which has worked with the EA on behalf of the parishes between Slimbridge and Elmore to ensure that a workable and realistic flood risk strategy can be produced.

The EA's Engagement Officers have been keen to involve as many people as possible in the decision-making process and made an early site visit to the study area on 16th January 2012 when a habitat creation scheme was proposed to them which would, on the face of it, also provide better long-term flood protection for the parishes of Fretherne-with-Saul and Frampton on Severn. During the course of the year it became apparent that the EA wished to take the scheme no further (with limited explanation as to why).

The site visit did eventually happen on 6th December 2012 when representatives from **Advance the Line** arranged a meeting with the landowner, EA, CRT and LSIDB. A technical coastal adviser from the EA's Wessex Region attended at the request of **Advance the Line** and he was interested to see the similarities between the study area and the area downstream of Sharpness/Lydney which fell within his remit.

It was generally agreed that the visit had been useful and a better understanding was gained of the developing situation. It is hoped that the EA, CRT and LSIDB will work more closely together and with the local landowners and community, adopting an integrated local delivery approach to ensure that a robust flood risk strategy is developed and maintained.

The draft wording of the *SEFRMS* invites the community and landowners to help with the monitoring of accretion and erosion processes at work within the study area. Whilst the involvement at local level is welcomed, this must not be seen as a substitute for long-term monitoring by those with expertise in and access to topographic and bathymetric survey data, LiDAR, aerial photography and ecological mapping.

Those tasked with developing the over-arching *SMP2* missed the opportunity to build up an understanding of the dynamics of the estuary between Sharpness/Lydney and Gloucester, choosing instead to note that there was little sediment data available and that the effects of the bore and fluvial flow had not been taken into account.

In relation to Gloucestershire, it is difficult to understand how the *SMP2* and *SEFRMS* can be successfully developed as strategies with so little knowledge available.

It is hoped that this report will be the catalyst that ensures that the area between Sharpness/Lydney and Gloucester is monitored to the same standards as those adopted for the rest of the estuary, thereby ensuring that from now on robust, informed decisions can be made regarding management of flood risk, be they connected with future versions of the *Severn Estuary Shoreline Management Plan*, *Severn Estuary Flood Risk Management Strategy* or in relation to any proposals for new national significant infrastructure within or adjoining the estuary.

APPENDICES

Appendix A

DRAFT SEFRMS WORDING FOR FRAMPTON ON SEVERN

Probability of Flooding/ Remaining Life of Defences
The length of the Gloucester and Sharpness canal from grid reference points SO745084 to SO741067 together with the earth embankment at Slimbridge that ties into the canal and the earth embankment at Hock Ditch that ties into high ground are the formal tidal flood defences to the Frampton area. The remainder of the canal acts as high ground. The risk of tidal flooding to Frampton properties is a 1 in 200 chance or less in any year.

Sea levels will likely increase in the future, but the high level of the canal banks and embankments will continue to provide a 1 in 200 or less in any year level of protection from the tide into the long term future.

Sea level rise note
The UKCP09 medium emissions scenario predicts about 0.1m of sea level rise by 2030, about 0.3m by 2060, and about 0.7m by 2110.

Currently sea level is rising at about 2 to 2.5mm a year. If this rate were to continue then sea level rise would be less than that predicted by the UKCP09 medium emissions scenario.

What can be done now and in the future
The EA will continue to maintain the earth embankment at Slimbridge that ties into the canal and the embankment at Hock Ditch that ties into high ground as funds allow to ensure they remain secure into the long term future.

The EA will regularly inspect the length of canal that acts as a formal tidal flood defence and liaise with the Canal and River Trust (CRT, formerly British Waterways) if any problems are identified that may result in increased flood risk.

CRT will continue to regularly inspect the canal and undertake works as necessary to ensure the on-going integrity of the embankment to maintain freshwater in the canal. CRT will liaise with the EA if they become aware of changes to the canal bank which may allow ingress of saltwater and/or increase flood risk.

The community and landowners can help monitor erosion/accretion on the Frampton and Saul warths

Environment Agency
December 2012

Appendix B

DRAFT SEFRMS WORDING FOR FRETHERNE WITH SAUL

Probability of Flooding/Remaining Life of Defences
Fretherne with Saul parish and Epney are currently protected to a 1 in 100 chance of tidal flooding by river defences to the north and west respectively. Earth embankments on the Hock Ditch side of the estuary also provide protection to Fretherne with Saul. Flood risk is highest from the river on the north side.

In the future, as sea levels and storminess increase, the level of flood risk will increase. If sea level increases by 0.1m then the risk of tidal flooding from the river would reach a 1 in 50 chance.

Sea level rise note
The UKCP09 medium emissions scenario predicts about 0.1m of sea level rise by 2030, about 0.3m by 2060, and about 0.7m by 2110.

Currently sea level is rising at about 2 to 2.5mm a year. If this rate were to continue then sea level rise would be less than what is predicted by the UKCP09 medium emissions scenario.

What can be done now and in the future
The EA intend to maintain and improve the banks in phases in response to sea level rise. Improvements would be aimed to take place before flood risk gets worse than a 1 in 75 chance. Improvements are unlikely to be required before 2030.

How these options were reached
There are a significant number of properties in this area, as well as infrastructure, listed structures and environmental features, which means it is likely based on current prioritisation systems for allocating funds, that public funding would be available to improve the defences.

How have the options changed?
The options for this area have not changed.

Environment Agency
November 2012

Appendix C

MONITORING POINT LOCATIONS

Monitoring Point	Description	National Grid References
MP 1	Long Ditch (opposite field boundary between Inner Splatt and Great Narles) to edge of warth	SO 73936 07006
MP 2	Long Ditch (opposite large breach in Great Narles) to edge of warth	SO 93745 07123
MP 3	Boundary hedge between Frampton and Saul to edge of warth	SO 74045 07763
MP 4	Hedge line behind Hock Ditch to edge of warth	SO 73663 08695

Appendix D

RESULTS OF MONITORING AND MAP REGRESSION

Data was taken from the following sources:

- Ordnance Survey 6 inch to one mile maps 1886, 1903 and 1954;
- Cambridge University Collection of Air Photographs 1973 and 1977;
- Google Earth 1999 and 2006;
- Satellite image supplied by Natural England 2001; and
- On site measuring 3rd November 2011 and 5th November 2012

Ordnance Survey

Monitoring Point	1886	1903	1954	2010
1	61.0 m	208.0 m	216.0 m	22.0 m
2	83.9 m	175.0 m	226.0 m	22.0 m
3	137.0m	306.0m	340.0m	60.0m
4	221.0 m	306.0 m	290.0 m	75.0 m

Air Photographs, Satellite Imagery and Physical Monitoring

Monitoring Point	1973	1977	1999	2001	2006	2011	2012
1	43.0 m	33.5 m	23.5 m	22.5m	22.0 m	19.0 m	17.5 m
2	58.0 m	45.0 m	30.2 m	29.0 m	25.4 m	15.0 m	12.9 m
3	144.0 m	111.0 m	99.2 m	99.0 m	78.0 m		
4	130.0 m	110.5 m	85.0 m	92.5 m	85.0 m		

Appendix E

Briefing for Gloucestershire NFU Severn Estuary Stakeholders Group

The Gloucester & Sharpness Canal as a Sea Defence

We have an exchange of letters with British Waterways (and now Canal and River Trust) relating to the Gloucester and Sharpness Canal acting as a flood defence at Frampton on Severn. The Canal and River Trust is now responsible for the Gloucester and Sharpness Canal and has taken on the roles and responsibilities which were previously undertaken by British Waterways.

Though the documents are not designed to be legally binding, we are satisfied that the Canal and River Trust are aware that the Gloucester and Sharpness Canal at Frampton serves a function as a flood defence and with their confirmation that they have taken on the roles and responsibilities of BW relating to the embankment.

British Waterways (now the Canal and River Trust) have confirmed that the Frampton embankment is being, and will be, regularly inspected and that they will undertake works as necessary to ensure the on-going integrity of the embankment to maintain water in the canal.

We have informed the Canal and River Trust of the community's concerns relating to "a weakness in the defence near Splatt Bridge field gate" and they have confirmed they will be looking into this at their next inspection.

The Gloucester and Sharpness Canal at Frampton is recorded on the National Flood and Coastal Defence Database which holds information on all flood defences. In addition to Canal and River Trust inspections, the canal embankment is on the Environment Agency's inspection programme of third party assets. We will liaise with the Canal and River Trust if we identify a problem with the embankment that may result in increased flood risk.

Inspection and Maintenance of the Siphons and Tidal Flaps.
The exchange of letters sets out our understanding with British Waterways (now Canal and River Trust) relating to maintenance.

The outfall flaps and other apparatus passing beneath the canal which forms an integral part of the defence are inspected and maintained by the Environment Agency as follows. (This does not include the siphons – please see below).

The Asset Performance team inspect the outfalls to assess the overall condition and signal any future work that may be required on the structure. The asset inspections in this area were last completed in July 2012 and show the outfalls to be at their target condition.

The Operations Delivery team visit the outfalls about once a month to ensure they are functioning correctly. Any issues are either dealt with on the visit or reported for further action.

The MEICA (Mechanical, Engineering, Instrumentation, Control and Automation) team inspect the Frampton Pill outfall every 6 months. They are mainly looking at the technical side of the structure and the operational safety aspect required by the Provision and Use of Work Equipment Regulations. They also check asset condition and complete routine maintenance such as checking winches, hinges and seals.

The Frampton Pill is de-silted when our monthly inspections identify the silt build up will soon become an issue.

In the Canal and River Trust's letter of 20 August 2012 they confirm that the siphons form part of their fixed operational infrastructure and they inspect them in accordance with their mandatory standard. The siphons are inspected monthly with a full principal inspection every 10 years. If the monthly inspection identifies a problem then this would be reviewed by a suitably qualified engineer and action taken as appropriate.

Designation of Third Party Assets
Defra's advice is
"Consider the general circumstances of the owner of the structure or feature. If the designating authority is confident that the owner is aware of the flood or coastal erosion risk management function that their structure or feature serves and that the management, use or treatment of that structure or feature does not give rise to adverse risks, then designation may not be appropriate. There is nothing in the provisions to prevent a designating authority reaching an agreement with a third party and in respect of flood risk management without recourse to a designation. It is likely that this will be the case when dealing with other competent organisations or bodies who own relevant structures/features".

We are confident that CRT are currently aware of the canal's function as a flood defence and we have an exchange of letters acknowledging this. We do not consider there is need to designate the asset at the current time.

Environment Agency
24th October 2012

creating a better place

Environment Agency

Mr John Ward
British Waterways
Heritage Skills Centre
Canal Lane
Hatton
Warwick
CV35 7JL

Our ref:
Your ref:
Date: 20 January 2012

Dear John

FLOOD DEFENCES AT FRAMPTON ON SEVERN

Further to our recent telephone conversation, I am writing to record our understanding relating to the Gloucester & Sharpness Canal at Frampton reached during discussion between our two organisations 2005-07:

The Environment Agency (EA) has identified that the Gloucester & Sharpness Canal at Frampton (grid reference from SO745084 to SO741067) serves a function as a flood defence. With the Agency's earth defences, the canal provides a level of protection against flooding from the River Severn for the village of Frampton. The standard of protection provided by the EA's defences is in excess of 1 in 100; that is there is a less than 1% chance in any one year of them overtopping. A level survey has confirmed the canal level is higher than the design level of our defences.

An independent engineer has inspected and reviewed the canal structure as fit for serving as a flood defence structure.

British Waterways (BW) as navigation authority for the canal, maintains the canal for navigation purposes.

The earth defences are inspected every six months by EA staff who monitor their condition and arrange any necessary maintenance works.

The outfall flaps and other apparatus passing beneath the canal which form an integral part of the defence are inspected and maintained by the EA on a one-two month basis. Upon being notified of any issues, inspection and maintenance would be immediate.

BW has it's own independent monitoring and maintenance regime which includes a monthly inspection of the canal with a view to preventing potential breaches of the canal bank.

INVESTOR IN PEOPLE

BW are signed up to receive Flood Warnings from the EA and will work with the EA to minimise the impact of flooding. BW have procedures in place for controlling breaches of the canal bank. Outside of normal working hours BW maintain a standby rota of duty crews, supervisor and engineer to respond to a flood warning.

In the event of a defect being identified in the defences the EA has the authority to carry out emergency repairs to any part of the defence. There would be a co-ordinated response by the EA and BW to any emergency repairs required to the canal bank.

I would be grateful if you would confirm receipt of this letter and that it also reflects your understanding of the situation.

Yours sincerely

Jo Martin

Flood Risk Management Team Leader

01684 864354

Environment Agency, Riversmeet House, Newtown Industrial Estate, Northway Lane, Tewkesbury, Glos GL20 8JG

~~Cont/d.~~

British Waterways

FAO: Jo Martin
Flood Risk Management Team Leader

Environment Agency
Riversmeet House
Newtown Industrial Estate
Northway Lane
Tewkesbury
Gloucester
GL20 8JG

26 January 2012

RE: FLOOD DEFENCES AT FRAMPTON ON SEVERN

Dear Jo,

I refer to your letter of 20 January 2012 regarding the Gloucester and Sharpness Canal at Frampton.

I can confirm that the situation as set out in your letter reflects British Waterways understanding of the situation.

Yours Sincerely,

John Ward

Engineering Manager Wales and West.

British Waterways Canal Lane Hatton Warwick CV35 7JL
T 01926 626 100 **F** 01926 622 759
www.britishwaterways.co.uk

Glandŵr Cymru
Canal & River Trust

Cadw cysylltiad rhwng pobl, natur a hanes
Keeping people, nature & history connected

20 August 2012

Environment Agency
Riversmeet House
Newtown Industrial Estate
Northway Lane
Tewkesbury
Gloucester GL2 8JG
For the attention of Joe Martin – Flood Risk Management Team Leader

Our Ref JW/KM/EA
Your Ref

Dear Jo

FLOOD DEFENCES AT FRAMPTON ON SEVERN

I refer to your email of 7th August 2012 regarding the Gloucester and Sharpness Canal at Frampton and the letter of 26th July 2012 to yourselves from Frampton Parish Council.

I can confirm that the Canal and River Trust is now responsible for the Gloucester and Sharpness Canal and has taken on the roles and responsibilities previously undertaken by British Waterways.

Specifically regarding the siphons, I can confirm that these form part of our fixed operational infrastructure and are inspected in accordance with our mandatory standard. The siphons are inspected monthly with a full principal inspection every 10 years. Clearly if the monthly inspection identified a problem then this would be reviewed by a suitably qualified engineer and action taken as appropriate.

I trust this meets your requirements however if you require any further clarification please do not hesitate to contact me.

Yours Sincerely

John Ward
Engineering Manager Wales and West
John.ward@canalrivertrust.org.uk

South Wales & Severn Waterways
Canal & River Trust The Dock Office Commercial Road Gloucester GL1 2EB
T 0303 040 4040 **E** enquiries.southwalessevern@canalrivertrust.org.uk www.canalrivertrust.org.uk

Appendix F

RECIPIENTS OF GAUGING THE TIDE INCLUDE:

ABP Marine Environmental Research Ltd
All Parish Councils bordering the Severn between Sharpness/Lydney and Gloucester
Atkins Ltd
Bristol Water
Campaign to Protect Rural England
Canal and River Trust
Cardiff University, School of Earth and Ocean Sciences
Country Land and Business Association
Defra
Department of Energy and Climate Change
English Severn and Wye Regional Flood and Coastal Committee
Environment Agency
Forest of Dean District Council
Frampton Court Estate
Gloucester Harbour Trustees
Gloucestershire County Council (Lead Local Flood Authority)
Gloucestershire Farming and Wildlife Advisory Group
Gloucestershire NFU Severn Estuary Stakeholders
Gloucestershire Wildfowlers Association
Halcrow
Lower Severn Internal Drainage Board
Mark Harper, MP (Forest of Dean)
National Farmers Union
Natural England
Neil Carmichael, MP (Stroud)
Owners of Fretherne Warth
Plymouth Coastal Observatory, Southwest Strategic Regional Coastal Monitoring Programme
Ravensrodd Consultants Ltd
Severn Estuary Coastal Group
Severn Estuary Partnership
Severn Rivers Trust
Severn Voice Task Group
Sharpness Port Authority
Stroud District Council
The Berkeley Estate
The Crown Estate
University of Reading
Wildfowl and Wetlands Trust

Our grateful thanks go to all the individuals and organisations that have contributed towards this report.

advancetheline@gmail.com
01452 740698

13th January 2013