Environment Agency
In partnership with

Pagham to East Head Coastal Defence Strategy

Appendix E
East Head Working Group Information
A01

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Contents

The East Head Working Group Draft Terms of Reference

East Head Working Group
Draft Terms of Reference

Aims

*To implement strategic, long term and sustainable coastal defence policy for the Area of **East Head** at the entrance to Chichester Harbour and the adjoining or potentially affected frontages by:*

- Advising on and Overseeing the implementation of Adaptive Management Programme for East Head.
- Developing and overseeing the implementation of schemes arising from the strategic programme.
- Obtain funding for schemes
- Monitoring progress of such schemes.
- Participating in reviews and revisions of the strategy.

To promote a co-operative and co-ordinated approach to management of this frontage by:

- Utilising shared knowledge and experience to jointly clarify issues, resolve mutual problems and agree outcomes.
- Liaising closely with stakeholders on all coastal issues.
- Ensuring that the DEFRA is fully involved with future proposals.
- Involving other organisations or commissioning extra analysis and reporting where the group agree this could contribute to matters raised.
- Helping to develop coastal monitoring programmes and sharing results.

Background

Adaptive Management was identified as being a viable approach by the East Head Working Group, which met to discuss policy options for managing the coastal frontage at East Head and West Wittering as a result of the 2006 consultation. The aim of this approach can be defined as follows

'The aim of Adaptive Management will be to preserve the social, economic, environmental and amenity value of East Head to the harbour community for the life of the Strategy. The emphasis will not necessarily be on trying to lock the feature in its present size, shape and location, nor should it be encouraging orientation in a pre-determined direction'

The Working Group was constituted by representatives of interested parties in the area. This Group helped define the Adaptive Management approach for inclusion within the draft Pagham to East Head Coastal Defence Strategy (PEHCDS) which will undergo public consultation after Easter 2008.

Objectives, Constraints, Triggers & Actions

(As agreed at Working Group Meeting on 14th February 2007)

1. Objectives

i. Manage flood risk to West Wittering residents
ii. Sustain economic/environmental/recreational interest of East Head
iii. Avoid adverse impacts on navigation in Chichester Harbour
iv. Support economic/commercial activities in West Wittering and Chichester Harbour
v. Ensure common understanding
vi. Communicate that common understanding to as wide a group as possible

2. Constraints

i. Climate change (sea level rise, increased storminess)
ii. Supply of sediment
iii. Legal and regulatory obligations
iv. Sustainability (working with nature and time frames)
v. Public opinion/acceptance
vi. Money (availability of funding)
vii. Complexity of coastal processes
viii. Uncertainty and risk

3. Triggers for action

i. Significant change to system
ii. Structural degradation
iii. Health and safety concerns (including collapse of structures)
iv. Environmental degradation
v. Adverse impact on navigation
vi. Increased risk of flooding to West Wittering

4. Possible actions

i. Do nothing
ii. Further analysis
iii. Dredging
iv. Beach recharge/recycling/management (including sand trapping using relocated marram grass (under active discussion) or catch fencing)
v. Repair/removal/re-alignment of beach structures
vi. Erosion protection (rock etc)
vii. Inland flood embankments

Membership

The membership shall adopt the following framework of the Working Group.

Working Group:
Chichester District Council (Chair - as Coast Protection Authority)
Chichester Harbour Conservancy
Environment Agency
National Trust
Natural England
West Wittering Estate
West Wittering Parish Council
Cakeham Manor Estate
F G Woodger Trust

The following be invited to attend the Working Steering Group meetings as observers:
Havant Borough Council,
West Sussex County Council

Meetings

Working Group should meet quarterly or at such greater frequency as may be necessary to deal adequately with the business of the group.

Funding

The Working Group shall agree and contribute equally to an annual fund for the groups administration and meeting room hire charges.

The funding arrangements for the procurement of group projects and technical studies shall be discussed and agreed by Working Group members. This may or may not involve a single party acting as financial "Lead Authority". Initially, national funding will be sought through the Defra Project appraisal system but if unsuccessful, local funding will be fully investigated.

Outcomes

The Working Group will deliver an implementation plan, including a timetable for delivery, which will be subject to revision from time to time in response to triggers agreed by the Working group. Decisions shall be taken by consensus.

Agreement

The following organisations have agreed to participate in the East Head Working Group and approve the above "Terms of Reference":

Signed	Name and Designation	On Behalf of
----------	----------	Chichester District Council
----------	----------	Chichester Harbour Conservancy
----------	----------	Environment Agency
----------	----------	National Trust
----------	----------	Natural England
----------	----------	West Wittering Estate plc
----------	----------	West Wittering Parish Council
----------	----------	Cakeham Manor Estate Ltd
----------	----------	FG Woodger Trust

May 2008

Expert Panel Brief v.7 May 2007

PAGHAM TO EAST HEAD COASTAL DEFENCE STRATEGY 2007
MANAGEMENT OF EAST HEAD

BRIEF FOR PANEL OF GEOMORPHOLOGY EXPERTS (v7)

1. Background

The Environment Agency, in partnership with Chichester and Arun District Councils, is developing a Coastal Defence Strategy for the Pagham to East Head frontages. An earlier strategy was completed in 2001 but was not approved by Defra. Its technical aspects have recently (2005) been reviewed taking into account current Defra guidance on project appraisal. A number of possible options have been considered and are summarised in a consultation document that has been circulated widely as part of a public consultation exercise.

The document suggests that the preferred option for East Head, the spit on the eastern side of Chichester Harbour, is managed realignment. This aroused considerable concern among the public, however, and among some of the organisations with interests in the area. Details of the consultation document and the responses received are given in Appendix A and copies can be provided as background information if required.

In view of these differences a working group (informally termed the East Head Working Group, EHWG) has been formed to determine an agreed approach to managing the spit and the adjacent coastline. It has the following members:-

- Chichester District Council;
- Chichester Harbour Conservancy;
- Environment Agency;
- National Trust (landowner);
- Natural England;
- West Wittering and Cakeham Manor Estates (landowners);
- West Wittering Parish Council.

There have been two meetings to date, during which the group has agreed that an 'adaptive management' approach should be followed by establishing a 'monitor-review-act' cycle and responding to events as they occur rather than following a pre-established timetable. It has also agreed overall objectives, constraints, triggers for action and the range of actions that could be taken. As yet, however, the group does not have a common understanding about the physical processes taking place in the area, about East Head's current and future stability or about the likely consequences of possible actions. In particular, the group does not agree what should be done over the next few months about some failing breastworks on the beach.

Similar problems are likely to arise again in the next few years and if the group is to be effective it has to establish an approach to dealing with them that all the members can support. In view of this, the group has agreed that a panel of experts who know the area and its geomorphology should be established to advise on these issues, as described below.

2. Methodology

2.1 Objectives

The panel members will use available information and their expertise to advise on:-

(i) the future evolution of East Head;

(ii) the impact of this evolution on access to East Head, flood risk to West Wittering and navigation in Chichester Harbour (including the shelter offered to small craft);

(iii) the impact of possible management actions on:-

  (a) the stability of East Head itself (in particular its continued connection to the mainland); and

  (b) sedimentation in the navigable channels nearby.

2.2 Membership

The panel members will be:-

Alan Brampton (HR Wallingford)
Malcolm Bray (Portsmouth University)
Ian Townend (originally ABPmer, now HR Wallingford)

Panel members have each advised one or more of the EHWG members in the past and this commission will not prejudice their opportunity to do so in the future.

2.3 Approach

A four-step process will be adopted, as follows.

Step 1:- Each panel member will consider the questions listed in Section 2.5 below, taking into account the information listed in Section 2.4

Step 2:- The panel members will meet to discuss their views and identify areas where they agree and where they differ. They will then produce a collective report responding to the questions and highlighting their agreements and differences. This report will be circulated to all members of the EHWG.

Step 3:- The panel members will attend a facilitated workshop with the EHWG, at which they will discuss their responses to each question with each other. Group members will not participate directly in the discussions but will be given an opportunity to ask questions and make observations.

Step 4:- A note summarising the outcome of the discussions on each question and highlighting areas of consensus and disagreement will be produced. The panel members will review this, advise of any revisions they consider necessary and confirm in writing the extent of their support for the final version and any qualifications they may wish to add.

2.4 Information to be provided

The following information will be provided to all panel members:-

- Monitoring data from Channel Coast Observatory
- Analysis of monitoring data undertaken for CDC by Malcolm Bray, including his latest paper "East Head and West Wittering: Interpretation of Beach Changes 2003-06" dated March 2007 (MB 0307)
- Review of Coastal Process Overview (2001), undertaken for EA by Jacobs

- List of Objectives, Triggers for action etc agreed by EHWG

Documents relating to or arising from the current consultation process are listed in Appendix A and reports of studies carried out in 2000/2001 in Appendix B. Copies of these documents can be provided if required.

2.5 Questions to be addressed

East Head's current form has been influenced by coastal structures constructed at various times including:-

- groynes (timber);
- breastworks (gabions, timber);
- erosion protection (dumped rock).

These structures are in various states of repair (some of the breastworks have failed structurally, others are on the point of failure). Its future form will be influenced by what happens to these structures as well as by natural forces and how these forces change over time. Panel members' responses should take all these factors into account, should discuss the limitations of the information that is available and should identify any further information or studies needed to reduce any significant uncertainty.

A. Questions relating to the unconstrained evolution of East Head

A.1 If the structures are not repaired or replaced (and nothing else is done), how is East Head likely to respond as they deteriorate and, in due course, cease to have any effect on coastal processes?

A.2 Assuming the structures effectively break down over the next 15 years, what is the most likely alignment of the shoreline and width of the harbour mouth in 25, 50 and 100 years, taking into account the effects of sea level rise and climate change?

A.3 What range of uncertainty is attached to the above answers, and what information would be needed to reduce this uncertainty (in particular, would additional monitoring or other action help and how long would it take to collect the necessary data)?

B. Questions relating to the impact of this evolution

B.1 If East Head evolves as outlined above, is there a risk that a tidal breakthrough will occur and result in its permanent separation from the mainland (rather than resealing), or that the feature will disappear and become an inter-tidal sand/shingle flat like the Winner Bank?

B.2 If such a breakthrough or disappearance does occur, will the flood risk to West Wittering be increased?

B.3 What is the likely impact on navigation in Chichester Harbour of:-

(a) the realignment of the shoreline and the consequent widening of the harbour mouth?

(b) the presence of a new channel following a permanent tidal breakthrough?

(c) the disappearance of East Head?

B.4 What range of uncertainty is attached to the above answers, and what information would be needed to reduce this uncertainty (in particular, would additional monitoring or other action help and how long would it take to collect the necessary data)?

C. Questions relating to possible management actions

At present the group disagrees about how East Head should be managed and. in particular, what action should be taken about the failed gabion breastworks at the hinge. This disagreement arises largely because there are differences in opinion about East Head's current stability and the influence of the coastal structures, in particular whether the current alignment of these structures is damaging East Head. In broad terms there are three scenarios.

Scenario 1:-

- East Head is currently in balance and its form is satisfactory (in particular it is connected to the mainland at all states of the tide);
- in view of this the existing structures should be maintained in their current position for as long as there is no evidence of instability (in particular erosion threatening either the structures or the connection to the mainland);
- in particular the failed breastworks should be repaired on their present alignment.

Although not explicitly stated, there is a strong feeling that if the failed breastworks are dismantled a breakthrough will occur there, cutting off East Head and increasing the flood risk to West Wittering. The implication is that if these breastworks are threatened by erosion in the future, they will need to be replaced by a new structure further back. The long-term vision, therefore, is of a coastline that continues to be protected by hard defences with any movement occurring in a series of discrete jumps as new defence lines are built.

Scenario 2:-

- East Head is currently out of balance as the mainland shoreline is being held in position by the existing structures while the spit is moving, leading to a dislocation at the hinge (the point where the spit joins the mainland) and damaging the geomorphological interest;
- if this situation continues the dislocation will increase, making the connection more unstable and increasing the risk of a breakthrough and the damage to the geomorphological interest;
- in view of this, it would be better to take opportunities to reduce the dislocation as and when they occur, rather than trying to maintain the defences in their current position for as long as possible;
- the failure of the breastworks is just such an opportunity and should be taken by removing sections as they deteriorate and allowing the coastline to realign itself with the spit;

- this should reduce rather than increase the risk of a breakthrough occurring and the risk could be reduced further by placing sand behind the current line of the spit (as was done the last time a breakthrough threatened).

The long-term vision is of a sand spit without hard defences that is allowed to respond to the forces acting on it. The risk of a permanent breakthrough will be managed by building up the beach behind the area where one might occur.

Scenario 3 – Part 1

- at present the consequences of major changes to the alignment of East Head or the structures that affect this alignment cannot be predicted with confidence;
- for the last 18 months East Head has been accreting, with the result that beach levels at the hinge have risen markedly;
- this appears to have followed a lowering of the updrift groynes allowing more sediment to move into the area;
- nevertheless severe storms can cause major changes to occur rapidly (as happened at the end of March 2007);
- in view of the above a cautious approach should be adopted with the aim of sustaining the present alignment of East Head for as long as possible since this will have the least overall impact on all interests;
- while the situation appears satisfactory (i.e. the triggers for action agreed by EHWG do not apply) the existing structures should be retained and kept in good condition;
- if the situation appears unsatisfactory (i.e. the triggers do apply) the supply of sediment to the hinge should be increased by making minor changes to the structures (e.g. shortening or lowering groynes) together with recycling or other beach-building measures;
- if these measures are unsuccessful (i.e. the situation does not recover satisfactorily) further measures leading to the gradual and controlled realignment of the frontage, including the removal or realignment of groynes or breastworks, may be taken;
- the impact of this realignment on East Head and on Chichester Harbour as a whole should be studied before any major changes are made.

The long-term vision is of a sand spit and adjacent coastline that retains a sustainable balance between its environmental, social, economic and environmental interests without having any adverse impacts on the neighbouring harbour.

Scenario 3 Part 2 – Implementation:-

1. Follow Malcolm Bray's 7 point recommendations (MB 0307) with the overall objective to maintain East Head using refined "measurable" EHWG triggers to prompt action. This would follow the Adaptive Management Monitor-Analyse-Adapt cycle (AMC) as illustrated.
2. Integrated quarterly surveys (including "forcing conditions" etc. In MB 0307), analysis and presentation of results should be ongoing. If a significant event (storm or action from point 3 etc) occurred it may be necessary to immediately instigate an additional survey and AMC.
3. All existing structures to be maintained unless shown in 1 above to need modification.
4. Record the current shape and form of East Head and store this in the appropriate GIS system in its 3 dimensional form – store as East Head "base" April 2007 (EH07). In addition to

Malcolm Bray's recommendation 1 (see 1 above) "surface elevation difference plots calculated from successive surveys" also carry out a differential plot between the latest survey and EH07 to show trends & potential threats to triggers (early warning).

5. EHWG to meet as and when necessary (triggered or forcing event etc..) to agree and approve specific action.

Against this background, the following questions are asked:-

C.1 In the short term, will removing the breastworks as they fail and allowing the coastline to realign itself with the spit tend to increase or decrease the risk of a permanent breakthrough occurring:-
(a) at the hinge (the point where the spit joins the mainland); or
(b) further north where the spit narrows?

C.2 In the short term, is it likely that removing the breastworks will have an adverse effect on the flood risk to West Wittering (i.e. by reducing the width or level of the coastal ridge and so allowing more water into the low-lying area behind during an extreme event)?

C.3 In the short term, is it likely that removing the breastworks will have an adverse effect on the navigable channels nearby and, if so, how substantial is this effect likely to be?

C.4 If removing the breastworks will increase the short-term risks to navigation or of flooding, what measures can be taken to alleviate them?

C.5 In the long term, will a line of hard defences along the coast be needed to minimise the risk of a breakthrough, of flooding in West Wittering or of adverse impacts on navigation; will other measures (i.e. building up the beach) provide the same security; or will no such measures be required?

C.6 If a line of hard defences is the most effective way of minimising the long-term risks, what are the consequences of maintaining the defences on their present alignment for the moment, what physical changes should prompt their re-location and what engineering/coastal process factors should be considered when deciding their new location?

C.7 What range of uncertainty is attached to the above answers, and what information would be needed to reduce this uncertainty (in particular, would additional monitoring or other action help and how long would it take to collect the necessary data)?

C.8 Are there any other coastal/estuary process issues, not covered above, that may have a bearing on the future of East Head and, if so, what are they and what might their impact be?

C.9 In view of the answers to the previous questions, which of the three scenarios described is most likely to provide a sustainable way of managing East Head in the future and should any modifications or alternatives be considered?

Appendix A Documents relating to the current consultation process

- 'Planning for the future'; the Pagham to East Head Coastal defence strategy 2007 initial consultation document
- Consultation responses from Chichester Harbour Conservancy and others
- Notes of meeting with parish councils, residents etc.

Appendix B Reports of studies carried out in 2000/2001

- Geomorphological analysis of East Head and Chichester Harbour (2001), ABP Research and Consultancy
- East Head research study and summary report (2001), ABP Research and Consultancy
- Numerical modelling studies and East Head, Chichester Harbour (2001), HR Wallingford
- A sediment trend analysis (STA) at the entrance to Chichester Harbour (2000), ABP Research and Consultancy

East Head Evolution Report June 2007

PAGHAM TO EAST HEAD COASTAL DEFENCE STRATEGY 2007:

MANAGEMENT OF EAST HEAD
GEOMORPHOLOGY EXPERTS RESPONSES TO EHWG QUESTIONS

1 Introduction

This brief report responds to the questions posed in the "Brief for Panel of Geomorphology Experts (v7)" dated 14 May 2007 and prepared by the East Head Working Work (EHWG). The members of the Panel, namely Malcolm Bray (University of Portsmouth), Ian Townend (HR Wallingford) and Alan Brampton (HR Wallingford) met on 7 June in a meeting chaired by Richard Young. They first reviewed and discussed past reports and surveys (up to March 2007) and their current understanding of the historic and recent evolution of the shoreline at East Head. In order to standardise the names of different parts of the shoreline, the suggestions of Malcolm Bray as shown on Figure 1 were accepted and used throughout this report.

It was further agreed that the following terms would be used to describe possible beach changes:

Over-washing	The action of waves and high tidal levels resulting in water being carried over the crest of a beach, carrying with it sand that forms a "wash-over fan" , i.e. a deposit of sand on the landward side of the beach crest.
Breaching	The formation through the line of a previous beach of a permanent channel that has tidal flows along it for more than half the tidal cycle, i.e. its depth is lower than that of Mean Sea Level.

It was concluded that it would be worthwhile providing EHWG with a brief presentation of the views jointly reached on this retrospective assessment of East Head in order to "set the scene" for the presentation of the Panel's views on the likely future evolution of this frontage and their suggestions for its future management. Accordingly, Ian Townend agreed to prepare a presentation of the historic evolution of the shoreline up to early 2005 when responses to the over-washing of the "neck" in October 2004 were being discussed. Malcolm Bray agreed to prepare a second presentation reviewing the recent changes in the shoreline, i.e. from before the breach up to March 2007.

The Panel then considered the three sets of questions, i.e. A, B and C, that were posed in the EHWG Brief and these are considered below. Perhaps inevitably, the Panel found that to provide helpful responses to these questions, it was often necessary to re-arrange their order or to re-phrase or modify them while hopefully providing as full an answer as possible. Finally, it must be noted that the East Head shoreline is a particularly complex one, about which a great deal has been written resulting in a large number of different views about the causes of its past evolution and its likely future behaviour. The Panel members have had a very limited amount of time to review all this information and produce this report to EHWG and the associated presentations. Perhaps surprisingly a great deal of agreement was reached on what the Panel felt were the important issues that needed to be addressed when deciding on an appropriate course of future action. Nevertheless, more detailed further investigations might alter the present views held by Panel members and this uncertainty needs to be borne in mind when reading the remainder of this report.

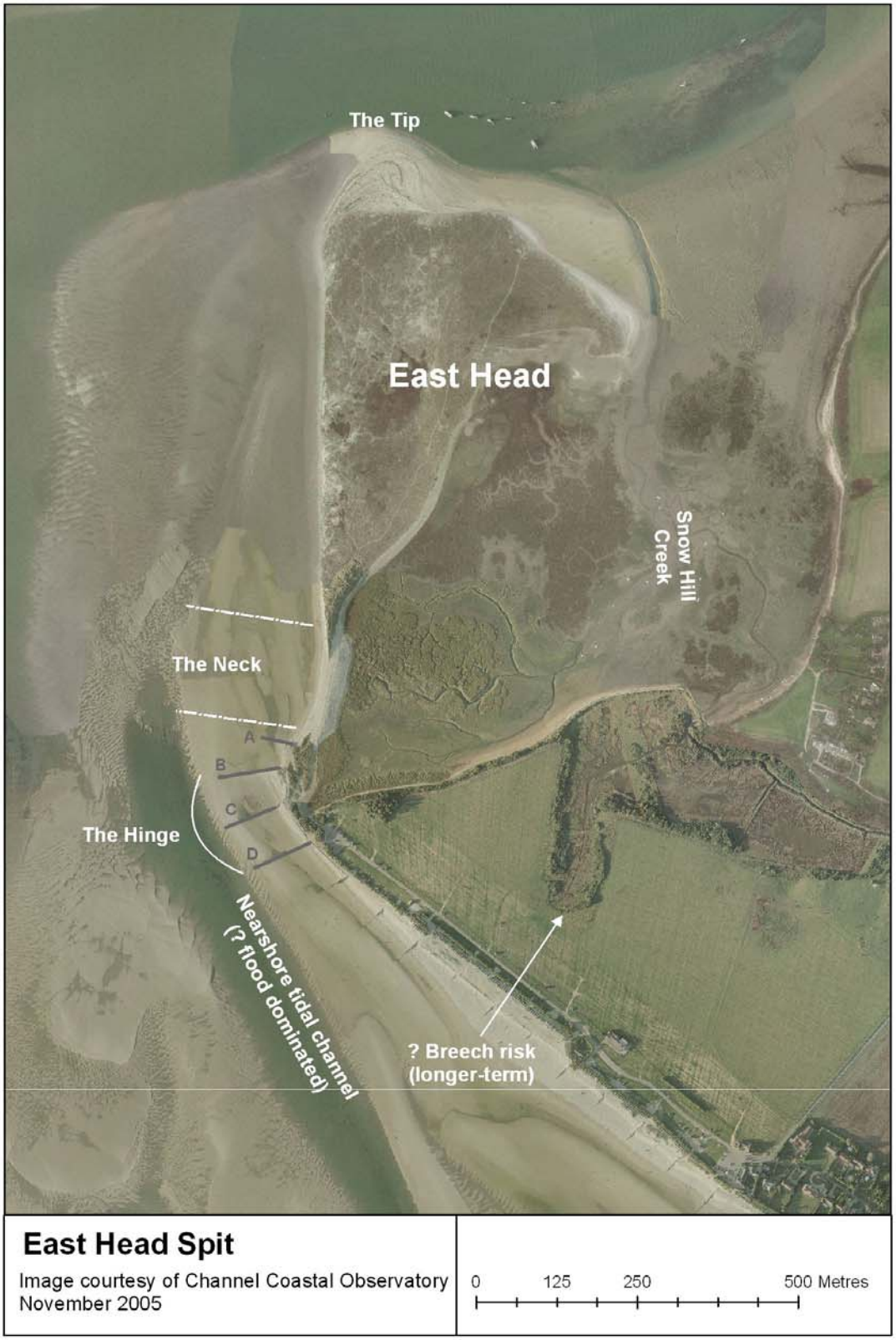

Figure 1 Location Plan

2 Unconstrained evolution of East Head (Questions A1 to A3)

This section of the report considers what might happen if the shoreline at East Head and at The Hinge were allowed to evolve without any intervention, i.e. allowing the various coastal defence structures to deteriorate and collapse and not seeking to "repair" any consequences of any erosion of the foreshore, beaches or dunes or any over-washing/ breaching.

In answering Questions A1 to A3 we have concentrated on the existing coastal defence structures along the limited frontage of The Hinge and the neck (see Figure 1) alone since these are of primary importance in terms of the future evolution of East Head and access to it, and in terms of the potential consequences on navigation and moorings in Chichester Harbour. Defences further east, i.e. seaward of the car park, also influence the flood risk at West Wittering but the Panel felt that these defences should be maintained at least in the short-term to provide an appropriate standard of flood defence along that frontage.

Returning now to the groynes and revetments at The Hinge, the Panel felt that the deterioration and failure of any one these defences could occur unpredictably in regard both to timing and the remaining efficiency of the structure in terms of affecting sediment movements and hence beach changes. Also the sequence of the failure of different individual structures is also unpredictable, although this too would have different effects on the changes in the shoreline. Finally it is unclear to the Panel whether the embankments immediately behind the defences at The Hinge have any innate capacity to resist erosion, e.g. are low glacial till outcrops, or are simply beach and wind-blown sand deposits. The latter seems more likely but rate of erosion at The Hinge will depend considerably on this difference.

Even if these structures were not to alter, i.e. they were maintained in their present form, the evolution of East Head would still be dependent on a range of physical processes and events that cannot all be predicted. These include changes in wave conditions from year to year, the occurrence of severe storm events, the simultaneous occurrence of high tidal levels and the meandering of tidal channels just offshore.

The combination of the variability in these "driving" processes and the likely but unpredictable deterioration in the defence structures means that any predictions of the future "most likely alignment of the shoreline" at The Hinge and East Head would be extremely uncertain. (Q A.3)

Monitoring and management over the next 2 -3 years might improve any predictions made, and in any event should be carried out (Q A.3). However, the Panel felt that this "most likely alignment" (see Q A.2) is not particularly valuable information in the context of deciding on how to manage the risks posed by the failure of the defences and the evolution of East Head. For this purpose, account needs to be taken of less likely but less favourable changes in the shoreline, even if the likelihood and extent of these changes are speculative.

Nevertheless, it is useful to provide a qualitative view on how East Head (itself) might alter as a consequence of the failure of defences at "The Neck" and "The Hinge" and for this it is necessary to first address Question A.2 and to first comment upon unconstrained evolution of the West Wittering and Hinge frontages (Figure 1) bearing in mind the residual effects of the existing defences as they deteriorate.

A possible time-line of events would be as follows. It has not been possible to agree the likely definitions of "Short term", Medium-term" etc, because the Panel members had differences in view as to both the sequence and timing of the changes described below. It is worth making the point here that there have been serious concerns about "imminent" breaching at the Hinge for over 30 years, so that making accurate predictions even over a few years into the future has proved very problematical. Recent changes culminating in the over-washing in October 2005 have suggested an acceleration in erosion and recession at East Head, but may be part of a "cycle" of retreat and advance that is not fully understood.

At the very least, a single severe storm in the next 2-3 years could produce many of the "Short-term" changes set out next, but this cannot be guaranteed.

Short-term
Gradual deterioration of groynes at The Hinge will result in the reduction of their efficiency in preventing longshore transport of the beach material so releasing sand and gravel which drift northward. This loss of sediment in the groyne "bays" would result in erosion and recession of the upper beach, i.e. above mean tide level.

The nearshore tidal channel, which is presently controlled by the seaward extremities of the longer groynes (B and C of Figure 1) is likely to migrate eastward (onshore) as these structures deteriorate, causing the beach face to become steeper, also resulting in recession of the upper beach.

Erosion of the upper beach and deterioration of the gabions and wooden breastworks will result in the exposure of the "embankments" behind them and it is likely that near-vertical cliffs in the front face of these will be formed, although this would result in some release of additional sediment from these banks.

It is the view of the Panel that the extra sediment released from the groyne bays A-D (see Figure 1) as a result of the above deterioration will improve beach widths or dunes along the Neck or the main body of East Head to some degree. The benefits of such extra sediment supply would be perhaps be outweighed by the possible inshore movement of the nearshore tidal channel.

Throughout this period, it is likely that there will be an increasing probability of severe storms at high tide causing over-washing of The Neck (resulting in the exposure of more of the rock revetment there), and perhaps of over-washing at The Hinge as well.

Changes in East Head are discussed in section 3.1 below, but briefly it is likely that it will both try to lengthen, with more sand arriving at its "Tip", and retreat landwards, perhaps accompanied by a landwards migration of the nearshore tidal channel parallel to its front face. The northward extension of East Head at the Tip seen in recent years may, however, be stalled in future if the Chichester Channel was not able to realign itself further north to accommodate this growth.

Medium-term
The residual defences will form temporary "hard-points," probably located at the points at which the groynes and breastworks meet. Erosion will then cut deeply into elevated bank behind breastwork/gabions between these "hard-points", which will rapidly become outflanked and stranded on the beach face as the upper beach retreats.

The chances of over-washing at the Neck and Hinge will be increased, and it is possible that a breach may form at least temporarily behind the Hinge. This is because there is the head of a tidal tributary creek immediately behind the embankment that could channel tidal waters resulting in enlargement of any over-wash channel to produce a tidal breach that could become permanent. However, because the Hinge is more exposed to wave action than the neck of the present East Head spit so that rather greater littoral drift and cross-shore transport might be expected to occur on the beach face with the result that natural closure could occur. For comparison, at Porlock Bay, West Somerset a permanent breach occurred in 1996 when a gravel barrier beach migrated landward into an existing drainage channel.

It is felt that such a breach is less likely to form behind the Neck since if it thought that the ground levels to its rear are higher than at the Hinge.

Erosion is likely to form permanent breaks through the embankments along the Hinge at discrete points between "hard-points" inundating low-lying land behind during high tides. The remnant groyne embayments widen and deepen away from original breakthrough points. Remnants of the bank are rapidly removed, but themselves act as temporary hard-points prior to their removal. Gravels released by erosion of the bank initially become trapped temporarily within embayments, but liable to drift away northward when residual portions are removed.

Long-term
The shoreline continues to migrate landward (eastward), although the position and orientation of this future shoreline will be governed by:

- The topography of low-lying land behind the Hinge, especially any locally higher areas above 2-3m O.D. that might anchor beaches or any very low gullies or channels into which beaches may roll and breach;

- The extent and position of changes in the nearshore tidal channel; and

- The availability of beach-forming sediment, e.g. from the offshore seabed and from the shoreline further east, the latter depending on the state of the remaining defence structures along the West Wittering shoreline.

Note that within this time period, there is also a threat of over-washing and even breaching occurring further east for example between the Hinge and the Café where there is a depression in ground levels across a narrow section of the car park (see Figure 1).

For a description of the Panel's views on the evolution of the main body of East Head, see section 3.1 below.

Very long-term
Uncertainties now start to cumulate to such an extent that estimations over this longer scale are risky and potentially counter-productive. However, we can anticipate accelerating rates of sea-level rise and possible increases in storminess that would tend to increase water depths and wave action over the nearshore banks and Chichester ebb delta that could accelerate coastal processes including recession of the shoreline. Again the presence of further gently rising topography behind the beach could

counteract this effect by allowing the beach to migrate upward as well as landward. It should also be noted that the foreshore in front would widen as any beaches retreat and this could offset the effects of more aggressive coastal forcing. Thus, there are pressures that would potentially enhance retreat, but as retreat occurred the foreshore would become increasingly adjusted to changing hydrodynamic conditions and retreat could then slow. For a description of the Panel's views on the evolution of the main body of East Head, see section 3.1 below.

The above generalised indication of future events is as far as the Panel felt that they could go in providing an answer to Question A.1; any attempt to quantify the rates of recession even in the short-term was regarded as too uncertain to be meaningful and would potentially suggest, quite wrongly in the Panel's view, that there was no need for prompt decisions to be taken.

An important general consideration worth inserting at this point is that the recorded past over-washing, breaching and rotation of East Head spit (over the last 300 years) amount to greater disturbances than the future changes discussed here. They were accomplished with relatively few detrimental effects upon: (i) flooding; (ii) the navigable channels or (iii) the longer term integrity of East Head spit. It suggests that whilst the system is undoubtedly complex and susceptible to small perturbations, its overall function and form is robust and capable of considerable natural adaptation. This however is dependent on the availability of sediment and space being available for such changes to occur.

3 The likely impacts of shoreline evolution

When considering the impacts on the future evolution of this part of the coastline, the Panel has given greatest weight to the any increase in flood risk at West Wittering and to the possible adverse effects on navigation and moorings in Chichester Harbour, since these were felt most likely to merit significant expenditure on managing the shoreline changes that will occur.

It was noted that possible adverse effects on pedestrian access to East Head, on the car park and /or on the geomorphological and natural heritage attributes of the area were recognised as likely to occur as well, but these are more likely to alter the details of any proposed future management of this shoreline rather than being the primary "driver" for such management (and providing significant levels of funding).

First, however, it is worth presenting the views of the Panel on the likely future evolution of the main "body" of East Head, in response to Question B.1, which can perhaps be summarised as "Peninsula,, Island or Inter-tidal Bank?".

3.1 Evolution of East Head (QB.1)

The spit neck for 200m immediately north of the Hinge (Figure 1) would be most affected by the above changes at The Hinge. The main body of East Head and its tip would be buffered from major changes by the volume of sediment available but will still be likely to retreat landwards. The following effects are likely to affect the Neck:

- There will be an increased exposure to waves at the neck following the anticipated changes at the Hinge;
- In the short term, there will be a slightly increased sediment supply due to (i) stored material being released from behind groynes and from erosion of embankments and (ii) removal of

transport discontinuity caused by Hinge which previously directed sediments along the lower foreshore such that they tended to bypass the spit neck;

- An increased potential for longshore and cross-shore transport provided that sediment is available (wave shadow or diffraction zone eliminated);
- The head of flood tidal channel is likely to migrate onshore and to cause steepening of the lower foreshore in front of the Neck;
- There would be an increasing probability of over-washing enabling the spit neck to migrate landward in accordance with shore retreat at the Hinge. This would act to maintain the relationship of the foreshore to the eastward migrating flood tidal channel;
- There will be an increasing possibility of at least temporary breaching due to over-washing. The Panel felt there will be a tendency for any breaches to seal naturally, but a "permanent" breach is possible should the Neck migrate back into the tidal channel in Snow Hill Creek;
- The likelihood and permanence of a breach would be greater it if occurred at the Hinge;
- The situation where a large tidal inlet like Chichester Harbour maintains two distinct low-water channels connecting it to the sea is very uncommon, and this suggests that a permanent breach of the type indicated here would be "unstable", i.e. likely to self-heal, although further investigation of this hypothesis is needed;
- The Panel did not think it likely that East Head would be likely to be over-washed often enough, or affected by other erosive processes, to the extent it would become submerged at high water, even within a 50 year period;
- The greatest uncertainty, sensitivity to specific events and the most rapid changes are likely in early stages of changes occurring at the Hinge e.g. in the next 25 years given the deterioration of the defences there described above.

In summary, the answer to this question (Q B.1) is that the main body of East Head is likely to move landwards (i.e. east) and perhaps extend north somewhat over the next 20 years. It will probably be a peninsula at high water for most of the time, but may periodically be an island at most, perhaps all states of the tide, making pedestrian access dangerous or impossible at such times. The Panel members were unable to agree a timescale for any significant changes in this pattern of evolution of East Head.

The effects of these changes, together with those at the Hinge, on the surrounding areas are discussed next.

3.2 Effects on flood risk at West Wittering (Q B.2)

Breakthroughs at the Hinge or at the Neck will not significantly increase the flooding risk at West Wittering in the foreseeable future.

The Panel reached this view because any channels created through the present Hinge and Neck would be narrow and any extra wave penetration onto the shoreline of Snow Hill Creek closest to West Wittering would be limited. Water levels at high tide in this creek would not be increased as a result of a breach; indeed some computer modelling results indicate that in storm conditions, water levels in this Creek are greater than on the outer face of East Head; flows through a possible breach might therefore be able to reduce this disparity in water levels.

In the medium to long-term, both sea level rise and possible erosion of the saltmarsh and banks of Snow Hill Creek will increase the risk of flooding in West Wittering, and it is perhaps arguable that the changes in East Head may affect the latter process. It is certainly worth reviewing the land and tidal levels and if necessary revising the existing flood risks maps for this area; it may also be sensible to carry out a specific study of the possible ways in which such flooding might occur, not only from Snow Hill Creek but through a potential future breach along the main "car park" frontage (Figure 1). Such a possibility might eventually be increased by changes in the routes of the tidal channels close inshore following changes at the Hinge or at East Head, perhaps leading to beach erosion and even to the future undermining of wall at the location marked on Figure 1. However, this was not felt to be more than a distant possibility, at present, and not therefore a significant factor in deciding how best to manage this part of the coastline.

While it was thought that the erosion of East Head to the extent that is was largely submerged at high tide was very unlikely, even within 50 years, such an eventuality spit could increase wave penetration to the estuarine shores of West Wittering, potentially threatening the sea walls that protect that frontage. Again this was not seen as a major consideration in the short-term future management of the Hinge and East Head shorelines.

3.3 Effects on navigation and moorings (Q B.3)

The potential effects on the usage of Chichester Harbour by boats was considered by the Panel under three main headings, reflecting three possible changes in the positions of the shoreline and tidal channels and hence in the waves and tidal flows.

(a) The retreat of the East Head shoreline and the consequent widening of the harbour mouth. It was concluded that while some widening was likely, the effects of it would be small. The widening would occur in areas where the inter-tidal foreshore gradients are very slack. As the East Head shoreline retreats eastwards, the water depths between its present and future position will, at least initially, be shallow even at high tide. There is a need to investigate the resistance of this part of the present foreshore to down-cutting, i.e. to abrasion and lowering by waves and tides but there is no reason to believe that such erosion would be significant at present.

In terms of changes to tidal currents, the Panel concluded that the cross sectional area of the mouth of the Harbour will be increased only slightly. As a result, this will not significantly affect the distributions of the peak ebb and flood tidal currents across the harbour mouth. Further, future sea-level rise would probably result in slow increase of the volume of water entering and leaving the harbour during each tide so that the inlet regime (tidal prism to cross-section area ratio) would naturally tend to increase in the future anyway. Such changes in tidal flows can be checked to a good degree of accuracy by further computer modelling, to determine in particular whether changes in the flows in the main navigation channel would be likely lead to an increase or decrease in its depths.

The widening of the harbour mouth, however, will allow slightly greater wave penetration at high tide, which may increase the disturbance felt by boats using the southern part of the harbour, particularly the seaward reach of the Chichester Channel. This might affect, for example the moorings close to and just inside the resent "Tip" of East Head and require these to be moved into more sheltered areas.

(b) The formation of a new tidal channel following a permanent breach at the Hinge or Neck
As discussed above, it is the view of the Panel that any such new channel would be likely to be unstable and therefore would be unlikely to grow to a size where it could conduct a significant portion of the harbour's tidal prism. It would therefore have relatively little influence on sedimentation in the main channel.

It could, however, even in the short-term have more local effects on the seabed and on waves and tides. For example it is possible that while it remained open, it could form its own ebb tidal delta on the lower foreshore immediately to the west of the Hinge causing some shoaling on the south east Winner. It could also intercept northward drift along East Head spit, potentially reducing the extent to which northward spit growth deflects the Chichester Channel.

The tidal flows through the hypothetical channel would increase current velocities in Snow Hill Creek, thus affecting the moorings there and perhaps altering depths. Predicting the timing, duration and effects of such a breach is likely to be impossible with any degree of certainty or agreement between experts, and there is thus likely to be a range of perceptions of the importance of such an event. However, the Panel felt that a more definite view of these issues could be formed by an analysis using computational methods to examine the likely stability of a "dual entrance" to Chichester Harbour. This was thought to be a worthwhile short-term action to improve confidence in some of the judgements arrived at within the brief discussions reported here.

(c) The submergence of East Head
As discussed above, the over-washing and erosion of the main body of East Head is felt to be only a remote possibility. However, if this were to occur then there would be a significant increase in wave penetration from the open sea into south eastern parts of the harbour, affecting moorings and navigation behind the present location of East Head and in the lower reaches of the Chichester Channel.

3.4 Confidence in above answers and further monitoring and modelling (Q B.4)

The major uncertainty in the above discussion on the impacts of possible future changes in the shoreline is whether a breach would occur, how long it would remain open and the extent to which it could "capture" tidal flow (prism) from the main channel. It is considered highly unlikely that any breach could evolve eventually to replace the present main channel, but further inlet modelling would be required to more confidently report upon this outcome.

The Panel believes that reasonable confidence could be placed in predictions of the effects of future effects on the risks to flooding and navigation that could be undertaken for **assumed** future shoreline "scenarios". The main problem, as stated just above, is in assigning a probability to the possible future positions of the shoreline and the depth and position of any new channel formed following a breach.

Future monitoring of the shoreline is already envisaged, as has been the case in the past, and there is a case for extending this in the short-term at least to improve knowledge of the nearshore seabed, particularly the tidal channel that runs close inshore at the Hinge, and of the saltmarsh and land-levels between the shoreline and West Wittering. Apart from monitoring changes in seabed levels, there is a need to gather information about the surface and sub-surface sediments particularly to seaward of the

present shoreline. This will help in establishing realistic future scenarios that could be tested in computer models. The Panel recognised, however, that such modelling itself is likely to be extensive in scope and of a considerable duration, and that this should not delay decisions regarding the short-term management of the shoreline.

4 Possible management actions (Questions C.1 to C.9)

The EHWG brief for the Panel provides a description of three "scenarios" regarding the stability of East Head, the effectiveness of the present defences and possible future management actions. These scenarios are now briefly discussed in turn before presenting answers to the nine questions posed (C.1. to C.9).

4.1 Scenario 1

In brief, the Panel could not agree with the main statements made under this Scenario, in particular that East Head was in "balance" and the existing defences should be maintained in their current form for any significant period. The view of the Panel was that even if a breach were to occur in the near future following deterioration and collapse of the gabions, other breastworks or groynes, then this would not increase flood risks to West Wittering. Neither was it felt that maintaining the present defence structures, or building similar structures further inland as and when needed, was an appropriate way to respond to the inevitable changes in East Head and at the Hinge except perhaps in the very short-term (2 – 3 years at maximum).

4.2 Scenario 2

In general, the Panel were in broad agreement with much of this Scenario, at least to the point where the expected deterioration and failure of the breastworks at the Hinge is discussed. Our view is that there is at least a possibility of a breach forming at the Hinge if the approach taken in Scenario 2 is adopted, because the ground levels at the head of the creek immediately behind the Hinge are apparently low. Rather than reducing the risk of a breakthrough here, restricting access and potentially affecting at least the moorings in Snow Hill Creek, it was felt that the suggested course of action, i.e. essentially abandoning and/ or removing the defences could add to these risks. This is essentially the opposite view to that proposed in the last bullet point under Scenario 2, and this leads on to a different view regarding the proposed reaction to the failure of the breastworks in the previous bullet point. This issue is returned to later.

4.3 Scenario 3

This "scenario" comprises nine bullet points that are now considered and discussed in turn.

- Not surprisingly in the light of the above comments, the Panel agrees with the view that little confidence can be attached to predictions of future changes in the alignment of East Head;

- The evidence available to EHWG regarding the improvement in beach levels over the past 18 months is not challenged but the March 2007 survey suggests that this trend may soon reverse;

- This statement is true in terms of the timing but the Panel does not believe that the lowering of groynes is necessarily the only, perhaps not even the major factor in the observed improvement in beach levels; to the extent that the action may have had minimal influence;

- Agreed. The future evolution of East Head is likely to proceed slowly until the next major such event when much more significant changes will occur rapidly. This "episodic" evolution" is impossible to predict except perhaps by taking some average over a long period of time. Decisions made about managing the at East Head have to bear in mind the possibilities of sudden and unwelcome changes occurring before intended counter-measures can be installed;

- While the Panel certainly agrees with the need for caution, it does not agree with the idea of "sustaining the present alignment of East Head for as long as possible", not least because it was felt that this would involve ever increasing intervention and expense. To do this would, in the view of the Panel, not only risk passing on an even more difficult problem to a future generation of managers, but also increase the likelihood of a sudden and dramatic change in the shoreline and in the wave and tidal regime, with correspondingly severe adverse effects;

- The Panel has the view that the retention and maintenance of defences at the Hinge is unsustainable in the long-term, but has advantages in the immediate short-term, as explained later;

- The Panel felt that the view that the Neck and main body of East Head could be sustained for long by simple adjustments to groynes at the Hinge or further east is probably very optimistic, and in any event this approach is likely to result in beach lowering and increased risks of over-washing and flooding further east. It seems likely that sand that has arrived in front of the Neck in the last part half of 2005 and in 2006 has been provided by tidal flows in combination with wave action, travelling along the lower beach and nearshore seabed. Waiting until an "unsatisfactory" situation arises is difficult because of the possibility of sudden and unexpected changes following a severe storm that could make proposed remedial action impractical;

- The Panel felt that the "gradual and controlled realignment of the frontage" is indeed the correct way to proceed, making sure throughout that the possibility of serious adverse effects occurring suddenly, as the result of one ore more severe storms occurring, is guarded against. This would probably involve the planned removal of defences at the Hinge, perhaps successively from their western end, once precautions had been taken to prevent breaching;

- The Panel concluded that a limited amount of extra monitoring and modelling would be beneficial if restricted in time to 2 years (3 years at maximum) and aimed specifically at optimising the future management of the shoreline at the Hinge and the Neck.

This future management would need to be designed, modelled, refined and agreed by EHWG, and perhaps a wider range of interested parties, to achieve the overall aims expressed in the paragraph following this ninth bullet point under Scenario 3 in the Brief. Achieving agreement will not be trivial and this is why the Panel felt that up to 3 years might be needed to undertake this task.

The proposed implementation (Part 2)of this Scenario seems generally sound, particularly in regard to the monitoring, although the Panel felt that the non-specific time period for intervention would be better replaced with a firm programme so that the present momentum of EHWG can be maintained. There is a danger that a period of quiescence in terms of beach levels stabilising will lead to stagnation in terms of achieving the gradual re-alignment that is needed, and perhaps a divergence of views on how best to proceed.

4.4 The specific questions on future actions (Questions C.1 to C.9)

In this section, the nine questions C.1 to C.9 in the Panel Brief are reproduced in italics (sometimes with minor changes) with the answers of the Panel following in normal font.

C.1 *In the short term, will removing the breastworks as they fail and allowing the coastline to realign itself with the spit tend to increase or decrease the risk of a permanent breakthrough occurring:*

(a) *At the Hinge (the point where the spit joins the mainland); or*

The panel felt this would significantly increase this risk in the short-term, although this could be addressed by appropriate management involving, for example, installing a "safety barrier" such as a buried rock or geotextile "sill" set back behind the Hinge to prevent the formation of a breach and recycling of sand from the Tip of East Head to restore adequate beach widths where localised problems arise. This recycling would need to be implemented within an adaptive management framework underpinned by effective monitoring.

(b) *Or further north where the spit narrows? (i.e. the Neck)*

There would be a slightly increased risk initially but the potential adverse effects could be guarded against as outlined above. This risk would probably reduce considerably with time as the alignment of the shoreline at the Hinge and the Neck adjusted towards a more stable position further landward.

C.2 *In the short term, is it likely that removing the breastworks will have an adverse effect on the flood risk to West Wittering (i.e. by reducing the width or level of the coastal ridge and so allowing more water into the low-lying area behind during an extreme event)?*

No. However, detailed topographic data should be collected covering the saltmarsh areas and the land behind and specific modelling of possible flood events carried out. The Panel felt that any existing or future risks of coastal flooding of West Wittering might be mitigated effectively by installing secondary embankments across potential flooding routes.

C.3 *In the short term, is it likely that removing the breastworks will have an adverse effect on the navigable channels nearby and, if so, how substantial is this effect likely to be?*

No, provided that measures are taken to avoid the formation of breaches that could lead to permanent tidal channels.

C.4 If removing the breastworks will increase the short-term risks to navigation or of flooding, what measures can be taken to alleviate them?

Possible prophylactic measures to prevent breaching and secondary flood banks are described above.

C.5 In the long term, will a line of hard defences along the coast be needed to minimise the risk of a breakthrough, of flooding in West Wittering or of adverse impacts on navigation; will other measures (i.e. building up the beach) provide the same security; or will no such measures be required?

Beach management coupled with appropriate secondary flood banks would be most appropriate in order to manage the realignment of the West Wittering frontage. However, it is recommended that any abandonment or removal of the existing defences should be undertaken cautiously in discrete sections starting at the Hinge and then progressing eastwards (updrift) in stages. This could mean that some of the existing defences would need to be maintained to ensure their function as they awaited their planned abandonment or removal.

C.6 If a line of hard defences is the most effective way of minimising the long-term risks

The Panel felt this premise to be false but for the sake of completeness provides answers to the "supplementary" questions to C.6,

what are the consequences of:

(a) Maintaining the defences on their present alignment for the moment;

The existing defences would require increasing expenditure on maintenance and renovation, and if the foreshore was to continue to lower, for example as a result of erosion of an underlying clay "shore platform" than increasingly robust defences would be required. There would be inevitable losses of sediment within the groyne bays and little new supply from further east so that without recycling or recharge, beach levels would gradually become lower.

Perhaps more seriously the discontinuity between the maintained shoreline at the Hinge and that of the Neck further north would increase. In the medium term there would be an increasing risk of a catastrophic (uncontrolled) breach at the Neck or at the Hinge if the defences there were not improved significantly.

(b) What physical changes should prompt their re-location?

It is recommended not to await events and be forced into a hasty realignment, but instead to begin this process now whilst there is time for necessary research and planning before the existing defences deteriorate and require potentially costly renovations. The shoreline cannot be held sustainably on its present alignment in the long term. A wider more dissipative inter-tidal profile is required that would be easier to defend and would allow for an improved amenity beach. It can only be achieved by a modest landward realignment of the present

shoreline. The present line could perhaps be held for some 10 to 15 years by upgrading defences, but the longer the required realignment is delayed the more difficult it will be to achieve. Starting planning now could allow withdrawal from the Hinge within 5 years. The Panel did not discuss the possible realignment and removal of defences along from the longer Wittering frontage although this will have to be contemplated as part of the design of the intervention suggested at the Hinge.

(c) What engineering/coastal process factors should be considered when deciding their location?

Detailed topography behind the existing defences will be critical in designing locations where beaches may be held and any secondary flood banks constructed. Rock or geotextile barriers may be needed at critical points to provide additional assurance against breaches that could potentially develop into tidal channels.

C.7 What range of uncertainty is attached to the above answers, and what information would be needed to reduce this uncertainty (in particular, would additional monitoring or other action help and how long would it take to collect the necessary data)?

The expert panel developed a fair consensus relating to the nature and time-scale of the options suggested above. The options themselves are not especially novel or untested individually, although their application in combination to achieve realignment of a shoreline at the junction of an estuary and the open coast does not have many precedents and naturally involves uncertainties. The important thing is to commission targeted studies and continue to monitor to carefully define the risks in advance, to design safety net features into the scheme e.g. anti-breach barriers, and to develop an adaptive management framework capable of early detection and mitigation of any remaining problems. Finally, it is important to do these things in a timely manner and not await events. The uncertainties and possible disagreements regarding the most appropriate management of this coastline can be reduced by beginning the planning process now, with a clear target date for implementation.

C.8 Are there any other coastal/estuary process issues, not covered above, that may have a bearing on the future of East Head and, if so, what are they and what might their impact be?

There is a need to consider the nature of any future shoreline management conducted updrift of the study area, for example a major re-alignment along part of the coastline further east at Medmerry. This might substantially disrupt a supply of sediment along the lower foreshore and nearshore seabed to the East Wittering frontage and in turn require changes in the defences there with further impacts on the East Head area.

Changes occurring within Chichester Harbour might also affect East Head, for example new reclamations or major managed re-alignment schemes within the harbour, continuing adjustments to effects of past reclamations and possible expansion or dieback of Spartina marshes. These are all factors that affect the volume of water entering and leaving the harbour mouth and thus could be influential in changing channels or altering the important ebb shoal banks (Pole Sands) with a consequential effect of the shorelines on either side of the harbour mouth. There are likely to be some effects of global warming, particularly future acceleration

of sea-level rise and perhaps changes in wind and hence wave directions and in the occurrence of severe storms and the tidal surges and extreme wave heights that they create.

C.9 In view of the answers to the previous questions, which of the three scenarios described is most likely to provide a sustainable way of managing East Head in the future and should any modifications be considered?

Scenario 2 presents the most appropriate sustainable long-term vision, but an important period of transition is required in order for management to move successfully towards that direction, satisfying the desires of the major interested parties. Such a transition would be most successfully achieved by employing major elements of Scenario 3. It is considered that Scenario 1 would be the least sustainable approach because many of the assumptions upon which it is based are either uncertain or incorrect in the view of the Panel.

Malcolm Bray
Alan Brampton
Ian Townend 14th June 2007

East Head Report Supplement July 2007

PAGHAM TO EAST HEAD COASTAL DEFENCE STRATEGY 2007:

MANAGEMENT OF EAST HEAD

SUPPLEMENT TO GEOMORPHOLOGY EXPERTS RESPONSES TO EHWG QUESTIONS

30 July 2007

1 Introduction

This document is a supplement to the brief report prepared for the East Head Working Work (EHWG) on the future management of the shoreline and coastal defences at East Head, presented at a meeting of EHWG on 18th June 2007. That report provided answers to the questions posed in the "Brief for Panel of Geomorphology Experts (v7)" dated 14 May 2007; the members of the Panel were Malcolm Bray (University of Portsmouth), Ian Townend (HR Wallingford) and Alan Brampton (HR Wallingford).

This supplement to the original report has the following objectives:

1 To provide some clarification of our report presented at that meeting where we were not clear or where our views were challenged and where extra details/ explanation would help the Group; and

2 To answer extra questions that the Panel felt should have been included in the brief in the light of the comments at the meeting and subsequently.

This supplement, however does not venture into the "outline design" of future coastal defence for the Hinge and Neck since this is a major task that is both beyond the scope of the Panel's brief and an area where the members of the Panel could not reach a consensus view without significant further work.

2 Clarification of original report and presentation

Given the short time available to prepare both the report and its presentation to EHWG, and the wide range of different perspectives and backgrounds of the members of that Group, it was perhaps inevitable that the descriptions and explanations provided by the Panel were sometimes not sufficiently clear. There appeared to be three main areas where clarification is needed, viz:

- The use of a single aerial photograph in presenting changes in beach/ foreshore levels;
- The meaning of future "beach management" at East Head; and
- The Panel's understanding of past shoreline changes at East Head.

These topics are addressed in turn below.

2.1 Presentation of recent changes in beach and foreshore levels

A part of the work undertaken by the Panel was to review the changes in beach and foreshore levels that were analysed by Malcolm Bray. His work was presented in a report to Chichester District Council dated March 2007, and included a number of coloured figures in Appendix 1 that showed areas that had become lower (coloured red) or higher (coloured blue) between surveys.

These "difference model" results were each superimposed onto a coloured aerial photograph so that the spatial pattern of erosion and accretion could be related to the main geographic features of East Head and East and West Wittering, the coastal defences at the Hinge etc. The same aerial photograph was used for each of these "difference model" result figures, since only one such photograph was available. The positions of the nearshore tidal channel off the Hinge and of the dune face along the Neck, as shown by this photograph are therefore the same in each figure, even if that figure shows results for different time periods.

The Panel interpreted the information shown by the red and blue shading to infer the changes in the route of the nearshore channel and the beaches and dunes on East Head, together with the presentation of cross-sectional profiles in Appendix 2. The first figure in Appendix 1 of this report, for example, does indicate a lowering of levels along the landward margin of the nearshore tidal channel in front of and to the south of the Hinge indicating that it has moved landward over the period August 2004 to August 2006.

2.2 The envisaged scope of future beach management

During the presentation on 18th June, Alan Brampton was asked to expand on the concept of the "beach management" recommended in the Panel's report. In our discussions, we envisaged the following management elements (items 1 and 2 are likely to be essential, whereas 3 and 4 would be optional according to circumstances):

1) Monitoring of the beach levels and widths, as well as the nearshore zone both inside and outside the entrance to Chichester Harbour. This monitoring is already undertaken by the CCO, although some local intensification of effort along the proposed realigned beach might be worth doing as a guide for/ check on the following elements.

2) Collecting sand from near the Tip of East Head, transporting it back to the Neck and placing it on the beach at the Neck and behind the Hinge. This will probably involve an initial and substantial volume followed by regular "top up" operations. This type of management is generally known as "recycling" (or "back-passing" in the USA), and has already been carried out once in summer 2005.

3) As an alternative, or in addition, it may be possible to "recharge" the beach at the Neck, bringing in sand from offshore for example by using a smaller dredger or barges. This is, however, generally much more expensive and requires specialised machinery.

4) Dune building and repair, involving the placing of fences both to prevent damage by trampling and to encourage deposition of wind-blown sand, the transplanting of Marram grass and the stabilisation of substantial dune "blow-outs" where their surface needs to be

stabilised for example by covering with netting, twigs, straw or similar, until dune-binding grasses re-establish.

It is worth commenting here on placing "recycled" sand on the seaward or landward (i.e. Snow Hill Creek) sides of the proposed realigned beach. Sand placed on the landward side is unlikely to be transported alongshore or offshore and is thus likely to provide a good access route to East Head. This is a major objective of the beach management envisaged by the Panel. Placing sand on the seaward side of the Neck will help prevent the outflanking of the groynes at the Hinge and provide a supply of sand to be blown onshore to create new dunes. However, the rate of longshore transport of sand along this frontage may be rapid, requiring more frequent and/ or substantial amounts of recycling.

2.3 Historical changes in shoreline of East Head

During the presentation on 18th June, the point was made that the shape of East Head had changed considerably in recent decades, sometimes gaining in area with substantial beach advance along its seaward face, rather than continually eroding and retreating landwards into Snow Hill Creek.

The Panel were aware of these past changes (see Figure 1 below), and did not seek to imply that such periods of beach advance could not occur again in the future. If this were to occur in front of the Neck in the near future, then the risks of breaching of that narrow spit, and the consequent threat to access to and from East Head would reduce. This in turn would reduce the need for any new measures to be taken to prevent such problems developing.

However, in general the tendency for landward retreat of the beaches and dunes along the Neck is clear, and at present there are obvious threats of further over-washing, disruption of the access to East Head and perhaps a breach developing. It would be better, in the view of the Panel, to prevent rather than cure such an outcome.

It is worth also commenting here that further retreat of this part of the shoreline would also make it increasingly difficult to retain sand in the groyne bays at the Hinge because of the differences in foreshore levels/ slopes beyond the end of the groynes. This would increase the risks of overtopping at the Hinge, threatening access to East Head and, in turn, increase the chances of a breach occurring there. Because of this, the Panel recommended not only widening the beach at the Neck, but forming a new barrier beach behind the Hinge.

3 Extra questions that need answering

The presentation to EHWG and the subsequent opportunity for members of the Group to provide written comments on it and the Panels report has resulted in a number of questions being raised, both by the Group and by the Panel members themselves, which were not included in the original Brief of 14th May. In some cases, the Panel feels that these questions fall well outside the scope of the original Brief and are not able to provide answers to them. Other questions are, however, within the "spirit" of the original Brief in the Panel's view, and should be answered to provide a more balanced response to the differing views of the members of the Group.

The primary of these questions (as circulated to the Panel by Alan Brampton on 19th June), **assuming that the "beach management" at the Neck is carried out as recommended**, is:

If it was decided to maintain the revetments and groynes at the Hinge, would doing so be detrimental to the concerns/ aspirations identified (i.e. access/ amenity/ flood risk/ geomorphology and navigation in the harbour)?

An answer to this question is needed since the Panel considered the "either" of maintaining those defence structures and the "or" of adopting an alternative coastal defence but did not address the option of "both" being carried out. This question is addressed in section 3.1 below.

The second question could be best summarised as:

Can the Panel expand on their idea of installing a "spine" of rock or a geotextile "tube" to provide a safeguard against a breach developing through the beach at the Neck or the Hinge?

Here the Panel did not feel it could make a decision about which option was better (or even possibly installing both, nor did it feel that it was part of its brief to propose an "outline design" for such a structure. However, it did recognise that some expansion of its views on what this structure was and was not intended to be was warranted. This topic is discussed in section 3.2 below.

3.1 Beach management AND maintenance of the defences at the Hinge?

There will always be a local difficulty with beach erosion along the frontage between East Wittering and East Head just west (or north) of wherever coastal defence structures such as groynes and breastworks end and where a beach without such defences begins. Before the beach widening at the Neck carried out in summer 2005, there was a substantial risk of "outflanking" of the defences at the Hinge and a commensurate increase in risk of a breach into Snow Hill Creek occurring. It would be an unacceptably high risk policy to maintain these defence structures and NOT to take steps to prevent a breach just to the north of them, in the view of the Panel.

However, given the proposed beach management / maintenance at the Neck and behind the Hinge, resulting in a wider barrier to over-washing and lessened risk of a breach, then the existing defence structures will be less at risk of outflanking. This is the situation considered here.

As originally suggested by the Panel, in the short-term, maintaining the groynes at the Hinge will also have the advantage of resisting any large-scale landward shift in the route of the nearshore tidal channel. If after a sufficient period for monitoring and studies, as also suggested by the Panel, it is concluded that these groynes are reducing the risk of adverse effects on the shoreline of this channel meandering closer inshore, then maintaining those groynes for even longer may be recommended. In passing, it is worth making the point here that such monitoring should not only cover the changes in the shoreline and nearshore tidal channel but extend to cover the whole of the entrance to the Harbour and the associated ebb and flood shoal deltas.

The view of the Panel is that maintaining groynes in the short term would not be detrimental to East Head, provided that this was combined with maintaining a wide high beach connecting East Head to the mainland. Indeed by constraining the nearshore tidal channel doing so may reduce

the problems of maintaining such a continuous beach, and hence reduce the risk of breaching, although this conclusion is somewhat speculative in advance of further studies.

We expect that the effort involved in this maintenance could increase significantly in coming years/ decades, and that doing this will not reduce the risk of flooding of West Wittering. Eventually, recession of the shoreline further north may mean that maintaining these defences may not provide an access to East Head at high water either; the main access envisaged then is along the widened beach at the Neck and behind the Hinge.

3.2 The proposed beach "spine"

The concerns of the Chichester Harbour Conservancy regarding the possible detrimental effects to navigation and moorings of a breach in the beach between East Head and the mainland have been made very clear, and taken into full account by the Panel. It is principally to reduce this possible risk that the Panel suggested not only "beach management" (see section 2.2 above) but also the inclusion of a structure as a "breach prevention" barrier.

In the view of the Panel this is its only purpose. It is **not** suggested as a structure to prevent wave overtopping and over-washing of this narrow beach, or to slow the rate at which it might move landwards or to provide an access route to and from East Head at high tide.

Indeed the Panel strongly advises against a structure that will interfere with the general day-to-day processes of wave propagation, tidal or wave-induced currents or beach sediment movements. Not only would a structure that has such effects be unacceptable to at least one member of the Group, it would inevitably lead to "end effect" problems further north and hence stimulate a desire for further "built" defences.

It is the view of the Panel that any such "spine" should essentially remain buried under the beach and only seek to prevent the development of breach, i.e. a tidal channel with its lowest level below that of Mean Sea Level; this is consistent with the definition of a "breach" adopted by the Panel in its original report. Accordingly, the Panel was envisaging a structure with its crest height no greater than this level, i.e. approximately 0m OD or a little higher.

This spine is therefore **not** suggested as an access route at high tide because if it is not covered with beach sediments then it will be underwater at that time. Indeed a "geotextile tube" would be liable to damage if it was used as a walkway. The access to East Head would be along the maintained beach, and such access may be disrupted occasionally when the beach is over-washed in severe weather conditions. The desire for restoration of access to East Head will be one of the main reasons for continuing beach management.

The choice of materials used, the position and dimensions of any spine and the eventual need to replace or reposition the structure as the beach above it retreats landward and the structure is exposed are all matters for a design study, together with the normal considerations of feasibility, cost (capital and maintenance), environmental impacts and acceptability to the members of EHWG and other interested parties. This is a substantial design study that is beyond the scope of the Panel's brief.

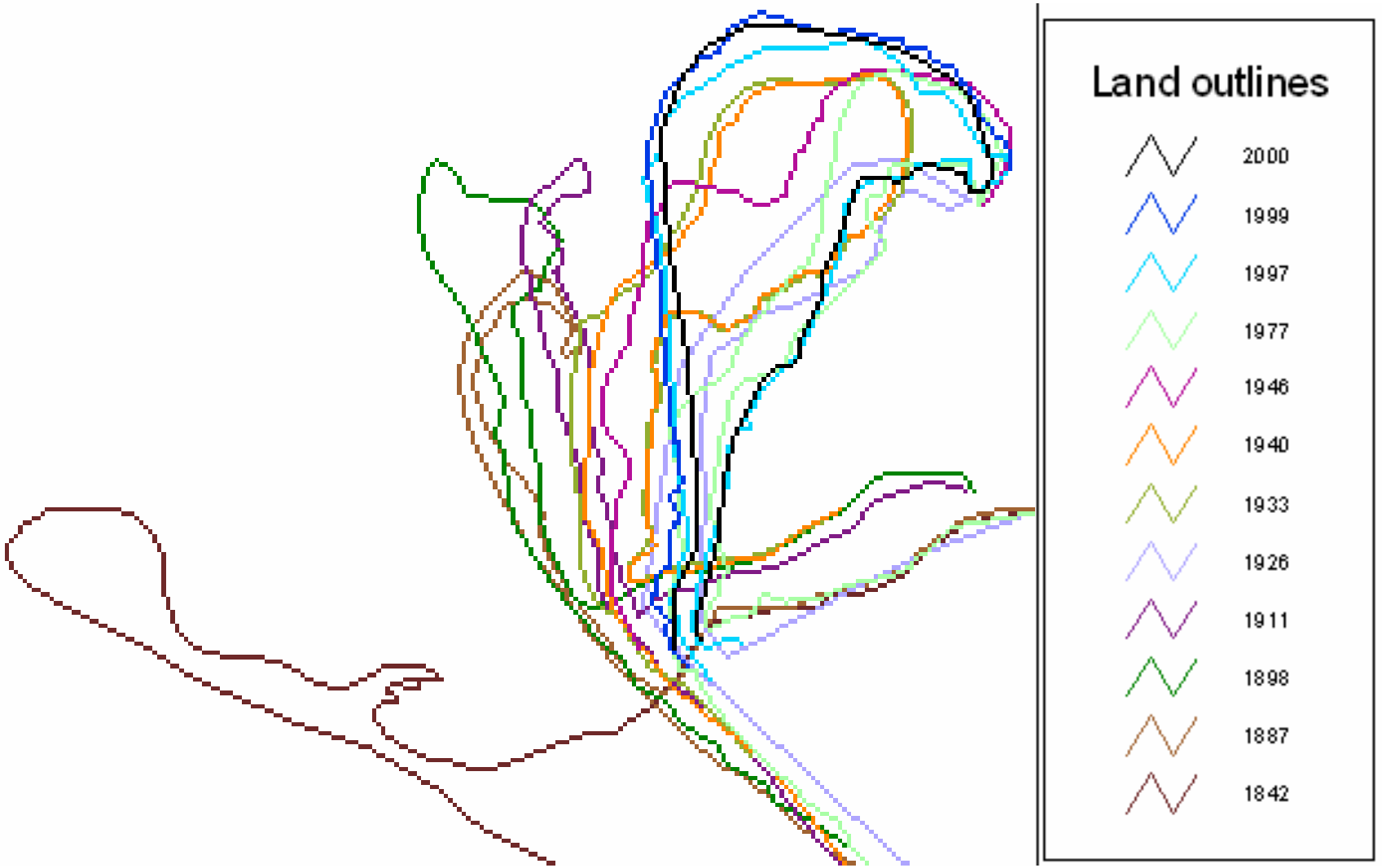

Figure 1 Historical shoreline positions, East Head

Expert Panel Clarification responses post Workshop 4

From: Pearce, Joe
Sent: 24 September 2007 17:35
To: Alan Brampton
Subject: East Head Working Group

Dear Alan

I'd like to update you on what's happened since the Expert Panel (i.e. you, Ian and Malcolm) submitted your Supplementary Report on the management of East Head and ask your advice about the best way of moving forward.

There was a meeting on 21st August of the East Head Working Group to discuss your report and its implications. Overall this was pretty successful as there was considerable agreement about the issues and what should be done. The agreements we were able to make are outlined in the attached draft document. This document also highlights one point of disagreement and a list of points that needed further clarification before moving on. I was therefore asked by the group to take the simpler points to the Panel to see if they can be clarified and explore if the Panel would be willing and able to provide further advice and how we might organise this. I would be grateful for your advice in answering the first, third and fifth of the defined draft points for clarification.

Referring to the document's Points of Clarification, the first relates to the issue raised in the Panel's main report in response to the brief where in Section 4.4, responding to Question C6, you refer to the '..risk of a catastrophic (uncontrolled) breach at the neck or the hinge..'

The third bullet point relates to your supplementary report section 3.1 where groynes are referred to in the third and fourth paragraphs and we were uncertain whether this referred to only groynes or this would include groynes and breastworks.

With regard to the fifth bullet point for clarification, it was agreed that there's enough information in the two Panel reports for Jacobs (the Pagham to East Head Strategy Consultants) to produce an initial draft of the section of the Strategy covering East Head. This will include some outline sketches of a possible beach and spine arrangement, to Illustrate the concept and provide the basis for some preliminary costings. This draft will be discussed at the next Working Group meeting, planned for 31st October [2007]. The Group agreed that input from the Panel on these preliminary outlines would of great benefit.

The Working Group may also wish for further input from the Expert Panel if and when they proceed towards detailed design of works. I realise that these go well beyond the Panel's original brief, which is why I'd like to talk to you about the best way to move things forward. I hope you don't mind if I call you on the telephone sometime during the next few days.

Thank you in anticipation.

Joe Pearce

Environment Agency Project Manager

From: Alan Brampton
Sent: 10 October 2007 09:09
To: Pearce, Joe; Malcolm Bray, Ian Townend
Subject: RE: East Head Working Group

Joe

Rather than trying to reconvene the Panel to answer the three points of clarification on our reports that the Working Group have raised, I have attempted to respond myself and will copy this email to Ian Townend and Malcolm Bray. If they strongly disagree with my views, they doubtless will say so.

In the first draft of out report (14 June) prepared before the meeting on the 18th of that month, in our response to question C6 we discussed the likely outcome of trying to maintain the defences at the Hinge in their present form into the indefinite future with no attempt to widen the beach behind and to the north of these defences (i.e. at the Neck). In this scenario we concluded that in the medium-term (say about 10 years hence?) there would be a risk of a "catastrophic (uncontrolled) breach at the Neck or at the Hinge" and the first Point of Clarification relates to this phrase. On reflection I can see that this could be interpreted as "likely to lead to significant risks to people and damage to property" or some such, when in fact we did not think that such a breach would lead to increased flood risks to West Wittering or elsewhere. The phrase might have been better written as a "sudden substantial breach that would be likely to result in the formation at the Neck or at the Hinge of an inter-tidal channel into Snow Hill Creek that would increase in depth and width over time".

The next clarification you asked about related to the section 3.1 of the Supplementary report we produced after the meeting in late July of this year. This section entitled “Beach management AND maintenance of the defences at the Hinge?" discussed the pros and cons of maintaining the groynes but not the breastworks (as in the original response to question C6 discussed just above) but assuming a wide sand beach had been installed behind the defences at the Hinge. My view on seeking to maintain those breastworks (either gabions or wooden planking as I recall) is that they would not provide any significant benefit from the view of reducing flood risk to West Wittering, and probably only marginally decrease the residual risk of a (temporary) breach and channel forming through the Hinge/ Neck area to Snow Hill Creek. They would however prevent or reduce the natural process of beach sediment, especially shingle, "rolling back" to reinforce the artificial beach placed behind the current defences at the Hinge and may, over time, lead to increased wave reflections and accelerating the lowering of beach levels within the groyne "bays". The localised scour envisaged here would make the

maintenance of these structures increasingly expensive and the aesthetic appearance of this section of the coastline less attractive. Of course, such problems could always be mitigated by periodic beach recharge if desired.

Finally you asked whether the Expert Panel could be reconvened to consider the draft of that section of a Coastal Strategy Study, being prepared by Jacobs Babtie, covering this section of coastline, noting that this would include sketches of the "beach and spine" scheme suggested by the Panel. This would, as you point out, require an extension to the Panel's original brief (and funding!) and it is likely that the Panel members would be minded to restrict their comments to the issues of "coastal morphological change" rather than comment on issues such as costs, construction details and methods etc. A final answer to this question, however, will depend upon the brief issued and the commissioning/ reporting arrangements; the Panel, I am sure, would wish to maintain its independence from any member of the Working Group and also avoid any potential conflicts of interest.

I hope this response is helpful to the Group

Dr Alan Brampton - Technical Director

Processes and Environments

From: Malcolm Bray
Sent: 10 October 2007 11:41
To: Pearce, Joe; Alan Brampton
Subject: RE: East Head Working Group

Alan and Joe,

I shall respond to Alan's message as follows:

1. I broadly agree with Alan's points and would be willing to serve again should the Expert Panel need to be reconvened.

2. As regards the "catastrophic breach" scenario - I think that we considered that catastrophic overwashing would be likely over the 10 year period (without controlling measures), but retained some uncertainty as to whether that would necessarily lead to establishment of a permanent new channel. Certainly, we felt that the risk of a permanent new channel was too great to ignore which provided the rational for devising a "soft" controlling structure set back a little from the present shoreline at the Hinge and spit neck.

3. I visited the site with our students on Thurs 4th Oct and beach levels appeared healthy, although the frontage has not been impacted for many months by any significant southerly or southeasterly storms co-incident with a spring tide.

4. Some of the gabion defences at the Hinge did appear to be deteriorating significantly (but not yet failing - but my inspection of defences was not detailed). It made me think that it could be useful to consider minor repairs to the gabions to extend their life by a few years to allow time for the "anti breach" scheme to be developed and implemented. If the gabions were to fail and a significant storm were to occur then there would be the risk of a breach BEFORE an anti-breach scheme could be implemented. That would be a concern because the Expert Panel has clearly identified this risk.

5. Ideally, any repairs to the gabions should operate in parallel to (not instead of) development of a longer term scheme to permit a very modest realignment at the Hinge and spit neck controlled by the "anti-breach" measures.

6. I noted variations in the lowish topography behind the Hinge that would influence the location of any realignment. The land levels are quite high, but not very wide immediately at the Hinge (dune and possibly "made" ground). They fall by 1-2 metres behind and then rise again naturally some 50-70m behind the Hinge on its eastern side.

Dr Malcolm Bray

Natural England's Position Statement on proposals for East Head

Natural England

Submission to East Head Working Group – 31 October 2007

Natural England's position on proposals for East Head:

1. Natural England supports management options for East Head that respect the conservation interest of the SSSI, SAC and SPA and the landscape of the AONB. We believe that the sustainable conservation and management of all of these features needs to recognise that they are dynamic and will continue to evolve in response to wind, waves, tides and a changing sediment supply.

2. We support allowing natural processes to continue shape the way East Head evolves. We acknowledge the legacy of past sea defence works which means that there is a desire to manage the transition to a more sustainable regime that can be largely self-adapting as the coast continues to evolve.

3. We support further recharge on the back of the hinge to mimic overwash, but the height and width must be low and narrow enough for overwashing to occur in major storm events. Given the perceived risk of a breach we see no reason why this should not happen in the immediate future. Such an additional recharge matches our support for restoration of a more natural system. (Ref: As was suggested by English Nature in 2004 and is detailed within the expert panel report of June 2007).

4. We support management of the existing groynes to control the evolution of alignment of the tidal channel immediately offshore from groynes 21-23. (Ref: Supplementary document July 2007, para 3.1)

5. We support managing groynes 20 to 24 by gradually lowering their height in order to manage, and create a smoother transition, from defended to undefended coast.

6. We support the removal of the gabions, between groynes 23 and 24, as and when they fail. We do not object to minor repairs to them. (Ref: M Bray's 10 Oct 07 e-mail)

7. As the coast evolves we support the management of the wooden breastworks, between groynes 20 and 23, through their gradual removal and/or as and when they fail or become unsafe, to support the shift of the coastline to a more sustainable alignment. (Ref: experts panel June 2007 report, para 4.3 bullets 5 and 8).

Natural England believes that there is sufficient information in the experts' panel report, along with on-site observations to demonstrate that the spit is on the wrong alignment and needs to begin to move to a more natural alignment.

8. We support an appropriate monitoring regime and the regular reviewing of management options as the coastline continues to evolve. (Ref: experts panel report June 2007, para 4.3 bullet 9).

9. We have no objection to the creation of a sand filled geotextile spine to reduce the risk of a breach. This would need to be at a height which avoids damage to the site while allowing 'rollback' of the neck. The expert panel and Jacob's initial

assessment suggest that this is approximately 0 to 0.2m OD (Ref: supplementary document July 2007, para 3.2 + Jacobs proposals). We support this being buried in (and covered by) the saltmarsh to the west of the hinge and neck.

10. We believe the current rock armour for which the temporary planning permission has expired needs to be properly regulated through a new planning permission. We believe sand/shingle filled geotextile 'spine' (discussed above) can provide suitable security against the risk of a breach during the restoration of East Head to a more natural regime. We believe that the existing rock armour structure was not designed (because it is too high) to maximise overwashing during extreme storm events and no longer represents the best way to manage the risk of a breach at the neck/hinge in a way that is compatible with the conservation and landscape of East Head. We would therefore support a condition linked to the planning permission for the geotextile spine and recharge at the hinge requiring the rock armour to be fully removed once it becomes exposed. We would be pleased to contribute to a discussion on the exact wording of any such condition. (Ref: June 2007 report para 4.4 C1(a))

11. We support addressing outflanking of groyne 24 by recharge as outlined in 3 above along with removal of the unregulated rock armour at this point.