From:	[redacted]
To:	beiseip@beis.gov.uk; SizewellC
Subject:	Expert Geomorphological Assessment EGA. Sizewell C. Formal request. 25 May 2022
Date:	25 May 2022 14:18:06
Attachments:	SizewellC-Coastal considerations and TR553.pdf

For the attention of Gareth Leigh, Head of Infrastructure Planning BEIS, ref: Sizewell C.
From:Nick Scarr Interested Party number 20025524.

RE: Expert Geomorphological Assessment EGA. Sizewell C. Formal request.

It is axiomatic that nuclear build safety-case assessments and modelling should be conservative and hence precautionary.

However, the Sizewell C shoreline change analysis (The Expert Geomorphological Assessment, EGA) is non-conservative and hence non-precautionary.

I therefore formally request BEIS and the Examiners to kindly ask of the seven experts, internal and external to Cefas, who prepared the assessment to explain their position.

Kind regards

Nick Scarr Interested Party number 20025524.

25/5/2022

I enclose my recent document for your convenience, Appendix 1 of which explains the non-conservative nature of the Applicant's EGA: "*Sizewell C—Coastal Considerations and BEEMS TR553 26/4/2022*"

Sizewell C—Coastal Considerations and BEEMS TR553 26/4/2022

Nick Scarr - Interested Party number 20025524. 26/4/2022

Head of Energy Infrastructure Planning, Department for Business, Energy, & Industrial Strategy, Sizewellc@planninginspectorate.gov.uk

Dear Gareth Leigh,

Ref: Comments on the responses of specified parties the Secretary of State's letters of 18 March 2022 and 31 March 2022. Response to your letter 25 April 2022.

Paper 1 addresses replies to your 'Coastal considerations' section.

Paper 2 addresses the Environment Agency's response to BEEMS TR553 which has been considered additionally to TR544. BEEMS TR553 has only recently appeared in the public domain.

Paper 1 – responses to 'Coastal Considerations' and the CPMMP.

The Q&As in much recent documentation relating to 'coastal considerations' appear to concentrate on technical details of the Soft Coastal Defence feature (SCDF) modelling and the *Coastal Process Monitoring and Mitigation Plan* CPMMP. This concentration risks obscuring the importance of an overall shoreline recession in the Greater Sizewell Bay caused by submergence of the low-lying Minsmere levels and Sizewell marsh that will surround Sizewell C.

This paper illustrates that the CPMMP and SCDF in their proposed form are not necessarily capable of protecting Sizewell C from submergence of the marshlands.

There are two main 'scenarios' relating to shoreline retreat in the bay: climate science and the offshore geomorphology.

1. Climate science:

The IPCC (International Panel for Climate Change) states:

- *"Sea-level rise under emission scenarios that do not limit warming to 1.5°C will increase the risk of coastal erosion and submergence of coastal land (high confidence),"*
  [redacted]

The Applicant's 'Expert Geomorphological Assessment' (EGA) presented in the DCO as an exercise in studying shoreline retreat does not appear to address the IPCC's statement of risk. The low-lying marshlands that surround the proposed Sizewell C could certainly be affected by a climate change scenario that fails to limit global warming to 1.5 degrees. The EGA also assumes a 'mid-range' climate change sea level rise that is non-conservative. See Appendix 1 for a review of the EGA.

It is not clear to me how this approach aligns with the Applicant's response in the '*Questions from the Government of Austria'* as published in BEIS letter reference EN010012, 25th April:

- Section 5.4.13. *"The Sizewell C site has been subject to full characterisation of all hazards… In relation to climate change, latest UK government guidance on climate change (UKCP18 – linked to latest IPCC guidance) has been taken into account for the full life of the station (**using maximum credible projections and sensitivities around maximum possible projections**)."*

2. The offshore geomorphology:

The nuclear coastline at Sizewell has been subjected to the most severe erosion in records established by Pye and Blott *before* the development of the Dunwich bank followed by accretion and stability of the nuclear coastline *after* the development of the Dunwich bank.

The importance of this is to recognise the geomorphic control and importance of the Sizewell-Dunwich banks to coastal erosion in the Greater Sizewell Bay. See REP2-393, section 2 page 17 on. S*ection 2 heading: 'Overview of Sizewell coastal erosion, morphology and stability. The importance of the Dunwich bank to coastal processes.'*

The Dunwich bank is non-consolidated geology, it is mud and shingle. It has changed much in its life and will continue to change, a change that, if conservatively considered, may result in full depletion. The non-coralline parts of the Sizewell bank are also at risk of full depletion. See REP2-393, section 6 page 39 on *'The Sizewell-Dunwich banks.'*

The Applicant, however, has adopted a somewhat **'changing narrative'** (Cefas's phrase) to the importance of the Sizewell-Dunwich banks summarised as follows:

i) The Applicant's position PRE-DCO – The Sizewell-Dunwich bank is of critical importance to nuclear shoreline security.

The Applicant states that the Dunwich bank is critically important to shoreline processes and a seemingly indispensable wave relief feature, the loss of which would cause shoreline erosion and 'knock-on' effects on the Sizewell bank. This is supported by academic research. Examples below:

- *"The [Sizewell-Dunwich] bank represents a natural wave break preventing larger waves from propagating inshore and thus reducing erosion rates along this shoreline. **As a result, the Bank forms an integral component of the shore defence and provides stability for the Sizewell coastal system**".* 'Sizewell C proposed Nuclear Development, Sizewell C EIA Scoping Report, April 2014, Planning Inspectorate Ref: EN010012, Page, 150. See REP5-253 for further information.
- "*The size, depth and position of this 'saddle' [of the Dunwich bank] is therefore **of critical importance** with regard to the risk of erosion and flooding between the proposed Sizewell 'C' site and Minsmere Sluice."* BEEMS TR139, Edition 2: A Consideration of "Extreme Events" at Sizewell, Suffolk, With Particular Reference to Coastal Morphological Change and Extreme Water Levels, Page 5.
- *"…it is feasible that changes at Dunwich bank could have knock-on effects at Sizewell." Beems TR058 Page 45**.***
- See REP5-253 for further information.

ii) The Applicant's position in the DCO application - The Sizewell-Dunwich banks will be an immutable (permanent) feature to end of station life (despite acknowledging the banks are changing).

The Applicant assumes and relies on the physical permanence of the Sizewell-Dunwich banks and their ***natural energy dissipating effects*** in the main Flood Risk Assessment (MDS FRA) modelling and the Expert Geomorphological (EGA) assessment.

- *"As such, the scenario with **the bank in place was adopted in the MDS FRA for all scenarios and epochs as a conservative approach.**" ExQ2 epage 130. See REP5-253*
- The EGA study into shoreline change assumes the permanence of the Sizewell-Dunwich banks and hence the permanence of its wave energy reduction. See Appendix 1.
- Mutability is then noted representing direct contradiction to the methodologies: "*Records over the last decade show…Dunwich Bank exhibited greater variability in both its morphology and position with…erosion north of 267000N, resulting in bank lowering of -0.5 – -1.5 m*". DCO: Coastal Geomorphology Appendix 20A, op cit., Page 21.
- See REP5-253 for further information.

iii) The Applicant's position during further DCO questions and Answers – the loss of the Dunwich bank would now *benefit* the low-lying land around Sizewell C and *increase its flood resistance*, a position diametrically opposed to all the Applicant's pre-DCO research.

- *"If Dunwich Bank were lost or substantially reduced (in extent or elevation) there is a greater potential for erosion of the shoreline around Dunwich and, importantly, the Minsmere – Dunwich Cliffs, resulting in a local increase in the supply of sand and pebbles (i.e., beach shingle) from the cliffs. This sediment would move south and could reduce erosion rates. Reduced erosion rates could tend to **increase resistance to flooding over the Minsmere and Sizewell frontages**."* Responses to the ExA's Third Written Questions (ExQ3) Volume 1 - SZC Co. Responses epage 68.

iv) The Applicant's position in the final stages of the DCO application: it is '*perfectly plausible'* that the Sizewell-Dunwich banks will deplete leading to '*loss of sea defence'* but this would now not represent '*a coastal flooding hazard initiator.'*

> *"One of the plausible scenarios in Reference [22] relates to depletion of the Dunwich-Sizewell bank**, leading to a loss of natural sea defence. However… it is not considered as a coastal flooding initiator** (see Section 3.5.1.1)."* and it continues by stating that coastal erosion itself is '*not a coastal flooding hazard initiator*'. See *'Sizewell C Site Data Summary Report'*, Section 3.5.1.1. The '*Data Summary Report'* was obtained under FoI from the ONR and is in draft form.

In my view the Applicant's pre-DCO understanding is rational. The subsequent conflicting responses to coastal processes are unsupported by both orthodox understanding and historical precedent therefore representing a significant cause for concern.

The Applicant is, it seems, intending to rely on the CPMMP, the management and mitigation of coastal processes by essentially moving and recharging shingle along the beachheads:

- "*Coastal erosion – this phenomenon is a **slow process** that will be monitored during the lifecycle of the site and will be considered as part of the Coastal Process Monitoring and Mitigation Plan (CPMMP).*" Page 47 '*Sizewell C Site Data Summary Report'.*

However, the breaches that have already occurred into the Minsmere levels occurred *to the north of Minsmere sluice*:

- The locations of breaches - 267400 on the 15/12/03 and 14/2/05 and 266900 on the 14/2/05. ***"This 200 m section is the most vulnerable stretch of coastline between Dunwich and Sizewell, and represents the most likely location of a major breach occurring during a future storm surge."*** Pye and Blott 2005, Coastal evolution RSPB op. cit., page 154 of 160. Page 28/160. See map REP2-393 Section 6 – locations marked with yellow stars.

These breaches are therefore **beyond the scope of the CPMMP** which does not fully cover the Minsmere levels. It is perfectly plausible to consider that the CPMMP resources could be overwhelmed by major erosional events, the occurrence of which can be sudden rather than a '*slow process'*. The shoreline at Sizewell is certainly dominated by frequent small low-energy events, so it is shaped by these most of the time, but then a storm (particularly Easterly) does much damage through erosion and flooding, often overnight.

Increasing the extent of the sea defences at some future date 'if required' might be thought a response to an overwhelmed CPMMP but they would take many years to build after the initial construction and cannot be regarded as 'reactive'.

Summary

Shoreline retreat of the Greater Sizewell Bay as presented in the Sizewell C DCO often contradicts the Applicant's own rational research pre-DCO. The EGA study of shoreline retreat is non-conservative, non-precautionary and the Applicant appears to be relying on 'mitigation measures' defined by its CPMMP. In my view this is a high-risk approach; a conservative (precautionary) approach should address the loss of major sections of the marshlands whether from depletion of the Sizewell-Dunwich banks or climate change sea level rise of anything above 1.5°C.

Concentration on the minutiae of SCDF modelling or CPMMP detail is valid and appropriate but risks overlooking the limitations of these features and processes when considered within the Greater Sizewell Bay. Inundation of the Bay is likely to occur from north of the Minsmere sluice, beyond the remit of the CPMMP, an inundation that will not necessarily be addressed by the seaward aspects of the Soft Coastal Defence Feature.

Paper 2 - Notes on BEEMS TR553.

The Environment Agency's response raises the fact that TR553 has been considered additionally to TR544. This paper responds to TR553.

BEEMS TR553 has been published on the Sizewell C portal on the 11/4/22 almost two months after being made available to the Environment Agency.

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010012/EN010012-010779-SZC%20-%20Appendix%205.pdf

The Applicant states the following:

- *"Technical report (BEEMS TR553: Modelling of Soft Coastal Defence Feature under Design Basis Conditions) was provided on **18th February 2022** for review* [to the Environment Agency] *… The report was **not submitted** as part of the DCO application or examination."* See: BEEMS TR553, Appx 5 page 10.

TR553 appears to be the basis for a Statement of Common Ground between the Environment Agency and the Applicant and therefore an important document.

BEEMS TR553 is an exercise in modelling the Soft Coastal Defence Feature and appears to directly address points raised in my paper REP7-220, "*Impacts on Coastal Process - TR545, CPMMP - Response to questions Deadline D7"*, on the limitations of BEEMS TR545. TR553 now represents orthodox conservative modelling in many areas including regarding the offshore geomorphology—i.e., the *absence* of the Sizewell Dunwich banks and the nearshore bars represents the higher inshore wave climate and hence conservative modelling.

This position is undeniably a step forward but starkly illustrates the variance with the Applicant's stance in the DCO, as stated in Paper1, that the *presence* of the Sizewell Dunwich banks and nearshore bars represents the highest inshore wave climate and hence conservative modelling for all epochs and scenarios as follows:

- *"…the assessment concluded that …with the Sizewell - Dunwich bank in situ, resulted in more conservative (i.e. worst case) nearshore wave conditions than with their removal. As such, the scenario with the bank in place was adopted in the MDS FRA for all scenarios and epochs as a conservative approach." REP7-052 (EN010012-007054- Responses to ExQ2 epages 104-115.*

Considerations relating to TR553:

1 2140 – the 'explicit date' for spent fuel removal.

TR553 now extends modelling to 2140, the 'explicit' date committed to by the Applicant for Spent Fuel removal from site, as follows:

- *"The key dates relevant to flood risk for the operation of the station are; the end of operation of the station at 2085…**end of interim spent fuel store 2140**…* 6.12 Rev: Reports Referenced in the Environmental Statement. Page 14 epage 144.
- *"…on-site risks would only be considered* [modelled] *to 2140 as the end of Interim Spent Fuel Store."* DCO: 6.12 Revision: Reports Referenced in the Environmental Statement. page 2 of 22, epage 228

However, it seems implausible that spent fuel can in fact be removed from site by this date. This is explained in my paper "*Sizewell C Main nuclear platform flood resilience in the next century."* – The relevant section is attached as Appendix 4.

2 The Sizewell Dunwich banks, their wave energy dissipation properties and the correct format for conservative modelling.

TR553 states:

*"It is worth noting that the combined waves and water levels of Scenario A1 and E1 are representative of offshore conditions applied directly to the XBeach-G model boundary, which is landward of **Sizewell-Dunwich Bank –this means that the natural energy dissipating effects of the bank** are not included in the A1 and E1 models, but are included in the XBeach-G F1 model."*

In other words, TR553 is adopting orthodox, conservative modelling that does not rely on the '*natural energy dissipating effects'* of the Sizewell Dunwich banks for the majority of scenarios and epochs and does not appear to assume their substantial retention.

- Unfortunately, the basis of the DCO and DCO Addendum shoreline change modelling is the converse of this approach that the *presence* of the Sizewell Dunwich banks represents conservative modelling for all scenarios and epochs as explained in Paper 1 above.

TR553 represents a major step forward by acknowledging the correct importance of the Sizewell Dunwich banks and applying conservative modelling to the Soft Coastal Defence feature (SCDF) by excluding the energy dissipating effects of the banks and nearshore bars. **The difficulty is that Greater Sizewell Bay is not considered within the same framework of parameters as TR553. What is conservative for the SCDF is conservative for the Bay in general and must be considered in unity.**

Summary

TR553, as stated, is a positive development; it shows the SCDF design to be seemingly functional within its remit and addresses the concerns raised in REP7-220 regarding TR545 and the need for conservative modelling.

TR553 illustrates, in my view, the need to consider the Greater Sizewell Bay shoreline change analysis with the same parameters as TR553 and not those used by the Expert Geomorphological Assessment in the DCO which relies fully on the '*natural energy dissipating effects'* of the Sizewell Dunwich banks and nearshore bars and only runs until 2070/87.

The SCDF cannot be regarded as distinct from the Greater Sizewell Bay.

It is not clear that 2140 is a plausible date for spent fuel removal and should this prove to be the case then it appears that the main nuclear platform would require increased flood resilience than currently proposed.

The reassessment of the two points above, namely a conservative appraisal of Greater Sizewell Bay shoreline recession to the end of station life and the need to provide post-2140 flood resilience, will help define if the ***extent*** of the sea defences around the main nuclear platform as presented in the DCO hearing are adequate.

Following:

Appendix 1 – The Applicant's Expert Geomorphological Assessment (EGA) as presented in the DCO.

Appendix 2 – The offshore sediment 'lost to the system'.

Appendix 3 – The Sizewell Dunwich banks showing important details. Extract from REP2-393

Appendix 4 – Sizewell C and the Applicant's claim for spent fuel removal by 2140. Is this a plausible timeframe? Extract from Post-D10 document "*Sizewell C Main nuclear platform flood resilience in the next century.*"

Appendix 5 - The control and influence of the Sizewell Dunwich banks on shoreline change and coastal processes. Extract from REP2-393.

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APPENDIX 1

The Applicant's Expert Geomorphological Assessment (EGA) to establish shoreline change - a response to DCO studies.

This is taken from Section 5 of my document REP2-393. As far as I am aware the Applicant has not updated the EGA from that presented in the original DCO.

EDF informs us in the DCO submission, that it commissioned seven expert geomorphologists to examine the shoreline change processes associated with Sizewell C:

> *"Seven Expert Geomorphologists, internal and external to Cefas, were convened to assess the physical and scientific evidence for shoreline change processes and to derive a plausible future shoreline baseline using the EGA [Expert Geomorphological Assessment] approach. "*
>
> DCO: 6.3 Revision: 1.0 Applicable Regulation: Regulation 5(2)(a) PINS Reference Number: EN010012 Volume 2 Main Development Site Chapter 20 Coastal Geomorphology and Hydrodynamics Appendix 20A Coastal Geomorphology and Hydrodynamics: Synthesis for Environmental Impact Assessment TR311 Sizewell MSR1 (Ed 4) Paragraph 7.2.1.

The EGA is based on the work of Cefas in Beems document TR311 and TR403 *'Expert Geomorphological Assessment of Sizewell's Future Shoreline Position' 21/3/19 rev. 21/4/20'*.

In my view there are fundamental limitations to the study which are non-conservative in their approach:

1. To adopt a future projection based on "reasonably foreseeable" conditions.
2. Sea level rise in the year 2070 is based on a 'mid-range' scenario.
3. The offshore wave climate remains unchanged.
4. The inshore wave climate remains unchanged.
5. The EGA limits its scope to 3Km of coastline.
6. The EGA limits its timescale to 2070 (2087). End of plant life, however, is 2190.
7. Shoreline sinuosity remains the same

See: Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., Page 134

These assumptions and limitations are each discussed below:

1) The Expert Geomorphological Assessment limited its study to ‘reasonably foreseeable conditions’ a phrase that does not appear to be completely clear in this context. EDF claims that ‘no assessment can be made of extreme events’, and the drivers of change are ‘moderate’ events:

> *“A projection based on the ‘reasonably foreseeable’ conditions was considered the most appropriate method of reaching consensus as **‘extreme events’ that could occur have a low (or poorly-determined) chance of occurrence** and geomorphic systems tend to be shaped by more frequent moderate events (Wolman and Miller, 1960), with the exception of cataclysmic change”.* Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., Page 134 and BEEMS TR403, p.33.

Wolman and Miller’s studies of geomorphic processes were produced in the 19**60**s; the explicit exclusion of extreme events—is *an unsupportable premise where conservative consideration should be a given.* The shoreline at Sizewell is dominated by frequent small low-energy events, so it is shaped by these most of the time, and then a storm (particularly Easterly) does much damage through erosion and flooding. Increases in overall energy supply to the coastline will occur from any increase in either storm frequency or intensity. See section 2 and 4 of Rep2-393.

- The EGA has no seeming consideration to IPCC statements: *"Sea-level rise under emission scenarios that do not limit warming to 1.5°C will increase the risk of coastal erosion and submergence of coastal land (high confidence)."* The low lying Minsmere levels and Sizewell marshes that will surround Sizewell C must be subject to this risk to at least some extent.

2) The ‘panel of seven geomorphologists’ stipulated a limited 0.52m sea-level rise at 2070 – a mid-category Representative Concentration Pathway.

> *“…future shoreline change affecting the Sizewell C development was assessed based on SLR in 2070 of 0.54m (the 95th percentile under the UKCP18 mid-range scenario).”*
> DCO: Coastal Geomorphology and hydrodynamics, Appendix 20A, op.cit., *Paragraph 2.4.1 Page 48*

This is not a conservative approach—advice from UKCP18 which advises that planners use H++ values, or at least RCP8.5, 95th percentile. See section 4 of Rep2-393.

3) The panel limited the offshore wave climate to ‘unchanged’. UKCP18 does not stress major increase in offshore wave climate, nevertheless, EDF notes in the Main Development Site Flood Risk Assessment:

> *“4.2.16 The Environment Agency guidance (Ref 1.7) suggests assuming a precautionary increase in wave height of 5% up to 2055 and then 10% from 2055 to 2115.”*
> DCO: Main Development Site Flood Risk Assessment, op.cit., Page 54.

Also, UKCP18 suggests ‘inherent uncertainty’ as regards ‘Significant Wave Height’ predictions as they represent an area of low predictive accuracy:

> *“Given the inherent uncertainty in projections of storm track changes and the limited sample size available, the wave projections presented here should be viewed as indicative of the potential changes with **low confidence**.”* UKCP18, Ibid., Page 28.

It continues that wave patterns are defined by local activity, which, for Sizewell C will be from a North/North/East fetch across the large expanse of the North Sea. The 1:100 return period (an 81.9% chance of occurring between now and 2190) wave height being 7.3m-7.8m.

4) For the 'inshore wave climate to remain unchanged' is to **explicitly state there is a reliance and dependency on the Sizewell-Dunwich offshore banks and longshore, nearshore bars remaining in their current form.** This bank network, as previously stated, attenuates and dissipates offshore wave energy —as stated in BEEMS TR553, it has ***'natural energy dissipating effects'***—reducing and controlling the inshore wave climate. To assume the banks' stasis and to rely on their 'energy dissipating effects' is then a non-conservative approach. (see Tucker, Carr et al.) (BEEMS TR311).

In my opinion, and that of leading authorities such as Mott Macdonald, the respected global engineering consultancy which undertook an extensive study of the area in 2014 considers that:

> ***"…at a local scale the SDBC [Sizewell-Dunwich Bank Complex] has the potential to change over time-scales shorter than a few decades."*** Mott Mac., op. cit., page 57.

Cefas also acknowledges uncertainty:

> ***"…our understanding of bank dynamics is poor"***
> BEEMS Technical Report Series 2009 no. 058, Sizewell: Morphology of coastal sandbanks and impact to adjacent shorelines. Page 47.

- The Marine Management Association states: ***'the northern end of Dunwich bank has lowered 2 metres in the past 10 years; <u>the most logical assumption would be for this trend to continue.</u>'*** This roughly equates to 4 million tonnes of bank deposits 'lost to the system' in a decade. See 5.1.7, MMO Reference: DCO/2013/00021, 30th Sept 2020. See Appendix 2 for details.

However, despite these considerations, EDF's Expert Geomorphological Assessment tells us in the DCO:

> *"The principal receptors (beach, bars, bank and crag) of the future baseline can be expected to resemble the present (i.e. no regime shift) over much or all of the station life."* Chapter 20 DCO: Coastal Geomorphology and Hydrodynamics. Paragraph 20.4.78.

The statement above outlining the approach of its geomorphological experts is in open contradiction to the following acknowledgement:

> *"It is important to note that changes to the broad coastal regime and coastal processes may occur within the station life."*
> The Sizewell C Project 6.14 Environmental Statement Addendum, Volume 3: Environmental Statement Addendum Appendices Chapter 2 Main Development Site, Appendix 2.15.A Coastal Geomorphology and Hydrodynamics. Para 6.5

In summary of point 4 it is axiomatic to state that conservative modelling must not rely on the '*natural energy dissipating effects'* of the Sizewell Dunwich banks for the majority of scenarios and epochs and conservative assessment may not assume their substantial retention over the next 150 years.

5) Conservative modelling of coastal processes should extend beyond the 3Km remit of the EGA.

6) The EGA limits its remit to 2070 (sea level rise) instead of end of station life which is 2190. In a recent 'East Anglian Daily Times' article*,* a senior coastal scientist at Cefas, and one of the seven expert geomorphologists responsible for the study is reported as saying:

"… that while Cefas does look far ahead into the future, it is generally only possible to predict detailed changes to the coastline over the next 10 years." He continues, *"We can try and predict as much as we like, but almost every prediction in the very long-term has no certainty around it." 'Flooding and 'extreme' storms won't put Sizewell C in danger, experts say'* by Andrew Papworth, East Anglian Daily Times, 06 August 2020', https://www.eadt.co.uk/news/cefas-sizewell-c-coastal-erosion-2684774

This is a different perspective from that of EDF which suggests in its public information newsletter, '*Doing the power of good to Britain*', and quoted in the introduction in REP2-393, that the Expert Geomorphological Assessment forecasts the 'very best assessment of long-term coastal change' and therefore shows Sizewell C to be 'future-proofed'. The EGA in the form presented in the DCO hearing does not support this statement.

7) *"The consensus view was that the 'natural' future shoreline was likely to be no more sinuous than it is"* Page 135 Appendix 20A

Summary of Appendix 4

In my view, the opportunity and capacity within which the review has taken place, combined with one of the geomorphologist's views that their forecasts cannot extend reliably beyond 10 years, fully compromises any value in the Expert Geomorphological Assessment's analysis of future shoreline recession. In summary, the EGA cannot be regarded as conservative in its assumptions and methodology as follows:

- The EGA has no seeming consideration to IPCC statements of *"Sea-level rise under emission scenarios that do not limit warming to 1.5°C will increase the risk of coastal erosion and submergence of coastal land (high confidence)."*
- The EGA does not apply RCP8.5 95 percentile climate change sea level rise,
- The EGA assumes no climate change induced change in storm frequency or intensity,
- The EGA relies on an unchanging offshore geomorphology (reliance on its unchanging form and energy dissipation characteristics). The EGA does not consider the possibility of extreme erosion that can occur on this particular section of Sizewell shoreline, erosion that has historical precedent.
- The EGA's timescale is to 2070/87 and end of plant life is 2190.

APPENDIX 2

The offshore sediment 'lost to the system'.

The Marine Management Organisation (MMO) states:

> *"5.1.7 In relation to p.20.4.77 on the future shoreline baseline geomorphic elements, it is assumed that the future baseline will resemble the present day. As mentioned above, the lack of assessment of changes to the offshore wave climate to a NE domination is a gap in the analysis. For the nearshore climate, it assumes the bank system is stable. However, the northern end of Dunwich bank has lowered 2 metres in the past 10 years; the most logical assumption would be for this trend to continue. This will affect the nearshore wave climate and should be included."*

MMO Reference: DCO/2013/00021 Planning Inspectorate Reference: EN010012 MMO Registration Identification Number: 20025459 Page 25 Deadline 2 submission.

The Applicant itself in the DCO states:

- ***"Records over the last decade show…Dunwich Bank exhibited greater variability in both its morphology and position with erosion north of 267000N, resulting in bank lowering of -0.5 to -1.5 m"*** DCO: Geomorphology Appendix 20A, op cit., Page 21. BEEMS Technical Report TR500).

Consider the material involved in this depletion:

The Northern 1/3rd of the bank would be about 1.5km long and 1 km wide approximately.

So, if we say overall 1.5m depletion, then approximate volume lost = 1500m x 1000m x 1.5m = 2.25 million cubic metres of material lost to the system. The specific gravity of the material is not known accurately but we might assume this equates to approximately 4 million tonnes of bank sand and mud deposits seemingly 'lost to the system' in a decade.

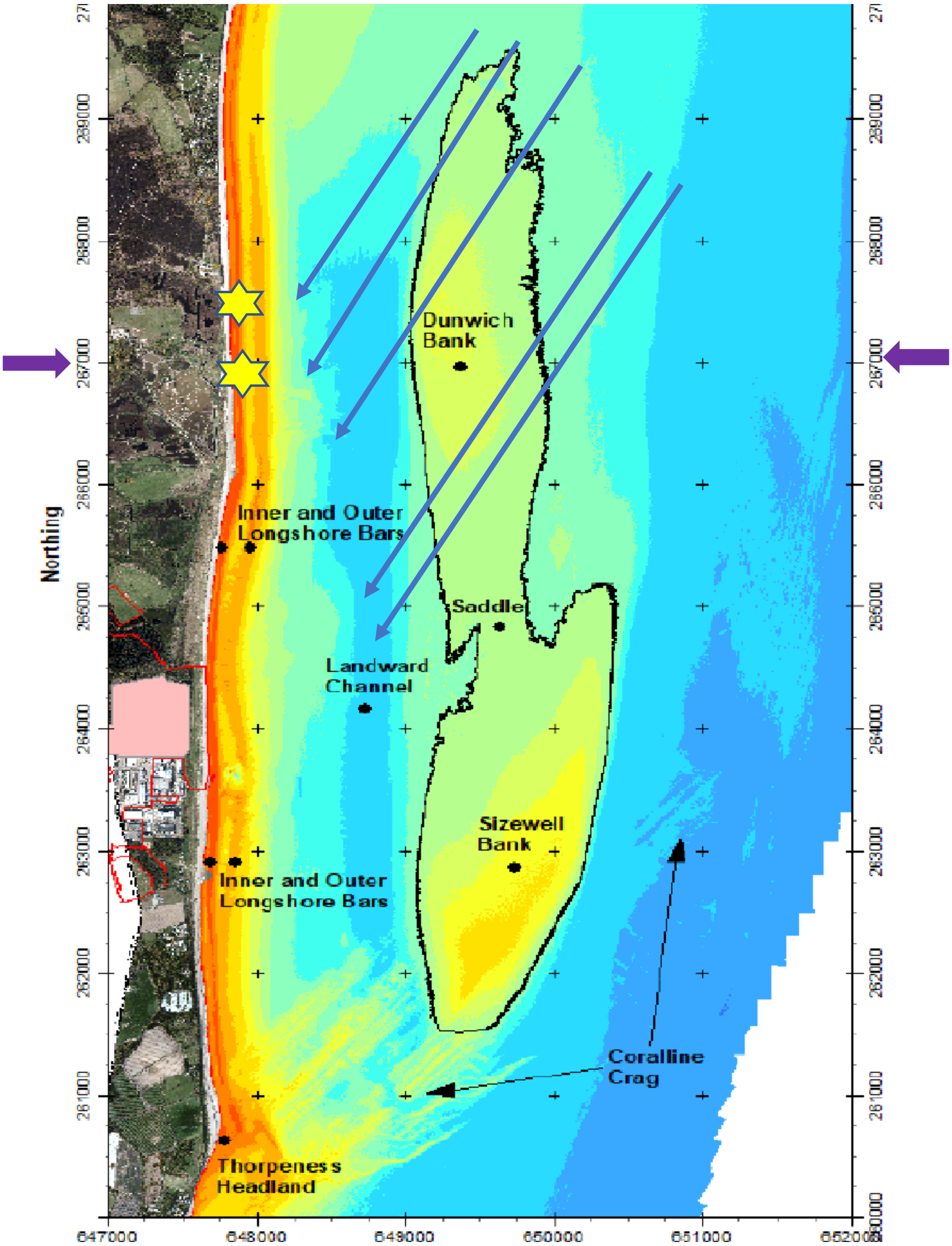
The point is that the amount is both significant and that it appears to be 'lost' to the offshore banks. This is consistent with findings in BEEMS where sediment from northern cliff erosion is not remaining 'in the system':

- "*The last 2 to 3 decades of strong erosion at Dunwich were not matched by ongoing accretion in the south*." BEEMS TR223, page 119 and Table 12, shows net erosion of the Sizewell C foreshore since 1993.
- No full survey of the Sizewell-Dunwich banks since 2016/7 appears to have been undertaken by the Applicant – an exercise trivial in its cost and complexity by comparison with other aspects of the development. The Applicant states: "*Due to its large size (633 ha above the -8 m AOD; [Ref. 18] the bank is not regularly surveyed",* a statement that is puzzling. See *Sizewell C Site Data Summary Report, SZC-NNBGEN-XX-000-REP-100022 100812635 Version 4.0a page 18.*

In summary of Appendix 2, in my view, it is clearly untenable to assume the retention of the Dunwich bank over the lifetime of the plant into the twenty-second century. Therefore, alongside the additional driver of climate change sea level rise, any conservative appraisal should accept and address significant shoreline retreat in the Greater Sizewell Bay during the lifetime of the plant.

APPENDIX 3

The chart below illustrates the Sizewell Dunwich banks.



The Sizewell-Dunwich Banks. The purple arrows mark 26700N— to the north of which the crest height of Dunwich bank is lowering. Chart base from BEEMS Technical Report TR500 'Sizewell-Dunwich Bank Morphology and Variability'. Page 14. Markup my addition.

- The orange and red lines show the 'inner and outer' nearshore, longshore bars. The DCO provided detailed bathymetry of the inner and outer Longshore bars and not the Sizewell-Dunwich banks.

- The pink square shows the proposed location of Sizewell C.

- ***"Records over the last decade show…Dunwich Bank exhibited greater variability in both its morphology and position with erosion north of 267000N,*** [shown by the purple arrows] ***resulting in bank lowering of -0.5 to -1.5 m"*** DCO: Geomorphology Appendix 20A, op cit., Page 21. BEEMS Technical Report TR500).

- The five blue arrows show the direction of the most significant storm waves from the North/North East— ***the largest and longest waves arrive from the N-NE sector. [1:100 wave heights 7.3m-7.8m***]. The driver of sudden and significant erosion on this stretch of coast is from the NNE NE and Easterly directions. The loss of just the northern section of the bank could allow unbroken storm waves to break on the foreshore and increase water volumes in the South Minsmere levels in flood conditions. See map in section 4.3. DCO: Geomorphology Appendix 20A. op.cit., Paragraph 2.3.2.2.2

  Haskoning's modelling assumes 'shore-normal' angles (all waves will strike the shore at 90 degrees). In the complex bathymetry offshore from Sizewell plus significant wave directions stated above do not appear to support this assumption. Shallow nearshore (even before the nearshore bar locations) wave refraction locally will redirect waves and cause them to line up parallel to local bathymetric contours. section 7.

- There has been net erosion of the foreshore in the area of the proposed Sizewell C since 1993 according to BEEMS Table 2. This may be an indication of compromise to the Dunwich bank. See BEEMS TR223 op cit., Page 119 and Table 12 on page 115.

- The two yellow stars show the locations of breaches - 267400 15/12/03 and 14/2/05 and 266900 14/2/05. ***"This 200 m section is the most vulnerable stretch of coastline between Dunwich and Sizewell, and represents the most likely location of a major breach occurring during a future storm surge."*** Pye and Blott 2005, Coastal evolution RSPB op. cit., page 154 of 160. Page 28/160

APPENDIX 4

Sizewell C and the Applicant's claim for spent fuel removal by 2140. Is this a plausible timeframe?

Introduction and purpose.

The Applicant's flood risk assessment for Sizewell C is committed to 2140 as the 'decommissioned date' for spent fuel confirmed by the following:

- ***"The lifetime of the development includes for removal of all spent nuclear fuel by 2140…The Application and flood risk assessment are explicit about the timeframes being assessed in relation to 2140."***
- ***"The key dates relevant to flood risk for the operation of the station are; the end of operation of the station at 2085…end of interim spent fuel store 2140…*** 6.12 Rev: Reports Referenced in the Environmental Statement. Page 14

- ***"…on-site risks would only be considered* [modelled] *to 2140 as the end of Interim Spent Fuel Store."***
  Royal Haskoning, flood risk modelling, page 2 of 22 in 6.12 Revision: Reports Referenced in the Environmental Statement.

This timeframe of 2140 is important as '*on-site risks would only be considered to this date'* according to the Applicant's own modelling presented by Royal Haskoning.

This paper is a response to the stated, 'decommissioned date of 2140' and posits the view that such a timeframe is imposed by the Applicant's flood risk assessment presented in its '*Table 2.1*'and its selected main nuclear platform level. This paper suggests this timescale for spent fuel removal is implausible and that the spent fuel store could remain in commission well beyond 2140 and consequently exposed to untenable flood risk.

1. The critical nature of the 2140 date—EDF's assessment of still water and wave overtopping of the main nuclear platform beyond 2140.

If we refer to the Applicant's 'Table 2.1':

> *"2.1.5 Table 2.1 [reproduced below] presents a list of overtopping scenarios for the reasonably foreseeable (RCP8.5 95 percentile) and credible maximum (H++ or BECC Upper) climate change allowances and respective extreme still water levels, highlighting in red bold those scenarios with extreme sea level above platform height that were not undertaken in this assessment"* FRA ADDENDUM: op cit., Main Development Site Flood Risk Assessment Addendum Appendices A-F Part 10 of 10

Table 2.1: Summary of wave overtopping scenarios

Return period	2090 epoch		2140 epoch		2190 epoch	
	RCP8.5	H++	RCP8.5	BECC	RCP8.5	BECC
200-year	4.58	5.19	5.48	7.58	6.31	**8.48**
1,000-year	5.12	5.73	6.02	**8.12**	6.85	**9.02**
10,000-year	5.98	6.59	6.88	**8.98**	7.71	**9.88**

FRA ADDENDUM: op cit., Main Development Site Flood Risk Assessment Addendum Appendices A-F Part 10 of 10

The figure of interest is the RCP8.5 1:10,000 in 2140. The table clearly shows that beyond 2140 the main nuclear platform is at risk of flooding in a 1:10,000 RCP8.5 scenario and that there is a consequent critical requirement for Sizewell C to be decommissioned (at least in terms of spent fuel removal) by this date for the safety of local populations, environment, and staff.

2. The profound difficulties in achieving a decommissioned date of 2140.

Government policy is that spent fuel is transported directly from site of creation to a geological disposal facility (GDF), **there is no 'intermediate' location for spent fuel proposed**. However:

2.1 Policy: Spent fuel is not waste and *is not currently destined for geological disposal*.

- *"…your understanding that spent fuel is 'not waste' and is not destined for geological disposal unless and until it is classified as waste, is correct."*
  13th October 2021 email to me from Radioactive Waste Management Ltd.

2.2 Spent Fuel Cooling: High burnup spent fuel of the type produced by Sizewell C requires a longer cooling period (see my paper REP2-503) before geological disposal can be considered and that does not correlate with a decommissioned date of 2140.

- The Nuclear Decommissioning Authority (NDA) suggests the cooling requirements will result in a decommissioning date for Sizewell C between **2180 to 2230**:

  "Current RWMD generic disposal studies for spent fuel define a temperature criterion for the acceptable heat output from a disposal canister. In order to ensure that the performance of the bentonite buffer material to be placed around the canister in the disposal environment is not damaged by excessive temperatures, a temperature limit of 100°C is applied to the inner bentonite buffer surface. ***Based on a canister containing four EPR fuel assemblies, each with the maximum burn-up of 65 GWd/tU and adopting the canister spacing used in existing concept designs, it would require of order of 140 years for the activity, and hence heat output, of the EPR fuel to decay sufficiently to meet this temperature criterion****."*

  *"****It is acknowledged that the cooling period specified above is greater than would be required for existing PWR fuel to meet the same criterion*** **[due to its higher levels of radioactivity and high decay heat radioisotopes]** *and RWMD proposes to explore how this period can be reduced. This may be achieved for instance through refinement of the assessment inventory (for example by considering a more realistic distribution of burn-up), by reducing the fuel loading in a canister* **[which will increase the geological disposal footprint]** *or by consideration of alternative disposal concepts. The sensitivity of the cooling period to fuel burn-up has been investigated by consideration of an alternative fuel inventory based on an assembly irradiation of 50 GWd/tU. For this alternative scenario it is estimated that the cooling time required will reduce to the order of* ***90 years*** *to meet the same temperature criterion."*
  NDA 'Geological Disposal Generic Design Assessment: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR' Jan 2014 section 6, page 6.

'Together Against Sizewell C' raised the above points from the Nuclear Decommissioning Authority (NDA) with the Office for Nuclear Regulation (ONR) who responded as follows with reference to HINKLEY POINT C:

"As an example, for HPC (using indicative timescales and dates):

- *The assumed availability date for the GDF ~2130 for fuel from new reactors.*
- *Assumed start of generation of HPC: 2025*
- *Assumed end of generation of HPC: 2085*
- *The date from which fuel will be sufficiently cool to start to transfer to the GDF (from 55-60 after end of generation): 2140-2145*
- *The date by which all fuel will be transferred to the GDF: ~2150-2155 (assumed to take just over 9 years)*
- *The dry fuel store will not be needed until ~10 years start of operation of HPC: ~2035*

- *The dry fuel store will then be needed for 50 years remaining operation of HPC, 55-60 years for the fuel to cool and 10 years to allow transfer of fuel to the GDF, which is 115-120 years.*
- *Removal of all fuel from site and end of use of the dry fuel store is therefore: ~2150-2155.*
- *The initial design life for the dry fuel store is 120 years (noting the design is conceived to allow for refurbishment or replacement) which would take it to: ~ 2155*
- *"In summary, the number of years before the fuel can be taken off site to the GDF is approximately 55-60 years from end of generation, which is because of the temperature criterion associated with the GDF canister. Fuel could potentially be moved from site safely earlier (but not currently to the GDF), although this is not planned." ONR reference HPGE202006066, 'TASC Review of the Minutes of the ONR/Stop Hinkley Meeting in Bridgewater January 2020 Authors: Chris & Jen Wilson Date: 17 June 2020'.*

The basis of the ONR's 'downward revision' of the NDA's specified high burnup spent fuel cooling period, as stated in its response above, is that not all fuel will be burnt to 65 GWd/tU. I accept this although the ONR is unclear as to what the average burn rate will be and hence, in my view, there is a sense of the arbitrary about the revision which would benefit from more detailed validation. In my opinion, there is a need for a statement of common ground between the NDA and the ONR defining this cooling period within somewhat finer limits than 55-140 years, particularly the period in cooling ponds.

Even if the 'revised cooling period' from the ONR is correct and applied to Sizewell C's spent fuel, and we accept the GDF will be commissioned and run smoothly, and one assumes that Sizewell C is completed on time (2035) and will operate until 2095 without lifetime extensions, then spent fuel could, at the very earliest, be removed by 2160/2165 (2095 + 55-60 years cooling +10 years to remove).

For spent fuel to be removed from site by 2160/2165 (20-25 years *after* the "*explicit timeframes"* committed to by the Applicant) requires the acceptance of ***major*** assumptions as follows:

1. Spent fuel will be classified as waste. This is currently not the case.

2. That there are no over-runs in construction time of Sizewell C.

3. That there are no lifetime extensions to Sizewell C.

4. That one accepts the validity of the ONR's downward revision of the required cooling period specified by the NDA from 140 years to 55-60 years.

5. That a GDF is available within 120 years, and it will take no more than 10 years to consign the Sizewell C spent fuel.

6. That the GDF can accept and consign Sizewell C's spent fuel at the same time as other nuclear waste if necessary. It is not at all clear that this will be the case.

7. That the timeframe for the deposition of other committed nuclear waste to be consigned prior to Hinkley C and Sizewell C— that is, legacy nuclear waste, including spent fuel from power stations and the highly enriched submarine spent fuel— operates within the allocated timescale without over-run. EN-6 confirms that the initial disposal of legacy wastes (i.e. those already in existence from AGRs and SZB) will take until 2130 to be consigned to the proposed GDF. See EN-6 Vol II page 16.

Therefore, in summary I suggest that the Applicant's 2140 date for decommissioning is implausible and that even the later dates of 2160/65 are dependent on major assumptions and unsupported by an agreed and conclusive analysis of fuel cooling requirements.

APPENDIX 5

The control and influence of the Sizewell-Dunwich banks on shoreline change and Coastal processes at Sizewell—three major historical 'episodes'.

This is taken from my main paper REP2-393, reproduced here for convenience.

EDF's BEEMS report TR058, quoting Pye and Blott, states:

> *"The 1836 [1736-1836] shoreline at Sizewell is the most eroded shoreline in the records assembled by Pye and Blott (2005), being some 60 – 100 m landward of its current position and just 20 m seaward of the present location of the Sizewell B cooling-water pump house. By 1883, the shoreline had advanced by up to 130 m, presumably as a result of the increased sediment supply from the cliffs to the north."*
> BEEMS Technical Report Series 2009 no. TR058, Sizewell: *Morphology of coastal sandbanks and impact to adjacent shorelines*. Page 40.
>
> *"Major changes have occurred along the coastline in the last 1000 years, with coastal projections north of Southwold, at Southwold itself, at Dunwich and at Thorpeness all having been eroded by significant distances (up to over 1 km)".* BEEMS TR139, Edition 2: A Consideration of "Extreme Events" at Sizewell, Suffolk, With Particular Reference to Coastal Morphological Change and Extreme Water Levels. Page 4 of 301.

For details of erosion/accretion described in the following, see: *Coastal Processes and Morphological Change in the Dunwich-Sizewell Area, Suffolk,* UK Author(s): Kenneth Pye and Simon J. Blott (May, 2006), pp. 453-473. See also Pye Blott, 2005, *Coastal Processes and Morphological Evolution of the Minsmere Reserve and Surrounding Area, Suffolk*.

Three 'approximately 100-year' episodes are recorded for Sizewell:

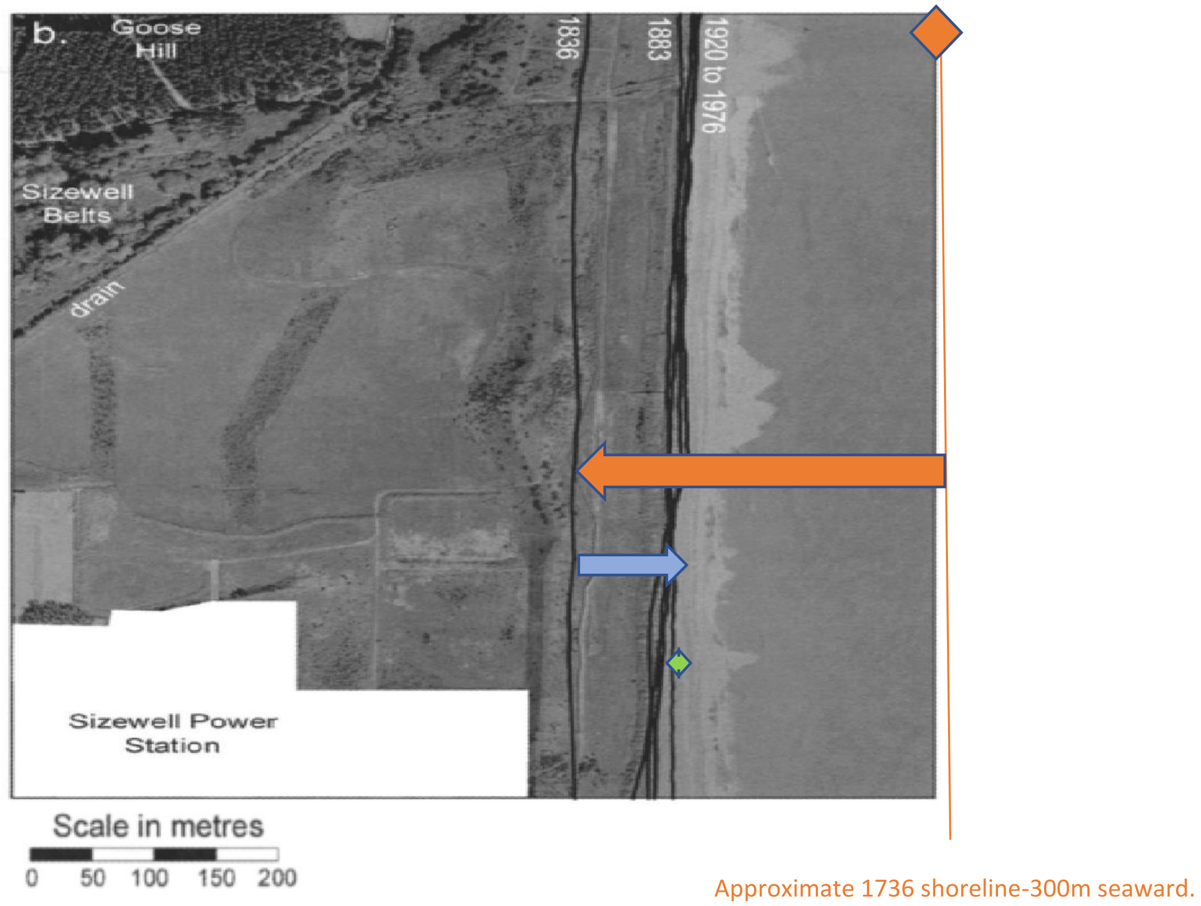
1. **Erosion:** As stated above, the Sizewell shoreline between 1736 and 1836 is *"the most eroded shoreline in the records"* according to BEEMS TR058 quoting Pye and Blott (2005). It appears that the 1836 shoreline had eroded approximately 300m in one century and was just 20m seaward of the present-day Sizewell B. Orange arrow in the air photo below.

2. **Accretion: The Sizewell-Dunwich bank grew after 1824 and protected the shoreline**; between 1836 and 1903/1920 the Sizewell shoreline accreted by 83m with sediment from cliffs to the north, particularly Dunwich, to roughly its present location. The present Sizewell shoreline is hence 'soft and erodible'. Blue arrow on the air photo below.
   - BEEMS states, however, *"The last 2 to 3 decades of strong erosion at Dunwich were not, however, matched by ongoing accretion in the south".* BEEMS TR223 op cit., Page 119, Table 12 on p. 115.

3. **Stability:** 1920- present day, relative stability. Green arrow on the photo below.

The following 'air photograph' taken in 2000 showing imposed historical coastline positions and Sizewell B power station shows the three episodes:

Three major 100-year episodes of erosion, accretion and relative stability of the Sizewell shoreline discussed earlier on a large-scale air photograph:



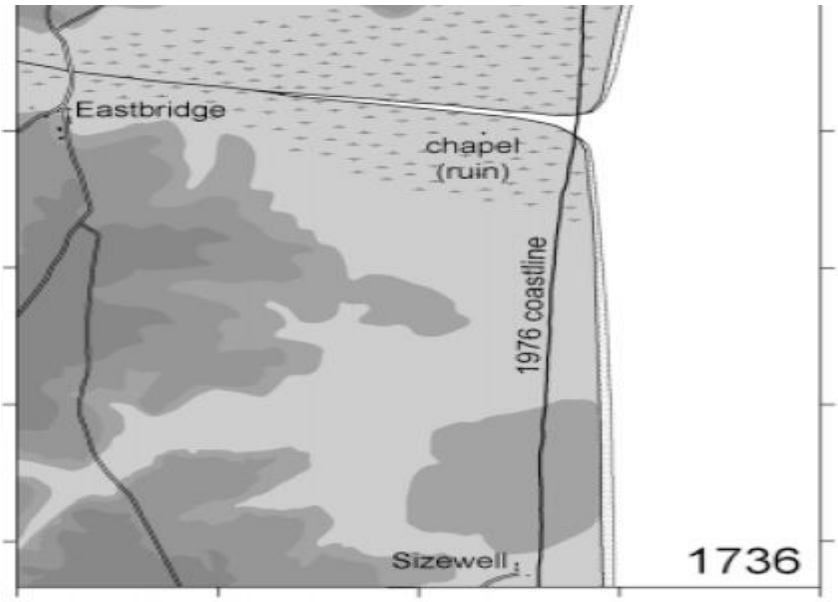
'Coastal Processes and Morphological Change in the Dunwich-Sizewell Area, Suffolk', UK Author(s): Kenneth Pye and Simon J. Blott Source: Journal of Coastal Research, Vol. 22, No. 3 (May 2006).

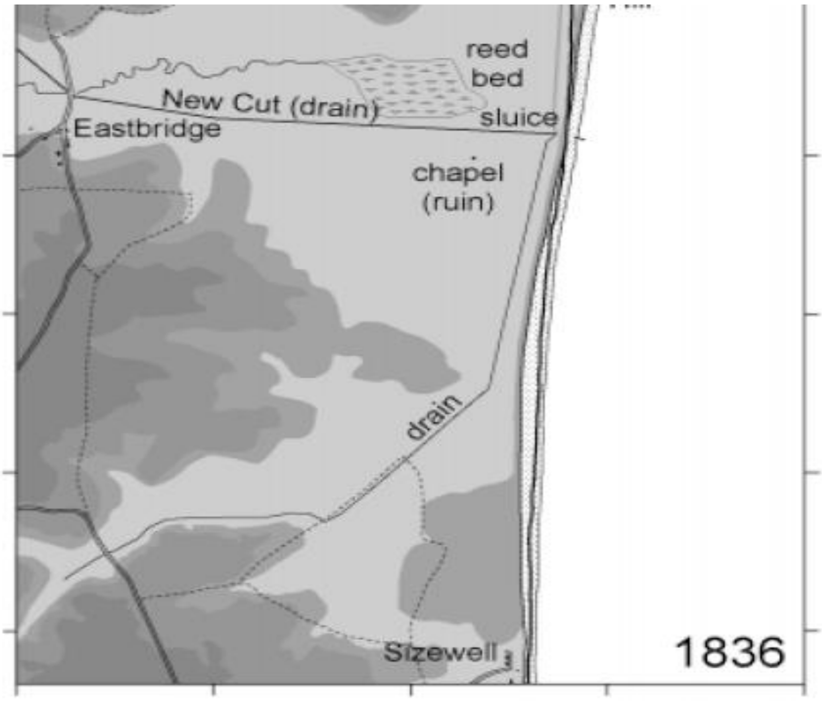
1. Orange arrow shows erosion period 1736-1836.
2. Light blue arrow shows accretion period post the development of the Sizewell-Dunwich banks, 1836-1920.
3. Light green double arrow shows the relative stability period 1920- present.

The following two historical maps illustrate the coastline in 1736 and 1836. The 1736 shoreline according to Pye and Blott appears to be approximately 300m-350m to seaward of Sizewell B and as stated earlier is *"…the most eroded shoreline in the records assembled by Pye and Blott (2005)".*

"Historical maps showing coastal changes at Minsmere since 1736, based on maps by Kirby (1737), Hodskinson (1783), and the Ordnance Survey (1837, 1883–84, 1928, and 1976–82). The position of mean high water in 1976 is displayed as a solid line on each map for reference. Topography is shaded at 5m intervals." See: 'Coastal Processes and Morphological Change in the Dunwich-Sizewell Area, Suffolk',

UK Author(s): Kenneth Pye and Simon J. Blott Source: Journal of Coastal Research, Vol. 22, No. 3 (May 2006). Page 462





Squares are 1km scale.

My own measurements, which are not included in this document, using modern Ordnance Survey and maps drawn of the Suffolk Coast in 1737 by John Kirby et al., and allowing for major errors, suggest erosion at Sizewell *far greater* than 350m in this period 1736-1836. This is consistent with other observations on this coast such as Benacre cliffs: *"the mean rate of retreat of the Benacre Cliffs was 7.02 meters per year"* BEEMS TR311, 2.3.3.

This extreme erosion that has particularly occurred at Sizewell may be explained by the following statement that wave energy coefficients are not constant along this length of coast:

> *"Indeed [wave energy coefficients] suggest a concentration of energy in the Sizewell area, [offshore of the Sizewell-Dunwich banks] especially for wave headings between 230 and 300 degrees. Wave refraction calculations also suggest that, particularly with waves come from the direction of maximum fetch (210 degrees),* ***there are energy foci along the coast, notably between Sizewell and Thorpeness.****"* Institute of Oceanographic Sciences, Sizewell-Dunwich banks field study, Topic Report 6, Carr, King, Heathershaw and Leeds. Page 15

It appears clear that sediment released in northern cliff erosion cannot be relied up on to remain within the system:

1. "*The last 2 to 3 decades of strong erosion at Dunwich were not matched by ongoing accretion in the south*." BEEMS TR223 Table 12, shows net erosion of the Sizewell C foreshore since 1993.
2. The Dunwich bank northern third has dropped between 1 and 2m – a huge amount of sediment seemingly lost to the system, not retained.

Based on the above, in my view there is **no plausible mechanism** that could justify the assumption for the maintenance and preservation of the unconsolidated Dunwich bank over the next two 100-year episodes of coastal processes, the uncertainties of which can only be increased by climate change sea-level rise and storm level change. This loss could result in significant shoreline erosion around Sizewell C. See my papers REP2-393, REP7-219, REP10-345.

In summary of Appendix 5 it can be stated that the Sizewell Dunwich banks are ***the*** decisive arbiter of micro-stability of the nuclear coastline at Sizewell. They protect the inner and outer longshore bars and after the growth of the Dunwich bank from 1836 has protected the shoreline from being the '*most eroded in records'* through accretion to stability. The banks will always be of critical importance to Sizewell C and conservative modelling cannot, under any circumstances in my view, rely on their overall retention and maintenance to end of station life. See my document REP2-393 sections 2, 6, 7.