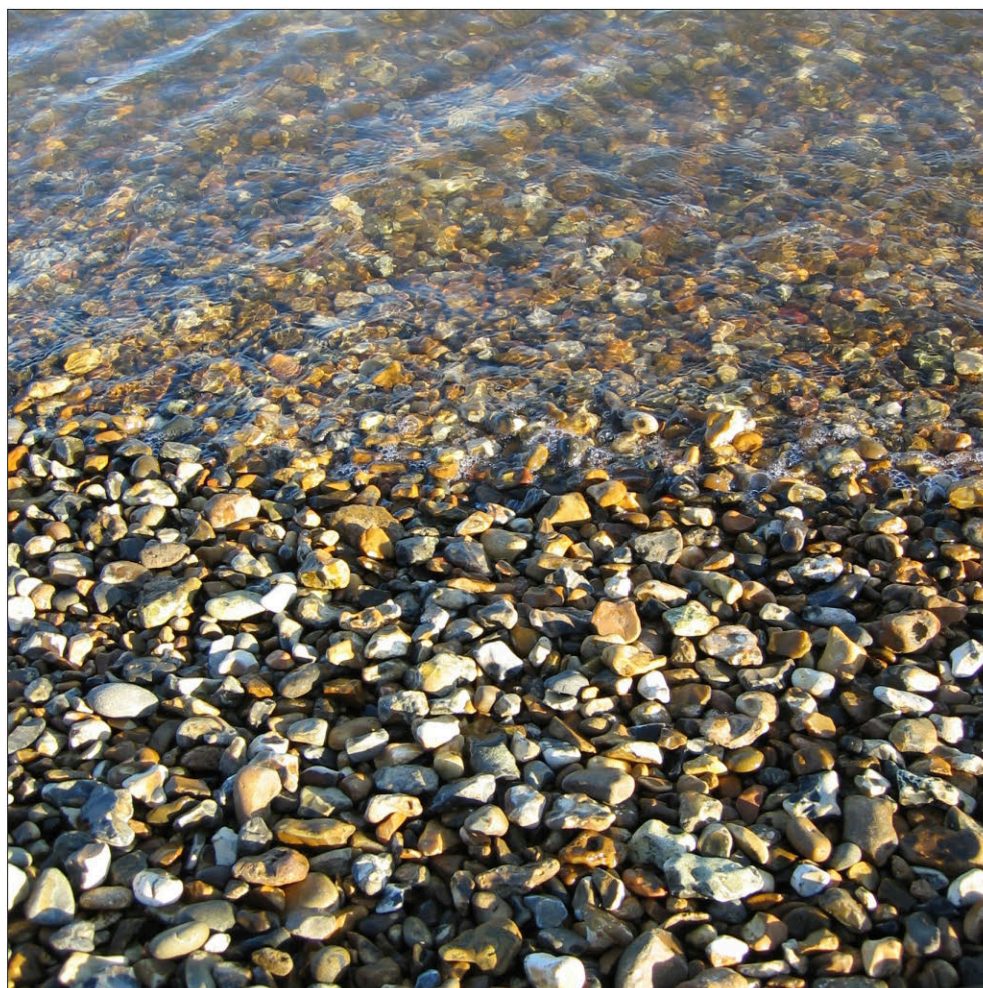




making sense of heritage

Palaeo-Yare Operational Sampling conducted under the short-term licencing provisional Written Scheme of Investigation

Interpretive Report



Ref: 83742.01
March 2015



**Palaeo-Yare Operational Sampling
conducted under the short-term licencing
provisional Written Scheme of Investigation**

Interpretive Report

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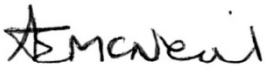

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Palaeo-Yare Operational Sampling conducted under the short-term licencing provisional Written Scheme of Investigation

Interpretive Report

Summary

Wessex Archaeology was commissioned by CEMEX UK Marine Limited, Hanson Aggregates Marine Limited, Lafarge Tarmac Marine Limited and Volker Dredging Limited, coordinated through British Marine Aggregate Producers Association to produce an interpretive report detailing the methods and results of the operational sampling events undertaken in the East Coast aggregate extraction block, under the auspices of the provisional Written Scheme of Investigation for the short-term licences and EH approved licence specific methodologies.

This report summarises the results of a series of operational sampling events carried out by the aggregate licence operators between May 2012 and December 2014.

Twenty-one operational sampling events have been carried out in nine out of the fifteen short-term licence areas (and sub-areas). Fourteen lithics and numerous faunal remains have been recovered from c. 80,000 tonnes of aggregate. This is a small number of finds, but the results have furthered our understanding of the region and have allowed us to address certain existing hypotheses.

Levallois-type material recovered from Areas 240 and 212 indicate a background level of hominin activity, at a low level based on current finds, broadly comparable in date to that attested by some of the original lithic finds from Area 240. These artefacts have not undergone a significant degree of post-depositional disturbance and can be considered *in situ* as far as can be determined.

Other recovered Palaeolithic material is not especially diagnostic, and probably post-dates perhaps 400,000 BP. However, this is consistent with the proposed post-Anglian development of the Palaeo-Yare and deposits.

Younger lithics (a Late Upper Palaeolithic blade core; one flake; one piece with miscellaneous retouch) associated with the early Holocene channel cutting into the Palaeo-Yare floodplain deposits indicate the potential for further artefacts associated with this channel. No artefacts of this age have previously been recovered in this region.

Based on the current data, it seems likely that the original recovery of a large amount of lithic material at Area 240 represents a 'hot-spot'. Although it is likely that other hot-spots exist associated with the now-submerged catchment of the Palaeo-Yare, this is not evident in the results of the operational sampling to date.

Given the operational limitations and logistics, the subscribed methodology at each wharf has worked with material being successfully recovered. One of the key factors at this stage is that there have not been as many sampling events as planned in the method statements principally due to operational limitations. It is considered that a broader spatial distribution of samples within licences during the full-term licence period is required in order to test the hypotheses.



Palaeo-Yare Operational Sampling conducted under the short-term licencing provisional Written Scheme of Investigation

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Acknowledgements

Wessex Archaeology was commissioned by CEMEX UK Marine Limited, Hanson Aggregates Marine Limited, Lafarge Tarmac Marine Limited and Volker Dredging Limited, coordinated through British Marine Aggregate Producers Association to provide an interpretive report on the operational sampling events conducted at aggregate wharves.

Wessex Archaeology would like to thank Mark Russell (BMAPA) and the licensees for their support during the operational sampling. Thanks to Dr Andrew Bellamy (Lafarge Tarmac Marine Ltd), Will Drake (Volker Dredging Ltd.), Graham Singleton and Joe Holcroft (CEMEX UK Marine Ltd) and Nigel Griffiths, Louise Mann, Laura Humphries and Amy Stewart (Hanson Aggregates Marine Limited).

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Dr Louise Tizzard and Dr Matt Leivers prepared the report. Kitty Foster and Karen Nichols prepared the illustrations and the project was managed and QA'd by Euan McNeill.

Palaeo-Yare Operational Sampling conducted under the short-term licencing provisional Written Scheme of Investigation

Interpretive Report

1 INTRODUCTION

- 1.1.1 Wessex Archaeology (WA) was commissioned by CEMEX UK Marine Limited (CEMEX), Hanson Aggregates Marine Limited (HAML), Lafarge Tarmac Marine Limited (LTML) and Volker Dredging Limited (VDL), coordinated through the British Marine Aggregate Producers Association (BMAPA), to produce an interpretive report detailing the methods and results of the operational sampling events undertaken in the East Coast aggregate extraction block (**Figure 1**).
- 1.1.2 Previous work relevant to this report includes work conducted in the Aggregate Dredging Licence Area 240 (Wessex Archaeology 2011a) on behalf of English Heritage (EH), funded by Aggregate Levy Sustainability Fund (ALSF); work commissioned by HAML which involved a programme of archaeological monitoring within Licence Area 240 (Wessex Archaeology 2011b); and the Palaeo-Yare Catchment Assessment (Wessex Archaeology 2013a, 2013b).

1.2 Background

- 1.2.1 In 2007/2008, Palaeolithic artefacts, including hand axes, flakes and cores as well as a series of bones (woolly mammoth, woolly rhino, bison, reindeer and horse) were discovered by Mr Jan Meulmeester in stockpiles of gravel at SBV Flushing Wharf. The finds were identified from stockpiles and reject piles between the 7th December 2007 to the 18th March 2008, dredged from licence Area 240 between the 7th December 2007 and 5th February 2008. The fresh condition of some of the hand axes indicated that they came from relatively undisturbed deposits. Comparison of the dates when the material was recovered with the movements of the dredgers supplying the wharf revealed that the finds had been dredged from a small area within Area 240. In order to prevent any damage to remains within this area, the dredging company (HAML) voluntarily implemented an archaeological exclusion zone covering this area.
- 1.2.2 Between 2008 and 2013 WA undertook a series of multi-disciplinary projects in order to understand the palaeogeography and archaeology of the area and to improve the future management of the potential effects of aggregate dredging on the marine historic environment.
- 1.2.3 Between 2008 and 2011 the *Seabed Prehistory: Site Evaluation Techniques (Area 240)* project was undertaken. The project included the acquisition and interpretation of geophysical data, geotechnical data, seabed sampling, vibrocoreing, palaeoenvironmental assessment, analysis and dating (Wessex Archaeology 2011a). This was followed in 2011 by a programme of archaeological monitoring of aggregate dredging within licence Area 240 and its subsequent processing in Holland commissioned by HAML (Wessex Archaeology 2011b). The project aimed to trial methods of bulk sampling the seabed using

standard aggregate dredging plant with the goal of intercepting and evaluating artefactual material, and evaluating the presence/absence, distribution, character, quality and preservation of Palaeolithic artefacts within the Area 240.

1.2.4 Based on the work carried out in Area 240 it was acknowledged by the industry and the aggregate companies that the evaluation of relationships between the archaeology and palaeogeography could not effectively be carried out on a licence by licence area basis and a regional approach was required. The *Palaeo-Yare Catchment Assessment* project was undertaken aiming to map key Palaeo-Yare sediment deposits and develop hypotheses about the archaeological potential of the region in order to support decisions relating to the assessment and management of future marine aggregate operations (Wessex Archaeology 2013a; 2013b).

1.2.5 The assessment of prehistoric character of the region has revealed a complex history of deposition and erosion. Eight sediment units were identified, dating from the Late Pliocene/Early Pleistocene to marine deposits associated with the last transgression in the Holocene (**Table 1**).

Unit	Interpretation	Age	Description
8	Marine deposits associated with the last transgression in the Holocene	Holocene	Shelly, gravelly medium to coarse sand.
7	Basal fill of a shallow under-filled channel feature (equivocal to onshore lower Breydon Formation)	Early Holocene	It comprises a basal unit of peat approximately 0.2 m thick overlain by a unit of sandy or shelly clay. Infilling of Channel B.
6	Fluvial alluvium	Possibly mid-Devensian	Sandy gravel. Only identified in Area 240.
5	Possibly represents an estuarine or near coastal depositional environment	Unknown, possibly contemporary with unit 6	Slightly gravelly, slightly silty, fine to medium grained sand infilling depressions. Only identified in Area 240.
4	Brown Bank Formation	Early Devensian (110 – 75 ka)	Unit 4 is a very distinctive unit generally associated with the buried channel feature in the north of Area 240 interpreted as the infilling of a cut sequence. It is comprised of fine-grained sediments (sands, silts and clays) deposited in a low-energy environment such as river or estuary. Similar aged sediments also observed in Area 401/402.
3b	Reworked glaciofluvial outwash	Wolstonian glaciation (380 to 130 ka)	Unit 3b is comprised of sands and gravels and forms the principal floodplain deposits of the offshore extents of the Palaeo-Yare.
3a	Reworked glaciofluvial outwash	Wolstonian glaciation (380 to 130 ka)	A channel (Channel A) infill deposit identified in Area 240 that is associated with a channel feature probably cut into Unit 2 during the Late-Anglian glaciation. Unit 3a is the deepest, and oldest, fill primarily associated with the channel feature in the northeast and

Unit	Interpretation	Age	Description
			comprises gravel and sand. Only identified in Area 240.
2	Yarmouth Roads Formation	Cromerian period (478 to 787 ka)	Unit 2 generally comprises silty, gravelly, fine to coarse sands. Observed throughout the region overlying Unit 1. To the south of Area 240 and to the east of the region Unit 2 is more complex and comprises silty sand with very frequent thin beds and laminae of firm to stiff clay and peaty organic clay.
1	Westkapelle Ground Formation	Pliocene/Early Pleistocene	The deepest unit and is observed throughout the region.

Table 1: Interpretation of geological units identified within the Palaeo-Yare catchment area (Wessex Archaeology 2011a; 2013a; 2013b)

- 1.2.6 The flint artefacts recovered from Area 240 (summarised in **Table 2**) were interpreted as being principally associated with a specific glaciofluvial sediment Unit 3b. Deposited during the Wolstonian (MIS 8/7), Unit 3b forms a floodplain deposit of the Middle Pleistocene channel of the Palaeo-Yare.

Finds	Handaxes	Cores	Flakes	Total
Initial discovery	33	8 (3 Levallois)	47 (20 Levallois)	88
East Coast REC (Limpenny <i>et al.</i> 2011)	-	-	1	1
Seabed Prehistory: Seabed Sampling (Wessex Archaeology 2011a)	-	-	13	13
Dredge and Wharf monitoring (Wessex Archaeology 2011b)	3	1	20 (1 Levallois)	24
Total	36	9	81	126

Table 2: Summary of artefacts recovered from Area 240

- 1.2.7 Additional finds recovered throughout the region and reported through the Marine Aggregate Industry *Protocol for Reporting Finds of Archaeological Interest* further highlighted the potential for prehistoric artefacts to be recovered.
- 1.2.8 The Operational Sampling work was conceived in order to allow the development of a regional framework which would result in a better understanding of the prehistoric archaeological resource in the region in terms of its distribution, significance and the mitigation of effects from dredging.
- 1.2.9 In consequence, a methodology was devised to investigate further the relationship between the archaeological/palaeoenvironmental material and the geological units within the short term licence areas within the Palaeo-Yare

system. The methodology was designed to provide information to improve future mitigation strategies for the minimisation of impacts upon cultural heritage receptors from dredging activity in the vicinity, including the modification or removal of the existing Area 240 exclusion zone. The first phase of this programme involved fieldwork conducted on board a dredging vessel and at the receiving wharf in Holland (Wessex Archaeology 2011b). The second phase involved the development of a series of methodologies to monitor wharves in receipt of material dredged from short term licences in the Palaeo-Yare system. These are given in **Table 3**.

Licence Area	Operator	Wharf
212	Hanson	Frindsbury
228	Volker	Cliffe
240	Hanson	Frindsbury
242-361	Hanson	Frindsbury
251	Cemex	Northfleet
296	Lafarge Tarmac	Ridham
319	Cemex	Northfleet
328	Hanson	Frindsbury
360	Cemex	Northfleet

Table 3: Licence areas, operators and wharves

1.3 Aims and Objectives

1.3.1 The aims of the operational sampling are to:

- provide a record of Palaeolithic material recovered in the course of dredging under the short-term licences;
- advance understanding of the distribution and significance of Palaeolithic material within the short-term licence areas of the East Coast Block of the Anglian Region, with reference to a series of hypotheses;
- inform a WSI that will accompany full-term licences in the East Coast Block of the Anglian Region.

1.3.2 The principal outputs arising from the implementation of the *Provisional Written Scheme of Investigations for the Anglian Region* (pWSI) (**Appendix I**) for the short-term licences has been a series of Operational Reports on the results of processing Operational Samples dredged from each Licence Area. On completion of the short-term licence period, a single integrated Interpretive Report that collates and reviews the results of all Operational Sampling conducted in the course of the Short-term Marine Licences will be prepared.

1.3.3 The aims and objectives of this report are to provide a summary and interpretation of the results of the operational samples conducted during the short-term licences.

2 HYPOTHESES

2.1.1 A set of hypotheses have been developed that can be applied to the licence areas within the region in order to test the key conclusions of the *Palaeo-Yare Catchment Assessment* (Wessex Archaeology 2013a) and address remaining uncertainties. The hypotheses are predominantly focussed on the proven potential for artefacts within the Palaeo-Yare floodplain deposits (Unit 3b).

2.1.2 The hypotheses have been divided into five groups relating to specific issues, and are summarised in **Table 4**. Full details are provided in the pWSI (**Appendix I**).

Hypotheses:	
Inhabitation	<p>H1a: Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.</p> <p>H1b: Palaeolithic material recovered from Unit 3b is predominantly <i>in situ</i>.</p>
Choice and use of location	<p>H2a: Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself.</p> <p>H2b: Palaeolithic material is recovered only from Unit 3b deposits within the limits of the Palaeo-Yare floodplain, and not within the Unit 3b outliers to the north and south of the floodplain</p> <p>H2c: The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.</p>
Natural processes	<p>H3a: The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.</p> <p>H3b: Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.</p> <p>H3c: Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures.</p>
Dredging History	<p>H4a: Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS.</p> <p>H4b: Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place.</p>
Operation Sampling methods	<p>H5a: Palaeolithic material is found at all wharves where Operational Sampling takes place</p>

Table 4: summary of hypotheses

2.1.3 As was envisioned, these hypotheses are being tested through physical sampling and monitoring of dredge loads from the licence areas as detailed in the pWSI. Certain licence areas lend themselves to certain hypotheses. For the short-term licence applications the hypotheses are dealt with on a licence area basis and are summarised in **Table 5**.

Short-term aggregate licence area	Sub-licences	H1a	H1b	H2a	H2b	H2c	H3a	H3b	H3c	H4a	H4b	H5a
240		✓	✓	✓		✓	✓	✓		✓	✓	✓
228		✓	✓	✓		✓	✓	✓			✓	✓
319		✓	✓			✓	✓	✓		✓		✓
251	West	✓	✓			✓	✓	✓				✓

Short-term aggregate licence area	Sub-licences	H1a	H1b	H2a	H2b	H2c	H3a	H3b	H3c	H4a	H4b	H5a
	Central	✓	✓			✓	✓					✓
	East	✓	✓	✓		✓	✓	✓				✓
360		✓	✓	✓		✓	✓	✓		✓		✓
361/ 242	West	✓	✓			✓	✓				✓	✓
	East	✓	✓			✓	✓		✓			✓
328	West	✓				✓		✓			✓	✓
	West-Central	✓				✓		✓	✓			✓
	East-Central	✓	✓		✓	✓	✓	✓	✓	✓		✓
	East	✓	✓		✓	✓	✓					✓
296		✓				✓		✓		✓		✓
212		✓				✓		✓				✓

Table 5: hypotheses tested by area

3 OPERATIONAL SAMPLING METHODOLOGY

3.1 Method Statements

3.1.1 Licence-Specific Method Statements apply the pWSI to the specific palaeogeographic circumstances of each short-term licence area.

3.1.2 Each Licence-Specific Method Statement sets out:

- details of the Licence Area Data Sheet upon which the Licence-Specific Method Statement is based;
- overall tonnage of aggregate to be dredged within short-term licence period;
- overall tonnage of aggregate to be dredged from Unit 3b within short-term licence period;
- the hypotheses that are to be tested in the short-term licence area;
- the overall tonnage that it is proposed to dredge as a sample during the short-term licence period, in order to provide a) percentage of overall tonnage and b) percentage of Unit 3b;
- the number of Operational Sampling events and size of each sample that is proposed;
- the general location at which it is proposed to dredge each sample (e.g. dredging lane);
- the proposed timetable for carrying out Operational Sampling events over the short-term licence period, including provision to alert EH of the planned dates for each Operational Sampling event when they become known;
- arrangements for recording the position from which each Operational Sample is actually dredged;

- arrangements for ensuring, as far as possible, that the dredged aggregate comprises only aggregate dredged from the recorded position of each Operational Sample;
- the name of the wharf to which samples will be taken for processing;
- arrangements for liaising with the wharf and with archaeological contractors to ensure that each Operational Sample is processed promptly and in accordance with the pWSI;
- arrangements for recording the conduct of dredging for each Operational Sample, including the provision of position-fixing data and any commentary on the conduct of the dredging that may have affected the effectiveness of the Operational Sample;
- arrangements for transferring records of the conduct of dredging, including position-fixing data, to the archaeological contractors for incorporation in the Operational Report.

3.1.3 Wharf Method Statements apply the pWSI to the specific operational constraints of the wharf to which it applies.

3.1.4 Each Wharf Method Statement sets out:

- arrangements for ensuring, as far as possible, that the Operational Sample is kept separate from other aggregate until it is processed, and that only aggregate from the Operational Sample is processed;
- overall arrangements for processing the Operational Sample, including indicative timetable, the anticipated duration of each processing event, and provision to alert EH of the planned dates for each processing event when they become known;
- arrangements for ensuring the availability of a sufficient team of archaeologists with specific competence in prehistoric archaeology to carry out investigations in the course of processing each Operational Sample;
- dimensions of the principle fractions that are sorted by grids/tables, including: oversize, coarse fraction and fine fraction;
- proposed quantity of Operational Sample that is to be subject to archaeological examination (expressed, for example, as tonnage, proportion or time interval) for:
 - Coarse fraction;
 - Oversize;
 - Fine fraction;
- details of working arrangements to ensure that archaeologists are able to examine effectively the quantity of each fraction of the Operational Sample that has been proposed;

- details of the position(s) from which archaeologists will view the coarse fraction before it enters the crusher;
- details of the position(s) from which archaeologists will be able to remove possible artefacts from the coarse fraction before it enters the crusher, including details of how such removal will be achieved;
- arrangements for archaeologists to scan the oversize pile and recover any artefacts observed;
- arrangements for archaeologists to scan piles from the fine fraction and recover any artefacts observed;
- arrangements for periodic monitoring of archaeological investigations at the wharf by English Heritage, if required;
- arrangements for immediate recording, labelling, packing, storing and any first-aid conservation of archaeological material recovered in the course of the investigations;
- arrangements for preparing an illustrated Operational Report on the conduct and results of archaeological investigation in the course of processing each Operational Sample.

3.2 Operational Limitations

3.2.1 Two sets of constraints served to limit the application of the methodologies.

Frequency

3.2.2 The proposed numbers of sampling events were not achieved. This was due primarily to limitations on practical opportunities to undertake sampling caused by factors such as weather, equipment breakdowns and customer/market demands.

Spatial Distribution

3.2.3 For production management purposes, production operations tended to focus on the same areas of seabed. Of the 152.89 km² of seabed licenced in the region at the end of 2013 108.11 km² is considered active dredge area (where extraction can actually occur). Of that area, only 28.18 km² was actually dredged during the year. Year-on-year, the resource management employed (which seeks to minimise the area of seabed dredged) means that only a very small area of 'new' seabed will be dredged – only 0.3 km² in 2012.

3.2.4 While some experimental or trial areas were dredged solely for the purposes of Operational Sampling, the resource management strategy does mean that some of the wider distribution of sampling suggested here will only be possible once production shifts to new working zones in other parts of the licence area.

4 OPERATIONAL SAMPLING RESULTS

4.1 Overview

4.1.1 To date, 21 Operational Sampling events have been carried out, as in **Table 6** and **Figure 1**. Material recovered during the operational sampling has added to the known archaeology (**WA 2228 – 2253** and **2258 – 2260**) within the East

Coast aggregate block (**Figure 2** and **Appendix II**). Fourteen lithics and numerous faunal remains have been recovered.

Licence Area	Operator/ Wharf	No. samples	Palaeolithic lithics		Lithics (others)	Faunal remains
			Middle	Early		
212	Hanson/ Frindsbury	2	2 Levallois flakes	-	-	1 mammoth tooth
228	Volker/ Cliffe	3	-	2 flakes	-	1 red deer antler
240	Hanson/ Frindsbury	4	-	2 flakes	-	1 bovid bone
			1 Levallois point	-	1 blade core	1 large mammal bone; 1 red deer antler; 1 mammoth-sized bone; 1 mammoth tooth
			1 Levallois flake	-	-	1 mammoth tooth
			1 axe flake	-	-	
242-361	Hanson/ Frindsbury	1	-		-	1 mammoth tooth; 5 large mammal bone fragments
251	Cemex/ Northfleet	3		1 ?scrapers	-	1 large mammal pelvis fragment
296	Lafarge Tarmac/ Ridham	4	-		-	1 red deer antler
			-		-	1 aurochs tooth; 1 large mammal bone fragment
			-		-	-
			-		-	-
319	Cemex/ Northfleet	2		1 flake	1 flake; 1 misc. retouch	1 mammoth tooth; 1 red deer
			-		-	1 large mammal bone fragments; 1 red deer antler
328	Hanson/ Frindsbury	1	-		-	-
360	Cemex/ Northfleet	1	-		-	9 antler; 3 ?mammoth; 5 large mammal bone fragments

Table 6: summary of Operational Sampling events and finds by licence area

4.2 Short-term licence areas

4.2.1 The results of the operational sampling in relation to each short-term licence area are presented below. Updated short-term licence datasheets are illustrated in **Figures 3 – 11** along with photographs of the recovered material (**Plates 1 – 19**).

Area 240

4.2.2 Four operational sampling events were undertaken in Area 240 in May 2012, April and July 2013 and January 2014 (**Figure 3**). The operational sampling trackplots are situated in the southwest of the Area. The trackplots partially cover,

and lie to the west and east of, seabed previously monitored for archaeology (Wessex Archaeology 2011a).

- 4.2.3 The operational sampling primarily targeted Unit 3b with small areas of Unit 2 and 5 also targeted. Based on previous work carried out in the vicinity (Wessex Archaeology 2011a, 2013a) the potential for further artefacts was considered to be high.
- 4.2.4 During the three operational samples 11500 tonnes of aggregate was processed. Six lithics were recovered.
- 4.2.5 **WA 2229 (Plate 2)** is a relatively undiagnostic flake with evidence of recent damage. The condition of this piece suggests that it is not from an undisturbed context. Staining indicates reworking in a gravel context, and damage to the ends particularly indicates later disturbance.
- 4.2.6 **WA 2230 (Plate 2)** is a thick secondary flake with abrupt retouch and crushing (from use rather than subsequent damage) along the right margin. It originates from core preparation or maintenance. It is markedly less stained and damaged than **WA 2229**. The condition indicates that **WA 2230** is not from an undisturbed context, but is unlikely to have undergone much disturbance.
- 4.2.7 **WA 2243** is a large Levallois point (**Plate 3**). Although it has suffered some damage (most probably during dredging and subsequent processing) the piece is very fresh, with unabraded ridges, indicating that it had not suffered any significant post-depositional effects, and was probably *in situ*.
- 4.2.8 **WA 2246** is a large tertiary flake of Levallois type (**Plate 5**). Although it has suffered some damage (most probably during dredging and subsequent processing) the piece is very fresh, with unabraded ridges, indicating that it had not suffered any significant post-depositional effects prior to dredging, and was probably *in situ*.
- 4.2.9 **WA 2252** is a relatively fresh tertiary flake (**Plate 7**), probably removed from a handaxe.
- 4.2.10 **WA 2243** and **2246** exhibit Levallois technology and are attributed to the Early Middle Palaeolithic (230,000 – 180,000 BP). **WA 2252** is probably of a similar date. **WA 2229** and **2230** are Palaeolithic and all these lithics, in type and condition are consistent with other lithics previously recovered in Area 240 thought to be associated with Unit 3b.
- 4.2.11 **WA 2244** is a large bipolar blade core (**Plate 3**). This piece is in poor condition, with much abrasion of ridges and a 'greasy' glossed surface. There are also many incipient cones of percussion on the unworked back, and damage to the platforms (ends). The damage to the platforms and consequent loss of technical detail precludes the precise identification of the piece's age, but its size, type, and the suggestions of faceting to the less damaged platform suggest very strongly that it is Upper Palaeolithic, and perhaps Creswellian (13,000 – 11,500 BP).
- 4.2.12 Although, abraded and in poor condition **WA 2244** is significant in that it is the first lithic of diagnostic Upper Palaeolithic age to have been recovered from the now-submerged Palaeo-Yare catchment. Based on the condition the lithic has not been recovered from an undisturbed context and it is possible that the lithic is

associated with the Channel B, situated to the west of Area 240. No sediments dating to this period of the Upper Palaeolithic have been identified. It is possible that the flint has been reworked from a landsurface dating to the Late Pleistocene into the younger Channel B deposits during the cut and infill of the channel. The initial development of Channel B is known to pre-date the infill sediments radiocarbon dated to 10,400 BP (10,710 –10,280 cal. BC, SUERC-11987). It is possible that the channel was cut earlier than originally surmised during the Late Pleistocene. In addition to the lithics numerous fragments of faunal remains were recovered (**WA 2231, 2245, and 2247**) including mammoth teeth, fragments of cattle and red deer bones and a fragment of red deer antler (**Plate 1, 4 and 6**).

Area 319

- 4.2.13 Two operational sampling events were undertaken in Area 319 during February and July 2013 (**Figure 4**) and approximately 8000 tonnes of aggregate was processed. The operational sampling targeted Unit 3b sediments which are situated within the Early Holocene channel (Channel B) and as such are potentially re-worked.
- 4.2.14 Three lithics were recovered (**Plate 8**). **WA 2232** is an iron-stained tertiary flake struck with a hard hammer, which may derive from biface manufacture or trimming, and which is almost certainly Lower Palaeolithic. **WA 2233** is a hard-hammer struck tertiary flake with considerable surface gloss (but no iron staining). This piece appears to have been struck from a flake core, and is probably (but not certainly) Holocene. **WA 2234** is a thermal flake with direct semi-abrupt concave retouch on one end. The piece is in much fresher condition than the others, and is undoubtedly Holocene. The (possibly) Holocene pieces may be *in situ*, while the Palaeolithic piece is likely to be from a derived context, probably due to the cutting-into of Unit 3b by Channel B.
- 4.2.15 The presence of Lower Palaeolithic (**WA 2232**) material within the area is consistent with the post-Anglian development of the Palaeo-Yare floodplain. The recovery from within the limits of Channel B indicates that either the flint has been recovered from Unit 3b sediments below the Channel B cut, that some of the fill within the base of Channel B is reworked older sediments (Unit 3b) or that the flint has been reworked into younger Holocene sediments within the channel. The mapped limits of Channel B are primarily based on the under-filled extents; the base of the channel is not clearly observed on the geophysical data in Area 319 due to the sediment type and degree of past dredging within the area.
- 4.2.16 Potential *in situ* Holocene lithic material are likely to have been recovered from the Early Holocene Unit 7 deposits associated with the infill of Channel B. Unit 7 deposits have not been mapped with Channel B in Area 319, however, this does not mean that such sediments are not present. Unit 7 was mapped in Area 240 based on the seismic signature caused by peat within the unit. The coarser grained sands and gravels of Unit 7 are not discernible from Unit 3b sediments in the geophysical data due to their similarity. However, the presence of the material indicates the presence of Early Holocene fill.
- 4.2.17 In addition to the lithics numerous fragments of faunal remains were recovered (**WA 2235, 2236, 2241 and 2242**) including mammoth tooth, fragments of unidentified mammal and red deer bones and a fragment of red deer antler (**Plate 9 and 10**).

Area 251

- 4.2.18 Three operational sampling events were undertaken in the central sub-licence of Area 251 in March and December 2013 and April 2014 (**Figure 5**) and approximately 13500 tonnes of material was processed. The sampling targeted Unit 3b floodplain sediments.
- 4.2.19 A single lithic was recovered (**Plate 11**). **WA 2237** is a large scraper made on a secondary flake. The piece is not a chronologically-secure type, but could be Lower Palaeolithic. The condition (some surface gloss on the ventral surface; abraded cortex on the dorsal surface; the absence of iron staining; the relatively unabraded state of the margins and ridges) indicates that this piece has not undergone any substantial post-depositional effects, and was probably *in situ*.
- 4.2.20 The recovery of possible *in situ* scraper from targeted Unit 3b sediments is consistent with assumptions made based on the initial material recovered from Area 240 (WA 2013a).
- 4.2.21 Other lithics retrieved during processing which were felt to be of possible archaeological potential were demonstrated on subsequent analysis to result from either natural (thermal) or mechanical processes, most probably percussion during dredging.
- 4.2.22 One fragment of pelvic bone from a cow or deer was recovered.

Area 360

- 4.2.23 Operational sampling was undertaken in Area 360 during April 2013 (**Figure 6**). Approximately 6000 tonnes were processed and comprised well-sorted sand with a 15% gravel content.
- 4.2.24 Numerous faunal remains were recovered (**WA 2240**) and included antler, part of the distal humerus of an unidentified very large mammal, along with other unidentified mammalian bones (including a rib and skull fragment) (**Plate 12**). Many of these were very highly abraded (lacking any surface) and/or mineralised, attesting to their considerable age. In addition, a single piece of post-medieval cattle distal tibia was recovered.
- 4.2.25 No lithics were recovered.
- 4.2.26 The operational sampling targeted sediments interpreted as Unit 3b floodplain deposits. However, the results of this operational sample suggest that Unit 3b is absent and that the underlying Unit 2 was targeted. This is indicated by the very sandy nature of the cargo, the high degree of sorting of what stone content there was, and the presence of mineralised animal bone.
- 4.2.27 In the west of Area 360 vibrocores acquired in 2009 indicated up to 2.5m sands and gravels interpreted as Unit 3b. However, this area has been dredged every year between 2009 and 2012 to low and medium intensity and the volume of removal is unknown. The vibrocores also indicate variability in the thickness of Unit 3b within a relatively small area. For example within the dredge lane under discussion vibrocores indicate less than 0.2m up to 2.5m thickness. The vibrocores also indicate variability within the unit with general gravel-size content of greater than 30% with minor sandy layers c. 10% gravel size. However, if Unit 3b had been targeted then a higher concentration of the large size fraction would be expected.

- 4.2.28 Based on the nature of the sediments, this deposit is considered likely to be Unit 2 and that this sampled section of Area 360 is not a location in which Palaeolithic material might be expected to occur. Also, confidence in the geophysical interpretation of Area 360 can be considered lower than other areas based on the visual monitoring of the dredge loads.

Area 242/361

- 4.2.29 Operational sampling was undertaken in the western short-term licence area within Area 242/361 (**Figure 7**). Based on the interpretation Unit 3b was targeted situated directly to the east of an area observed on the geophysical data as heavily dredged; EMS data indicates dredging to a to a medium cumulative intensity.
- 4.2.30 Approximately 3000 tonnes of aggregate was processed from a cargo of 4500 tonnes. The vast majority of this material (particularly in the 40-100mm fraction) is believed to be derived from Unit 2, based on the dredging tracks, the degree of past dredging and the characteristics of the material (both colour and silt content), which differs from typical gravelly Unit 3b sediment.
- 4.2.31 Since the acquisition of the geophysical data in 2010 this dredge lane has continued to be dredged in 2011 and 2012 and could account for some removal of Unit 3b.
- 4.2.32 A single mammoth tooth was recovered along with five fragments of large mammal bone (**Plate 13**). Many of these were abraded (lacking at least one surface) and/or mineralised, attesting to their considerable age. Similar mineralised and abraded faunal material recovered with the original 2007/2008 recovery (WA 2011) was considered likely to be associated with Unit 2.

Area 328

- 4.2.33 Operational sampling was undertaken during September 2013 in the easternmost area of the short-term licence Area 328/1 (**Figure 8**). The operational trackplots indicate that Unit 2 and Unit 3b sediments were targeted. Both of these units are overlain by Unit 8 recent marine sediments up to 2m thick which will also have been targeted. The Unit 3b areas represent outliers situated to the north of the floodplain.
- 4.2.34 Approximately 3,500 tonnes of aggregate was processed from a cargo of 4,500 tonnes. The vast majority of this material (particularly in the 40-100mm fraction) is believed to be derived from Unit 2, based on the dredging tracks, the degree of past dredging in the area and the characteristics of the material (both colour and silt content) which differ from Unit 3b. Some material of Unit 8, indicated by vibrocore in this area to comprise reworked clayey, gravelly sand may also have been sampled.
- 4.2.35 No archaeological material was recovered during this sampling event. Given the assumption that Unit 2 and 8 were targeted, archaeological material would not be expected.

Area 296

- 4.2.36 Four operational sampling events have taken place in the eastern sector of Area 296 during January, April, August and October 2013 (**Figure 9**). Approximately

440 tonnes of gravel >20mm was recovered from cargoes amounting to 12,800 tonnes.

- 4.2.37 Three fragments of faunal remains were recovered (**WA 2228, 2238 and 2239**) including a fragment of probable red deer antler (**Plate 14**), a fragment of unidentifiable large mammal and a single aurochs tooth (**Plate 15**).
- 4.2.38 Following the interpretation of data in Area 296 as part of the Palaeo-Yare Catchment Assessment (Wessex Archaeology 2013b), discussions with Dr Bellamy led to a re-interpretation of the sediment units within Area 296.
- 4.2.39 Area 296 comprises Unit 2 sediments overlain by a sheet-like deposit (**Figure 2 and Figure 9**). This unit varies in composition throughout the area but is generally composed of slightly shelly, slightly silty sand and gravel up to 3m thick. This unit has been interpreted as a reworked sediment unit possibly dating to the early transgression around 8000 BP. This deposit is overlain by a series of sandwaves and bedforms of recent marine sediments.
- 4.2.40 The operational sampling targeted the sheet-like deposit and overlying recent marine sediments (Unit 8). The lack of lithic material from this area was not unexpected.
- 4.2.41 Additionally, a single dump bolt, made of Muntz metal, an alloy of copper, zinc and iron also known as yellow metal (patented by Muntz in 1832) was recovered by the wharf's metal detector.

Area 212

- 4.2.42 Two operational sampling events were undertaken in September and November 2013 in the southern central zone of Area 212 (**Figure 10**). In September, approximately 3,500 tonnes of aggregate was processed from a cargo of 4,500 tonnes; in November the trial was abandoned due to operational difficulties.
- 4.2.43 Two flakes were recovered, both of which show signs of Levallois technique. This would place their age either approximately around the Early Middle Palaeolithic (before 180,000 BP), or in the Late Middle Palaeolithic (before 35,000 BP). Although the former date is more likely given the small number of Levallois flakes known within British contexts for the Late Middle Palaeolithic, two isolated examples are impossible to date accurately. **WA 2249 (Plate 16)** has a 'chapeaux de gendarme' butt, and shows considerable patina and signs of rolling. **WA 2250 (Plate 17)** appears considerably fresher and shows relatively little damage. It also has signs of convergent flaking technique.
- 4.2.44 Additionally a single mammoth tooth was recovered (**WA 2251, Plate 18**). This tooth is broken in two and does not appear to be complete. The condition of the broken surfaces suggests that the break occurred sometime prior to dredging.
- 4.2.45 The Area 212 short-term licence area generally comprises Unit 2 (Yarmouth Roads Formation, silty sand with occasional bands of clay and amorphous peat) overlain by Unit 8. Unit 8 is variable across the area and comprises up to 2.5m of shelly sand and gravel interpreted as modern reworked sediment unit.
- 4.2.46 In two vibrocores within the vicinity of the operational sampling trackplots a sediment unit of silty, very gravelly (25%) sand is recorded up to 1.7m thick, which is overlain by reworked marine sediment. Based on the core log

descriptions this sediment unit is possibly indicative of a remnant deposit of Unit 3b that may have once been more extensive but has since been reworked under marine conditions, with now only small patches remaining.

- 4.2.47 This unit indicated in the vibrocore logs is not observed extensively on the geophysical data and as such the extents cannot be mapped. However, the vibrocore data indicate that there may be remnant small patches of coarse sand and gravel unit which are possibly associated with the floodplain deposits of Unit 3b observed to the south. Although due to the distance from the floodplain and the potential extensive removal of this unit by past dredging any association is difficult to confirm, although could represent a tributary to the main floodplain which has since been eroded and reworked.
- 4.2.48 Given the location of the trackplots, the evidence from the vibrocore and the good condition of the Levallois flake, it is considered likely that the artefact has been recovered from the remnant gravelly sand lag deposit.
- 4.2.49 Interestingly, given the proximity between Area 212 and Area 296 (**Figure 2**) visual inspection of the operational sample cargoes indicates a distinct geological and geomorphological transition confirming geophysical and geotechnical interpretations.

Area 228

- 4.2.50 Three operational sampling events were undertaken in April, October and December 2014 (**Figure 11**). Approximately 13,800 tonnes of aggregate were processed.
- 4.2.51 Two flakes were recovered (**Plate 19**). One (**WA 2258**) is a large secondary flake from a relatively early stage in the reduction sequence. The piece is very rolled, patinated and worn, and there is some more recent damage. The ventral surface retains its original surface only in patches, but these bear regular ripple marks suggesting a deliberate rather than accidental removal. The second (**WA 2259**) is a tertiary flake with three flake scars on the dorsal surface, all struck from the same direction. This flake is again very rolled and patinated, but less so than the first. It appears to have been struck with a hard hammer.
- 4.2.52 Additionally a single piece of mineralised antler, probably from a red deer, was recovered (**WA 2260, Plate 19**).
- 4.2.53 The short-term licence area is situated to the west of Channel A within the floodplain of the Palaeo-Yare. It is a complex area geologically, particularly in the east near the limits of the channel. The area has also been dredged heavily which further complicates the interpretation. Throughout the area, Unit 3b overlies Unit 2 sediments which comprise clays and fine grained sands, although it is difficult to establish how much of Unit 3b remains.
- 4.2.54 Vibrocore data (2011) indicate the sediments throughout the majority of the area comprise grey and beige coloured sands and gravels with no molluscan inclusions. The gravels comprised flint with quartz, quartzite, basalt, limestone and sandstone. These are interpreted as Unit 3b sediments deposited in a glaciofluvial alluvial environment.

Hypotheses

4.2.55 **Table 7** provides an overview of the hypotheses tested on a licence area basis for each operational sampling event. The results are discussed on a regional scale in **Section 5.2**. For the areas of seabed tested by the operational sampling the table indicates whether each hypothesis was valid, not valid, neither confirmed or denied, or not tested.

Short-term licence area	Sub-area	H1a	H1b	H2a	H2b	H2c	H3a	H3b	H3c	H4a	H4b	H5a
240		Valid	Valid	Not tested	-	Neither	Neither	Not tested	-	Not tested	Valid	Valid
228		Not tested	Not tested	Valid	-	Valid	Not tested	Not tested	-	-	Possibly not valid	Valid
319		Valid	Not valid	-	-	Neither	Neither	Not valid	-	Not tested	-	Valid
251	West											
	Central	Valid	Valid	-	-	Neither	Neither	-	-	-	-	Valid
	East											
360		Valid	Not tested	Not tested	-	Not tested	Not tested	Not tested	-	Not tested	-	Valid
361/ 242	West	Valid	Not tested	-	-	Not tested	Not tested	-	Not tested	-	Not tested	Valid
	East											
328	West											
	West-Central											
	East-Central											
	East	Not tested	-	-	-	Not tested	-	-	-	-	-	Not valid
296		Valid	-	-	-	Neither	-	Not tested	-	Not valid	-	Valid
212		Valid	-	-	-	Not tested	-	Not tested	-	-	-	Valid

Table 7: hypotheses testing results from individual licence areas

5 DISCUSSION

5.1 Introduction

5.1.1 The most significant results of these trials have been the recovery of Levallois-type material from Areas 240 and 212 (three flakes and a point). These indicate a background level of hominin activity, albeit based on current findings, broadly comparable in date to that attested by some of the original lithic finds from Area 240. The condition of the material suggests that – although not strictly *in situ* – these artefacts have not undergone a significant degree of post-depositional disturbance.

5.1.2 Other Palaeolithic material is relatively scarce (up to six flakes and a possible scraper). None of the pieces is especially diagnostic, and could range in date

from perhaps 400ka. None of it is out of place in post-Anglian development of the Palaeo-Yare and deposits such as Unit 3b.

- 5.1.3 Later lithics (a Late Upper Palaeolithic blade core; one flake; one piece with miscellaneous retouch) appear to have been associated with Holocene channels cutting into the Palaeo-Yare floodplain deposits on the western side of the area (in Areas 240 and 319). These are significant in that these are the first artefacts of this ages recovered from a submerged context in this region.
- 5.1.4 The quantity of lithic material recovered is small: 14 pieces from somewhere in the region of 80,000 tonnes of aggregate (although this total includes a number of the cargoes for which there was no expectation of recovering material). In comparison, notwithstanding the different recovery methodologies, the initial 88 lithics in 2007/2008 were recovered from 55,000 tonnes, but from a gravel-rich licence area, where Unit 3b was prevalent.
- 5.1.5 Faunal remains were recovered across most of the region with the exception of Area 328. The faunal remains recovered were all fragmentary and abraded indicating that they derived from secondary context and cannot be directly associated with particular sediment units within the Palaeo-Yare, although it is possible that the highly abraded and mineralised bones are of a similar age to Unit 2. This is consistent with the majority of the faunal remains recovered previously within the Palaeo-Yare (Wessex Archaeology 2013a) and this region of the southern North Sea.

5.2 Hypotheses assessment

- 5.2.1 Twenty-one operational samples were undertaken during the short-term licence period, across the 15 short-term licence areas (and sub-areas) with higher concentrations in some areas compared to others. Where more than one operational event was undertaken in a single licence area, the trackplots are concentrated in particular areas.
- 5.2.2 One of the aims of the operational sampling was to test a number of hypotheses in order to advance the understanding of the distribution and significance of Palaeolithic material within the short-term licence areas of the East Coast Block of the Anglian Region.
- 5.2.3 Eight of the operational sampling events produced fourteen lithics and although the recovery of this material (or its absence, where none was found) has increased our understanding of the inhabitation of the area there is not enough information to comment on all of the hypotheses. The results of the hypotheses testing are discussed below, based on the whole of the short-term licence period operational sampling.

Inhabitation

- 5.2.4 The hypotheses on inhabitation are intended to assess if the Palaeo-Yare floodplain was inhabited and if the evidence of inhabitation dates only to the Wolstonian period.
- 5.2.5 H1a: *Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian* is valid in that no artefacts were categorically recovered from non-Unit 3b sediments. However, the recovery of lithics of an age younger than Unit 3b indicate a more complex situation than the hypothesis dictates, and suggests that

Unit 3b sediments in Area 319 are more reworked than the floodplain deposits due to the development of the later channel (Channel B).

- 5.2.6 The recovery of lithic artefacts of an Upper Palaeolithic (Area 240) and Holocene date (Area 319) indicate the potential for post-Early Middle Palaeolithic artefacts to be recovered from within and on the edges of Channel B (early Holocene) and invalidates the hypothesis that inhabitation only dates to the Wolstonian period.
- 5.2.7 H1b: *Palaeolithic material recovered from Unit 3b is predominantly in situ*. Based on the Palaeolithic material recovered to date the sample is not large enough to validate this statement. Two lithics are interpreted as near *in situ*, and two are probably *in situ*. Four lithics are rolled and abraded indicating a secondary context. This mix of contexts is comparable to the artefact assemblage recovered in Area 240. It is considered likely that throughout the region there is a mix of *in situ* and secondary context artefacts.

Choice and use of location

- 5.2.8 Hypotheses associated with choice and use of location were designed to assess whether a cultural element to the use of the landscape could be detected. These hypotheses were intended to test whether people inhabited the area represented by Unit 3b according to spatial preferences; and whether activity was focussed or dispersed.
- 5.2.9 H2a: *Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself* has not been tested as no operational sampling events were undertaken in Channel A (Late Anglian channel). Artefacts have been recovered from the floodplain deposits.
- 5.2.10 H2b: *Palaeolithic material is recovered only from Unit 3b deposits within the limits of the Palaeo-Yare floodplain, and not within the Unit 3b outliers to the north and south of the floodplain* has been tentatively disproved by the recovery of a single lithic from a potential (unmapped) remnant of Unit 3b deposit in Area 212. The sediments from within Area 212 are thought to be either an outlier or a possible remnant of a tributary system associated with the floodplain.
- 5.2.11 H2c: *The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations* has been neither proved nor disproved on a regional basis, although it is considered likely. There is no evidence of clusters of material other than the original recovery from Area 240. However, this is based on a small sample. Further operational sampling events would be required to assess this hypothesis.

Natural processes

- 5.2.12 H3a: *The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b* has been neither proved nor disproved, since the amount of recovered material was too small to provide a valid sample, and the detail of sediment structure was not always available from current data.
- 5.2.13 H3b: *Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past* has been tentatively disproved. A tertiary Lower Palaeolithic flake was recovered from Area 319 within the reworked early Holocene channel.

- 5.2.14 H3c: *Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures* has not been tested as no operational sampling event targeted these features.

Human process, including dredging history

- 5.2.15 Dredging activity has taken place within the East Coast region over the several decades. The aim of these hypotheses was to test whether evidence for previous dredging, identified through geophysical or EMS data, could be used to indicate an absence of Palaeolithic material.

- 5.2.16 H4a: *Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS* has neither been proved nor disproved. Only two operational sampling events (one in Area 296; one in Area 228) targeted areas classed as high cumulative intensity. However, the majority of the targeted area had only been dredged to medium intensity.

- 5.2.17 In addition to this, in Area 296 Palaeolithic material was not expected to be recovered based on the palaeogeographic interpretation, nor was any found. As such, this hypothesis has not been tested adequately at this stage.

- 5.2.18 H4b: *Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place* has been neither proved nor disproved. The operational samples in Area 240 predominantly targeted Unit 3b sediments but also covered some areas where Unit 3b is thought to have been dredged out. Although artefacts were recovered during these samples it is not possible to state whether the artefacts were from the dredged out areas or from Unit 3b.

Operational sampling methods

- 5.2.19 This hypothesis aimed to test whether the methodologies were effective at all wharves where they are deployed. To date, this has proved to be the case. The differing methodologies have not proven to significantly affect the outcomes of the operational sampling.
- 5.2.20 H5a: *Palaeolithic material is found at all wharves where operational sampling takes place* was proved in that at each wharf a methodology was developed, implemented and material (Palaeolithic or faunal remains) were recovered.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

- 6.1.1 Twenty-one operational sampling events have been carried out in eight out of the fifteen short-term licence areas (and sub-areas). Fourteen lithics and numerous faunal remains have been recovered from c. 80,000 tonnes of aggregate. The lithics consisted of Palaeolithic material from five licence areas, including probable *in situ* material in three licence areas. This is a small number of finds, but the results have furthered our understanding of the region and have allowed us to address some of the hypotheses.
- 6.1.2 Levallois-type material recovered from Areas 240 and 212 (three flakes and a point) indicate a background level of hominin activity, albeit at a low level based on the current volume of finds, broadly comparable in date to that attested by

some of the original lithic finds from Area 240. These artefacts have not undergone a significant degree of post-depositional disturbance.

- 6.1.3 Other recovered Palaeolithic material is not especially diagnostic, and could range in date from perhaps 400ka. This is consistent with the proposed post-Anglian development of the Palaeo-Yare and deposits and is also consistent with the handaxes previously recovered from Area 240 (WA 2013a).
- 6.1.4 Younger lithics (a Late Upper Palaeolithic blade core; one flake; one piece with miscellaneous retouch) associated with the early Holocene channel cutting into the Palaeo-Yare floodplain deposits indicate the potential for further artefacts associated with this channel, particularly associated with Area 240, Area 319 and Area 251. No artefacts of this age have previously been recovered in this region.
- 6.1.5 Based on the data gathered before and during the short-term licence period, it seems most likely that the original recovery of a large amount of lithic material from within a fairly tightly-defined part of Area 240 represents a 'hot-spot' of activity: what would be considered a site in terrestrial terms, perhaps (in the case of Lower Palaeolithic material) a knapping site or camp site. Although it is likely that other such sites exist associated with the now-submerged catchment of the Palaeo-Yare none have been encountered during operational sampling to date, with the recovered material instead representing a more normal background noise indicating a generalised and widespread hominin presence within the Palaeo-Yare catchment (the odd tool lost or broken during a hunting trip, for instance) but no concentrations that might equate with a site.
- 6.1.6 The number and type of faunal remains recovered were not unexpected and are comparable in type and condition to those previously recovered from the region.
- 6.1.7 Given the operational limitations and logistics discussed in Section 3.2, the subscribed methodology at each wharf has worked with material being recovered and reliable results obtained. Consistency of archaeological personnel has also increased the reliability of interpretation, particularly regarding the nature of the aggregate and whether it is probable Unit 3b or Unit 2.
- 6.1.8 One of the key factors at this stage is that there have not been as many sampling events acquired as planned in the method statements principally due to operational limitations. However, it is considered that a broader spatial distribution of sampling events is required in order to fully test the hypotheses.
- 6.1.9 Two hypotheses have not been tested (H2b and 3c), the remainder have been addressed but with certain reservations due to the small sample number.
- 6.1.10 Based on the findings to date the hypotheses have been revised for the long-term WSI, particularly to address the recovery of Upper Palaeolithic and younger artefacts and the use of past dredging activity to inform predictions of potential archaeology. However, more data is required and these issues will be dealt with as operational sampling continues.

6.2 Recommendations

- 6.2.1 Based on the results to date and the known archaeology in the region it is considered that further operational sampling is needed in Areas 240, 251 (all sub-areas) and 319. These areas have yielded artefacts and are likely to provide further information on the archaeology of the region. Additional sampling in these

areas should try, if possible, to target the seabed to give a better spatial distribution rather than dredge the same lanes, or set of lanes.

- 6.2.2 Area 212 was not expected to yield any artefacts, however it is clear that possible pockets of Unit 3b outliers remain and have some potential for further archaeological recovery. Further sampling is recommended.
- 6.2.3 In Area 296, the eastern area that has been sampled has resulted in no lithic artefacts, as was expected. If the operator continues to dredge this area it is recommended that no further sampling is required in this portion of the licence. However, a sample in the west of the area would be advantageous in order to confirm these results and establish the potential throughout the area.
- 6.2.4 The Area 360 cargo was very sandy and based on the nature of the cargo it was considered that the underlying Unit 2 was targeted and it is likely to be the case elsewhere in the short-term licence area, although small remnant pockets of Unit 3b may exist. Further sampling in this area is considered lower priority compared to other licence areas.
- 6.2.5 The Area 242/361 sampling operation indicated Unit 2 target based on the nature of the cargo it was considered that the underlying Unit 2 was targeted. Further sampling, particularly in the eastern area is recommended.
- 6.2.6 The Area 328 sampling indicated that Unit 2 was targeted and there was little evidence of the presence of the Unit 3b outliers. No further sampling in this easternmost area is advised. However, sampling in the other sub-areas of this short term licence area is currently outstanding.
- 6.2.7 Area 228 was not expected to yield any artefacts based on recent dredging history, however it seems that areas of Unit 3b sediment remain. Although these may have some potential for further archaeological recovery given the low density of material recovered, the intensity of historic dredging and the spread of sampling undertaken to date, further sampling is unlikely to add significantly to the body of information of the archaeology of the region.

6.3 Post-fieldwork Assessment

- 6.3.1 While the results of the operational sampling undertaken during the short-term licence period have been of undoubted significance and warrant further analysis and publication in a peer-reviewed journal, the quantity of material recovered to date has been slight. In consequence, any conclusions that could be drawn would be tentative, and would not further our knowledge of the hominin inhabitation of the region significantly.
- 6.3.2 The results of the sampling, and the significant investment which has been made in it, would be better served by publication at a later date, once a larger body of data has been gathered. This would not only include the possibility for recovering more artefacts, but would also allow for more consideration of the dating of sediments and modelling of the landscape, again based on a larger dataset than is currently available, should a programme of (for instance) vibrocoreing or Amino Acid Racemization be considered worthwhile.
- 6.3.3 At present, the results of the sampling undertaken during the short-term licence period could better be presented as a part of a paper detailing the

management of the off-shore resource as it has been developed and implemented over the course of this project.

6.4 References

Limpenny, S.E., Barrio-Froján, C., Cotterill, C, Foster-Smith, R.L., Pearce, B., Tizzard, L., Limpenny, D.L., Long, D., Walmsley, S., Kirby, S., Baker, K., Meadows, W.J., Rees, J., Hill, J., Wilson, C., Leivers, M., Churchley, S., Russell, J., Pacitto, S., and Law, R., 2011, 'The East Coast Regional Environmental Characterisation', Cefas Open report 08/04.

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APPENDIX I: PWSI

Provisional Written Scheme of Investigations for the Anglian Region

Draft
ver. 070912

1. INTRODUCTION

This archaeological Written Scheme of Investigations (WSI) has been prepared with the assistance of the British Marine Aggregate Producers Association (BMAPA) on behalf of four aggregate companies: CEMEX UK Marine; Hanson Aggregates Marine; Tarmac Marine Dredging; and Volker Dredging. These companies are engaged in dredging in licence areas that make up the Norfolk Block of the Anglian Region.

The WSI is provisional (pWSI) because it is intended to accompany a series of short-term (15-27 month) Marine Licences starting in October 2012. The short-term licences will be superseded by full-term (15 year) Marine Licences from [December 2013-April 2014]. It is the intention that experience and results gained from the operation of the pWSI will inform a WSI to accompany the full-term Marine Licences.

The Norfolk Block of licence areas in the Anglian Region coincide with an extensive deposit of sand and gravel from which archaeological material of national and probably international significance has been recovered¹. The archaeological material includes flint handaxes and other humanly-worked flint from the Palaeolithic, accompanied by animal bones and other indicators of the contemporary environment. The deposit with which the archaeological material is associated – referred to as ‘Unit 3b’ – appears to date from the Wolstonian glacial period approximately two to three hundred thousand years ago. The archaeological material appears to have moved very little from the place where it was originally discarded by our Neanderthal predecessors, i.e. it seems to be ‘in situ’. This characteristic, together with the presence of material such as animal bones and an increasingly-secure palaeo-environmental context, in relatively large quantities and in a region from which very little equivalent material has been recovered previously, all add to the significance of both the archaeological material and the deposits with which it is associated.

Although the importance of the archaeological material and the deposits is acknowledged, there is still a great deal of uncertainty about their distribution. Key uncertainties have been framed in the Palaeo-Yare Catchment Assessment in terms of a series of hypotheses, which are set out below.

This pWSI has been prepared in order to record and advance understanding of the significance of Palaeolithic material within the short-term licence areas of the Norfolk Block of the Anglian Region. As indicated above, the pWSI is also intended to inform a WSI that will accompany full-term licences in the same block.

Unlike WSIs prepared for other schemes, this pWSI is not specific to a single licence area or aggregate company. It has been recognised that questions about the distribution of Palaeolithic material cut across different licence areas operated by different companies, hence there is combined interest in adopting a common approach both in terms of developing effective archaeological methodologies and pooling results. This collaboration

¹ Wessex Archaeology, September 2012, Palaeo-Yare Catchment Assessment: Technical Report. Ref: 83740.02.

reflects also the joint approach to conducting the Marine Aggregates Regional Environmental Assessment (MAREA) for the Anglian Region and the recent Palaeo-Yare Catchment Assessment.

The core element of the common approach is 'Operational Sampling'. Aggregate companies will periodically dredge a large sample of sand and gravel from known locations within each short-term licence area. The sample will, as far as is practicable, be kept separate from other sand and gravel until and during processing. Processing will be subject to investigations by archaeologists with specific competence in prehistoric archaeology. Archaeological investigations will include observation of aggregate as it is being processed in order to spot Palaeolithic artefacts, together with the opportunity to safely remove artefacts that are spotted. Observation will focus on processing of the coarse fraction (typically 40mm-100mm), though provision will also be made to examine oversize material (typically over 100mm) and material from the fine fraction (typically less than 40mm).

This pWSI sets out the common approach including aim, objectives, methodological principles and mechanisms for combining and integrating both the methodological and archaeological results in order to inform the WSI for the full-term licences. In order to enable the pWSI to be applied in practice, the pWSI is accompanied by three sets of documents:

- Licence Area Data Sheets, which set out the specific palaeo-geographic circumstances of each short-term licence area;
- Licence-Specific Method Statements, which set out how the pWSI will be implemented on the basis of the specific palaeo-geographic circumstances of the licence area;
- Wharf Method Statements, which set out how archaeological investigations will be carried out at specific wharves, taking into account the operational constraints of the wharf to which it applies.

This pWSI covers the nine short-term licence areas in the Norfolk Block of the Anglian Region. Consequently, this pWSI is accompanied by nine Licence Area Data Sheets and nine Licence-Specific Method Statements. Each of the four companies is likely to focus its processing of Operational Samples on one wharf each, hence the pWSI is accompanied by four Wharf Method Statements.

The methods and results of each episode of Operational Sampling, including the archaeological investigations that accompany it, will be set out in an Operational Report. The Operational Results will be integrated and reviewed alongside previous work (including the Palaeo-Yare Catchment Assessment) to inform the WSI that will accompany the full-term licences.

This pWSI is concerned with Palaeolithic material. It is not intended to address, and does not cover, prehistoric material of later date that might be present in the Norfolk Block. Nor does it address or cover archaeological material of maritime or aviation interest. It is anticipated that mitigation for later prehistoric material, maritime and aviation remains will be addressed by licence-specific arrangements, including implementation of the Marine Aggregate Industry Protocol for Reporting Finds of Archaeological Interest (MAI Protocol).

2. LEGAL FRAMEWORK

This pWSI is invoked by the following condition, which is attached to the Marine Licence for each of the nine short term licence areas:

The licence holder must participate in the production and implementation of a provisional Written Scheme of Investigation (pWSI) for the Anglian region, to be prepared by an appointed archaeological consultant and in agreement with English Heritage. The pWSI will address the archaeological sampling methodologies and schedules to be employed over the course of a number of licences in the Anglian region. The pWSI will include a series of site specific Method Statements to apply these principles to individual licence areas. The agreed pWSI and licence specific Method Statement are to be supplied to English Heritage and MMO at least 21 days before the start of any proposed licence specific investigations.

For each short-term Marine Licence, this pWSI, the relevant Licence-Specific Method Statement and Licence Area Data Sheet, and the relevant Wharf Method Statement jointly make up the documentation that is to be implemented in order to satisfy this condition.

3. ARCHAEOLOGICAL BACKGROUND

Following the initial report of handaxes and other material from Area 240 in 2008, a series of investigations has been carried out, which are summarised in the Palaeo-Yare Catchment Assessment. The results of these investigations, and of the Assessment, have led to the following conclusions:

- The Middle Palaeolithic Assemblage is mixed, i.e. contains artefacts of in situ and secondary context.
- The Middle Palaeolithic Assemblage is primarily associated with Unit 3b within Area 240.
- There is potential for Palaeolithic material in secondary context associated with Units 2, 3b, 4, 7, 8 and the bank structures (of unknown age).
- Natural processes throughout transgressions and regressions subsequent to deposition have not completely removed sediment units. With regards to the in situ elements of the Middle Palaeolithic assemblage, remnants of in situ Unit 3b, sediments are present within the region.
- Extensive dredging of the region has not necessarily completely removed Unit 3b sediments within the area.
- There is potential for in situ archaeological material to be present elsewhere within the region where remnants of Unit 3b are located.
- Faunal remains and palaeoenvironmental material are likely to be sourced from Units 2, 3b, 4 and 7. These could be in situ or secondary context and may be located throughout the region.
- Uncertainties remain due to the data limitations used for the assessment and the degree of dredging undertaken since the geophysics data were acquired.

4. AIM AND OBJECTIVES OF THIS PWSI

The aim of the pWSI is to set out the archaeological sampling methodologies and schedules to be employed with respect to Palaeolithic material over the course of short-term Marine Licences in the Anglian region.

The objectives of archaeological sampling are as follows

- To provide a record of Palaeolithic material recovered in the course of dredging under the short-term licences.

- To advance understanding of the distribution and significance of Palaeolithic material within the short-term licence areas of the Norfolk Block of the Anglian Region, with reference to a series of hypotheses.
- To inform a WSI that will accompany full-term licences in the Norfolk Block of the Anglian Region.

The principal outputs arising from the implementation of this pWSI will be a series of Operational Reports on the results of processing Operational Samples dredged from each Licence Area, and a single integrated Interpretive Report that collates and reviews the results of all Operational Sampling conducted in the course of the short-term Marine Licences.

5. ROLES AND RESPONSIBILITIES

For the purposes of this pWSI, the following roles have the meaning set out below:

Company	CEMEX UK Marine; Hanson Aggregates Marine; Tarmac Marine Dredging; Volker Dredging.
Regulator	Marine Management Organisation
Curator (Regulator's Advisor)	English Heritage
BMAPA	British Marine Aggregate Producers Association
Archaeological Contractor(s)	Archaeological organisations appointed by each Company to carry out activities to implement this pWSI on behalf of the Company
Archaeological Consultant(s)	Archaeological organisations appointed by the Companies and/or BMAPA to prepare the pWSI and provide consultancy services where required.

Companies

Each Company is responsible for implementing the archaeological condition on each short-term marine licence.

Each Company will ensure that relevant staff are aware of the condition and of this pWSI and of the requirements and responsibilities it places on the Company and its staff.

Each Company will afford access to the Curator for the purposes of monitoring this pWSI, subject to the requirements of health, safety, welfare and environmental protection.

Each Company will agree with English Heritage a Licence-Specific Method Statement for each of its short-term licence area, and a Wharf Method Statement for each wharf where processing is to take place.

Each Company will copy the agreed Method Statements to the MMO 21 days before licence specific investigations commence.

Each Company will ensure that each Operational Report is submitted to English Heritage and copied to MMO.

Each Company will contract one or more suitably competent and experienced Archaeological Contractor(s) to carry out archaeological activities.

Regulator

The MMO will acknowledge receipt of agreed Method Statements, and of Operational Reports.

Curator

English Heritage will carry out its activities in respect of this pWSI in accordance with the Codes, Standards and Guidance of the Institute for Archaeologists.

English Heritage will acknowledge receipt of documentation, including Method Statements and Operational Reports.

BMAPA

BMAPA has no formal role in the archaeological condition on the short-term Marine Licences, or in this pWSI. However, BMAPA will continue to support the implementation of this pWSI and the condition, and to facilitate such correspondence and meetings as may be considered necessary.

Archaeological Contractor(s)

Archaeological Contractors will carry out their activities in respect of this pWSI in accordance with the Codes, Standards and Guidance of the Institute for Archaeologists.

Archaeological Contractors will adhere to this pWSI and agreed Method Statements.

Archaeological Contractors will promptly bring to the attention of the Company any circumstance that may impede the effective implementation of this pWSI and/or satisfaction of the relevant archaeological condition.

Archaeological Contractors will facilitate monitoring by the Curator of activities in respect of this pWSI where access for such monitoring has been agreed with the relevant Company.

Archaeological Consultant(s)

Archaeological Consultants will carry out their activities in accordance with the Codes, Standards and Guidance of the Institute for Archaeologists.

Archaeological Consultants will promptly bring to the attention of the Company any circumstance that may impede the effective implementation of this pWSI and/or satisfaction of the relevant archaeological condition.

6. COMMUNICATION

All communication about the implementation of this pWSI will, in the first instance, be between the Company and English Heritage, copied to the MMO. Notwithstanding, agreement may be made for communication to be co-ordinated through e.g. BMAPA in respect of overall approach, or Archaeological Contractors in respect of details of Operational Sampling.

Documentation will be submitted by email. The date of submission will be regarded as the date of receipt. Where documentation is submitted after 5pm on Friday, the date of receipt will be the following Monday.

Unless other arrangements have previously been agreed:

- Licence-Specific Method Statements are to be submitted by each Company to English Heritage for agreement.
- Any comments on documentation by English Heritage will be submitted to the Company within 10 working days of receipt.
- Where no comments are received from English Heritage within 10 working days of receipt, Method Statements will be regarded as having been agreed.
- Method Statements (and associated pWSI) must be agreed at least 21 days in advance of the first Operational Sampling event, with the agreed documentation provided to English Heritage and MMO.

Unless other arrangements have previously been agreed, each Company will ensure that English Heritage is informed of each Operational Sampling event (dredging and processing) at least two weeks in advanced of the planned date for such Operational Sampling to commence.

Meetings may be convened between the Companies, individually or collectively, and English Heritage to discuss implementation of the pWSI and satisfaction of archaeological conditions. Such meetings may be attended by BMAPA, Archaeological Contractors and Archaeological Consultants as required, plus such other parties as may be agreed.

7. MONITORING

The principal means of monitoring the implementation of this pWSI will be the Operational Reports submitted by Companies to English Heritage following completion of each episode of Operational Sampling.

English Heritage may also monitor this pWSI by way of monitoring visits to Operational Sampling activities at wharves. Such monitoring visits will be agreed in advance with the relevant Company and will be subject to the requirements of health, safety, welfare and environmental protection. Where such monitoring visits have been agreed, the monitoring will be facilitated by the relevant Archaeological Contractor.

Any concerns about implementation of this pWSI will be raised promptly by English Heritage or the relevant Company. Both the Company and English Heritage will work jointly to resolve the concerns that have been raised as swiftly as possible.

8. REVISIONS TO THIS PWSI AND ASSOCIATED DOCUMENTATION

This pWSI may be revised only with the agreement of all of the Companies and of English Heritage. The revised pWSI will be copied to the MMO by the Companies.

Any revisions to the pWSI must be consistent with the requirements of the archaeological conditions that apply to short-term Marine Licences.

Individual Method Statements may be revised with the agreement of the relevant Company and English Heritage. Revised Method Statements will be copied to the MMO by the relevant Company.

Revisions to Method Statements must be consistent with the pWSI.

9. STANDARDS AND METHODS

All archaeological activities will be undertaken in accordance with the Codes, Standards and Guidance of the Institute for Archaeologists (<http://www.archaeologists.net/codes/ifa>).

Archaeologists engaged in Operational Sampling activities at wharves must have specific competence in prehistoric archaeology, including substantive experience of identifying Palaeolithic material.

Methodologies for archaeological activities will accord with the Model Clauses for Written Schemes of Investigation for Offshore Renewables Projects (http://www.dur.ac.uk/eh.rsa/pdf/WSI%20model%20clauses%20archaeology%20Renewables_low%20res.pdf), notably sections on:

- Archaeological Recording, Reporting, Data Management and Archiving.
- Archaeological Samples and Artefacts.

10. HYPOTHESES

As part of the Palaeo-Yare Catchment Assessment, a set of hypotheses have been developed that can be applied to the licence areas within the region in order to test the conclusions of the study and enable the overall understanding of the presence, significance and management of early prehistoric material to be refined.

These hypothesis, which are grouped under five headings, provide the framework for this pWSI and are repeated below:

Inhabitation

H1a: Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.

H1b: Palaeolithic material recovered from Unit 3b is predominantly in situ.

These hypotheses are intended to test if people were inhabiting the floodplain (i.e. material is in situ and associated with Unit 3b); and if the evidence of inhabitation dates only to the Wolstonian.

Choice and Use of Location

H2a: Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself.

H2b: Palaeolithic material is recovered only from Unit 3b deposits within the limits of the Palaeo-Yare floodplain, not within the Unit 3b outliers to the north and south of the floodplain.

H2c: The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.

These hypotheses are intended to test whether people inhabited the area represented by Unit 3b according to spatial preferences; and whether activity was focussed or dispersed.

Natural Processes

H3a: The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.

H3b: Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.

These hypotheses are intended to test whether taphonomic processes affect the distribution of Palaeolithic material, where such processes are indicated by changes in the sand/gravel composition of Unit 3b.

H3c: Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures.

This hypothesis is intended to test whether Palaeolithic material is protected from dredging impacts where it is 'overburden' making up major bank features that is being targeted.

Human Processes, including Dredging History

H4a: Palaeolithic material is not present where dredging history indicates that high level of dredging has taken place since the introduction of EMS.

H4b: Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place.

These hypotheses are intended to test whether evidence of previous dredging – from either EMS or geophysical data – can be used to indicate an absence of Palaeolithic material.

Operational Sampling Methods

H5a: Palaeolithic material is found at all wharves where Operational Sampling takes place.

This hypothesis is intended to test whether the methodology is effective at all the wharves where it is deployed.

11. LICENCE AREA DATA SHEETS

Licence Area Data Sheets are derived from the Palaeo-Yare Catchment Assessment, and have been submitted collectively as the Palaeo-Yare Catchment Assessment: Addendum Report (Wessex Archaeology 2012, WA ref: 83740.03).

Each Licence Area Data Sheet shows the extent of the short-term licence area relative to the results of the palaeogeographic interpretation achieved through the Palaeo-Yare Catchment Assessment. The extent of Unit 3b is shown, together with other relevant features such as the extent of Channel A and major bank features that appear to be covering Unit 3b. The location of boreholes interpreted as part of the Palaeo-Yare Catchment Assessment and previous archaeological discoveries are also shown. Evidence of previous dredging, derived from EMS and / or geophysical data are included.

The Licence Area Data Sheets summarise the specific factual data available for each short-term licence area, and provide the basis upon which the hypotheses relevant to the licence area and the locations for Operational Sampling are selected.

12. LICENCE-SPECIFIC METHOD STATEMENTS

Licence-Specific Method Statements are intended to apply this pWSI to the specific palaeogeographic circumstances of each short-term licence area.

Each Licence-Specific Method Statement will set out:

- Document details of the Licence Area Data Sheet upon which the Licence-Specific Method Statement is based. The Licence Area Data Sheet should be appended to the Method Statement.
- Overall tonnage of aggregate to be dredged within short-term licence period.
- Overall tonnage of aggregate to be dredged from Unit 3b within short-term licence period.
- The hypotheses that are to be tested in the short-term licence area.
- The overall tonnage that it is proposed to dredge as a sample during the short-term licence period, in order to provide a) percentage of overall tonnage and b) percentage of Unit 3b.
- The number of Operational Sampling events and size of each sample that is proposed.
- The general location that at which it is proposed to dredge each sample (e.g. dredging lane).
- The proposed timetable for carrying out Operational Sampling events over the short-term licence period, including provision to alert EH of the planned dates for each Operational Sampling event when they become known.
- Arrangements for recording the position from which each Operational Sample is actually dredged.
- Arrangements for ensuring, as far as possible, that the dredged aggregate comprises only aggregate dredged from the recorded position of each Operational Sample.
- The name of the wharf to which samples will be taken for processing.
- Arrangements for liaising with the wharf and with archaeological contractors to ensure that each Operational Sample is processed promptly and in accordance with this pWSI.
- Arrangements for recording the conduct of dredging for each Operational Sample, including the provision of position-fixing data and any commentary on the conduct of the dredging that may have affected the effectiveness of the Operational Sample.
- Arrangements for transferring records of the conduct of dredging, including position-fixing data, to the archaeological contractors for incorporation in the Operational Report.

13. WHARF METHOD STATEMENTS

Wharf Method Statements are intended to apply this pWSI to the specific operational constraints of the wharf to which it applies

Each Wharf Method Statement will set out:

- Arrangements for ensuring, as far as possible, that the Operational Sample is kept separate from other aggregate until it is processed, and that only aggregate from the Operational Sample is processed.
- Overall arrangements for processing the Operational Sample, including indicative timetable, the anticipated duration of each processing event, and provision to alert EH of the planned dates for each processing event when they become known.

- Arrangements for ensuring the availability of a sufficient team of archaeologists with specific competence in prehistoric archaeology to carry out investigations in the course of processing each Operational Sample.
- Dimensions of the principle fractions that are sorted by grids/tables, including: oversize, coarse fraction and fine fraction.
- Proposed quantity of Operational Sample that is to be subject to archaeological examination (expressed, for example, as tonnage, proportion or time interval) for:
 - Coarse fraction
 - Oversize
 - Fine fraction
- Details of working arrangements to ensure that archaeologists are able to examine effectively the quantity of each fraction of the Operational Sample that has been proposed
- Details of the position(s) from which archaeologists will view the coarse fraction before it enters the crusher.
- Details of the position(s) from which archaeologists will be able to remove possible artefacts from the coarse fraction before it enters the crusher, including details of how such removal will be achieved.
- Arrangements for archaeologists to scan the oversize pile and recover any artefacts observed.
- Arrangements for archaeologists to scan piles from the fine fraction and recover any artefacts observed.
- Arrangements for periodic monitoring of archaeological investigations at the wharf by English Heritage, if required.
- Arrangements for immediate recording, labelling, packing, storing and any first-aid conservation of archaeological material recovered in the course of the investigations.
- Arrangements for preparing an illustrated Operational Report on the conduct and results of archaeological investigation in the course of processing each Operational Sample.

14. OPERATIONAL REPORTS

An Operational Report will be prepared for each episode of Operational Sampling.

The Operational Report will report on both the dredging and processing elements of each episode of Operational Sampling.

Each Operational Report will satisfy the Licence-Specific and Wharf Method Statements relevant to the episode of Operational Sampling. The report will present an account of methods, results and conclusions in sufficient detail to allow archaeological activities to be understood without recourse to the project archive.

Operational Reports will incorporate details of the dredging carried out to obtain the Operational Sample, including position-fixing, as provided by the Company to the Archaeological Contractor.

Operational Reports will set out details of the examination and scanning of the coarse, oversize and fine fractions, including timing and duration, and estimates as to the proportion and / or tonnage of Operational Sample that was observed.

Operational Reports will include a commentary on any aspect of dredging, processing and / or archaeological investigations that may have affected the effectiveness of the Operational Sample.

Operational Reports will be illustrated, to include a plan showing the location from which the Operational Sample was dredged relative to the Licence Area, photographs illustrating the conduct of archaeological activities at the wharf, and photographs of Palaeolithic material (and any other material of archaeological interest) recovered during Operational Sampling.

Operational Reports will be submitted to English Heritage by (or on behalf of) the Company, and copied to the MMO. Receipt will be acknowledged by English Heritage and the MMO respectively.

Reports submitted to English Heritage will not be 'Draft' and there is no expectation that EH will return comments. However, English Heritage may comment on Operational Reports and in the event that substantive changes are made as a consequence, then the Operational Report will be re-issued, submitted to English Heritage and copied to the MMO.

15. RESULTS: PREPARATION OF INTERPRETATIVE REPORT

In order to meet the aim and objectives of this pWSI, the results from Operational Sampling are to be combined, integrated and reviewed across all of the short-term licence areas. The combined results will be reviewed in conjunction with the Palaeo-Yare Catchment Assessment and presented as an illustrated Interpretative Report.

The Interpretative Report will be prepared by an Archaeological Contractor appointed by the Companies and/or BMAPA. The Archaeological Contractor must have specific competence in prehistoric archaeology, including experience of interpreting Palaeolithic material from marine contexts.

Considered in conjunction with the Palaeo-Yare Catchment Assessment, the results of Operational Sampling will provide an overall record of Palaeolithic material recovered in the course of dredging under the short-term licences set within the relevant palaeo-geographic context. This record will help offset the impact of dredging by conserving the significance such archaeological material has been discovered.

The overall record set within its palaeo-geographic context will be reviewed in order to advance understanding of the distribution and significance of Palaeolithic material within the Norfolk Block of the Anglian Region. Specifically, the record will be interpreted in relation to the hypotheses set out above. It is anticipated that these hypotheses will be used to structure the Interpretative Report. Discussion of the final hypotheses, on the effectiveness of the Operational Sampling methodology, will include consideration of the commentaries on aspects of dredging, processing and / or archaeological investigations contained within the Operational Reports.

In providing answers to the hypotheses, the Interpretative Report will seek to inform directly the WSI that is to accompany the full-term marine licences. The Interpretative Report may include recommendations regarding revisions to the hypotheses and revisions to any aspect of the Operational Sampling methodology. The Interpretative Report may conclude that

further Operational Sampling in the course of the full-term licence period is not warranted, or propose other forms of mitigation.

The Interpretative Report will include a 'post-fieldwork assessment' which includes an assessment of the potential of the results for further analysis and publication. This element will include proposals for peer-reviewed publication of significant results.

The Interpretative Report will be submitted to English Heritage by (or on behalf of) the Companies, and copied to the MMO. Receipt will be acknowledged by English Heritage and the MMO respectively.

The Interpretative Report submitted to English Heritage will not be 'Draft' and there is no expectation that EH will return comments. However, English Heritage may comment on the Interpretative Report and in the event that substantive changes are made as a consequence, then the Interpretative Report will be re-issued, submitted to English Heritage and copied to the MMO.

16. ARCHIVES

General practices in respect of archiving will accord with the Model Clauses for Written Schemes of Investigation for Offshore Renewables Projects (http://www.dur.ac.uk/eh.rsa/pdf/WSI%20model%20clauses%20archaeology%20Renewables_low%20res.pdf) and other applicable standards.

Each episode of Operational Sampling is expected to give rise to a material archive (i.e. artefacts and other physical remains that are retained in the course of processing), a paper archive (e.g. recording sheets) and a digital archive (e.g. database files, GIS files, digital still and video photography). The whole archive for each Operational Sampling episode should be collated, cross-referenced and packaged according to professional standards.

Where elements of the material archive require conservation, this should be carried out according to professional standards to a state whereby the material is stable for storage purposes.

It is anticipated that the archive for each Operational Sampling episode will be retained by the Archaeological Contractor that carried out the archaeological activities associated with it, pending agreement over deposition.

Preparation of the Interpretative Report is expected to be carried out on the basis of the Operational Reports. However, if there is a need to re-examine the archive for one or more episodes of Operational Sampling (e.g. to examine artefacts from different sampling events as an assemblage) then the relevant archive(s) will be made available to the Archaeological Contractor commissioned to prepare the Interpretive Report. In such instances, the Archaeological Contractor preparing the Interpretative Report will be bound by the same methods and professional standards in respect of the archive as the Archaeological Contractor that has made it available. The archive will be returned to its originator once the Interpretative Report has been finalised.

Arrangements for long-term deposition of the archives from Operational Sampling will be made by the Companies. For the purposes of deposition, the archives from all the Operational Sampling episodes will be combined as a single archive. Arrangements for deposition will be made with a suitable publicly-accessible depository with a collections policy that encompasses Palaeolithic material from East Anglia.



It is understood that Palaeolithic material recovered in the course of dredging is owned by The Crown Estate. Arrangements for deposition will include transfer of title from The Crown Estate to the legal entity that is accepting the archive.



APPENDIX II: GAZETTEER OF ARCHAEOLOGICAL FINDS

WAID	Area	UTM31N	UTM31N	Site type	Position accuracy	Geological Context	Arch. Period	Description	Sources
		Easting	Northing						
2145	240	426683	5822349	FINDSPOT	Centre of N-S orientated dredge lane		Middle Palaeolithic; Upper Palaeolithic	2 sections of de-laminated mammoth tusk recovered from Area 240: Hanson_0126 3 (2007 - 2008)	BMAPA_5103
2146	240	426460	5822460	FINDSPOT	Centre of dredge tacks in the HAML exclusion zone		Palaeolithic	Mammoth teeth, tusk fragments and antlers. Significant Palaeolithic assemblage. Due to importance not ultimately addressed through implementation service recovered from Area 240: Hanson_0133 3 (2007 - 2008)	
2147	240	426460	5822460	FINDSPOT	Centre of dredge tacks in the HAML exclusion zone		Palaeolithic	88 lithic finds, incl. 28 handaxes. Significant Palaeolithic assemblage. Due to importance not ultimately addressed through implementation service recovered from Area 240: Hanson_0133 3 (2007 - 2008)	
2148	240	425198	5824420	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2149	240	425215	5824442	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2150	240	425197	5824456	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153



2151	240	425286	5824478	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2152	240	425211	5824491	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2153	240	425239	5824497	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2154	240	425298	5824504	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2155	240	425321	5824512	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2156	240	425319	5824515	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2157	240	425294	5824588	Environmental	Reported position		Mesolithic	Large concentrations of peat recovered from Area 240: Hanson_0150 3 (2007 - 2008)	BMAPA_5153
2158	240	425192	5824198	Faunal	Centrepoint of dredge lane		Palaeolithic	Mammoth tooth recovered from Area 240: Hanson_0169 3 (2007 - 2008)	BMAPA_5196
2159	240	425260	5824596	Faunal	Centrepoint of dredge lane		Palaeolithic	2 mammoth teeth recovered from Area 240: Hanson_0180 3 (2007 - 2008)	BMAPA_5179
2160	240	425260	5824596	FINDSPOT	Centrepoint of dredge lane		Unknown	Struck flint, probable waste flake recovered from Area 240: Hanson_0180 3 (2007 - 2008)	BMAPA_5180
2161	240	425465	5826119	Faunal	Approximate position of vessel		Palaeolithic	Mammoth tooth recovered from Area 240: Hanson_0268 5 (2009 - 2010)	BMAPA_5336



2162	242	439002	5825275	Faunal	Centrepoint of dredge lane		Unknown	Fossilised humerus fragment from a large mammal, possibly a mammoth recovered from Area 242_328A_361B_361C_HAML: Hanson_0202 4 (2008 - 2009)	BMAPA_5220
2163	251	423654	5816000	Faunal	Poor positioning. Could be Area 251 or 102 (Humber)		Middle Palaeolithic	Animal bone, possible hippopotamus (?Ipswichian interglacial) recovered from Area 251: CEMEX_0093 2 (2006 - 2007)	BMAPA_5074
2164	251	422508	5817821	Environmental	Centrepoint of 1400m N-S track		Mesolithic	Peat sample recovered from Area 251: CEMEX_0296 5 (2009 - 2010)	BMAPA_5349
2165	251	434520	5820104	Faunal	Approximate position of vessel		Unknown	Animal bone, auroch metatarsal recovered from Area 251: CEMEX_0307 5 (2009 - 2010)	BMAPA_5361
2166	360	434908	5822739	Faunal	Approximate position of vessel		Unknown	Mammoth Bone recovered from Area 360: CEMEX_0340 6 (2010 - 2011)	BMAPA_5394
2167	254	426144	5827497	Faunal	Centrepoint of dredge lane		Unknown	Fragment of bone, possible deer metatarsus recovered from Area 254: UMD_0041 1 (2005 - 2006)	BMAPA_5016
2168	254	426144	5827497	Faunal	Centrepoint of dredge lane		Palaeolithic	Upper molar of a woolly mammoth (Mammuthus primigenius). recovered from Area 254: UMD_0045 1 (2005 - 2006)	BMAPA_5024
2169	296	429984	5832115	Faunal	Centre of Area 296		Unknown	Piece of bone from a large mammal recovered from Area 296: UMA_0076 2 (2006 - 2007)	BMAPA_5062



2170	296	429984	5832115	Faunal	Centre of Area 296		Palaeolithic	Mammoth tooth, largely unworn so possible milk tooth recovered from Area 296: UMA_0107 2 (2006 - 2007)	BMAPA_5116
2171	296	429983	5832115	Faunal	Centre of Area 296		Unknown	Femur of a large mammal recovered from Area 296: UMA_0117 3 (2007 - 2008)	BMAPA_5088
2172	296	429984	5832115	Faunal	Centre of Area 296		Unknown	Degraded animal bone, possibly artiodactyl recovered from Area 296: UMA_0160 3 (2007 - 2008)	BMAPA_5161
2173	296	429984	5832115	Faunal	Centre of Area 296		Palaeolithic	Fragment of an upper cheek tooth of a fossil mammoth, possibly from a relatively young animal recovered from Area 296: Tarmac_0332 5 (2009 - 2010)	BMAPA_5399
2174	296	429983	5832115	Faunal	Centre of Area 296		Unknown	Mammoth Tooth recovered from Area 296: Tarmac_0354 6 (2010 - 2011)	BMAPA_5426
2175	319	423232	5819411	Faunal	Approximate position (within 1800m)		Palaeolithic	Fragment of tusk, possibly mammoth recovered from Area 319: CEMEX_0276 5 (2009 - 2010)	BMAPA_5339
2176	319	423553	5819963	Faunal	Approximate position (within 1200m)		Unknown	Left metatarsus of a large deer, possibly red deer recovered from Area 319: CEMEX_0281 5 (2009 - 2010)	BMAPA_5341
2177	360	434832	5822648	Environmental	Centrepoint of dredge lane		Early Mesolithic	c 250 large fragments of waterlogged and mineralised wood, eroding peat layer recovered from Area 360: CEMEX_0039 1 (2005 - 2006)	BMAPA_5044



2178	360	434832	5822648	Environmental	Centrepoint of dredge lane		Early Mesolithic	4 fragments of fibrous herbaceous peat, containing possible fine comminuted charcoal recovered from Area 360: CEMEX_0039 1 (2005 - 2006)	BMAPA_5045
2179	360	434832	5822648	Faunal	Centrepoint of dredge lane		Early Mesolithic	12 fragments of mineralised bone, probably large herbivore recovered from Area 360: CEMEX_0039 1 (2005 - 2006)	BMAPA_5046
2180	360	434832	5822648	Faunal	Centrepoint of dredge lane		Early Mesolithic	3 fragments of deer antler recovered from Area 360: CEMEX_0039 1 (2005 - 2006)	BMAPA_5047
2181	360	434832	5822648	FINDSPOT	Centrepoint of dredge lane		Early Mesolithic	Fragment of worked flint recovered from Area 360: CEMEX_0039 1 (2005 - 2006)	BMAPA_5048
2182	360	434823	5822459	Faunal	Approximate position		Palaeolithic	Mammoth tooth recovered from Area 360: Cemex_0265 4 (2008 - 2009)	BMAPA_5338
2183	360	434823	5822459	Faunal	Approximate position		Palaeolithic	Antler, possible Megaloceros (giant deer) recovered from Area 360: Cemex_0265 4 (2008 - 2009)	BMAPA_5338
2184	360	434344	5822621	Faunal	Approximate position		Palaeolithic	Elephant, or possibly mammoth, atlas vertebra recovered from Area 360: CEMEX_0284 5 (2009 - 2010)	BMAPA_5346
2185	360	433476	5822697	Faunal	Approximate position (within 500m)		Unknown	Fossilised Deer Bone recovered from Area 360: CEMEX_0341 6 (2010 - 2011)	BMAPA_5386



2186	360	433890	5822660	Faunal	Centrepoint of dredge lane		Unknown	Bones and teeth: 1 claw or tooth; 1 large bone - split in two; 2 pieces of bone - one with remains of marrow; and 1 piece of vertebrate recovered from Area 360: CEMEX_0379 7 (2011-2012)	BMAPA_5445
2187	360	435025	5823016	Faunal	Centrepoint of dredge lane		Unknown	Fossilised bone recovered from Area 360: CEMEX_0405 7 (2011-2012)	
2188	242	437463	5823517	Faunal	Northwest corner of dredge lane		Palaeolithic	Pieces of mammoth bone recovered from Area 242: Hanson_0018 1 (2005 - 2006)	BMAPA_5011
2189	242	437463	5823517	Faunal	Northwest corner of dredge lane		Palaeolithic	Pieces of mammoth teeth recovered from Area 242: Hanson_0018 1 (2005 - 2006)	BMAPA_5012
2190	242	437463	5823517	Faunal	Northwest corner of dredge lane		Palaeolithic; Mesolithic	Possible deer bone recovered from Area 242: Hanson_0018 1 (2005 - 2006)	BMAPA_5013
2191		433070	5823801	FINDSPOT	Centre of East Coast Dredging block		Palaeolithic	Flint flake recovered from Area Unknown: UMA_0182 3 (2007 - 2008)	BMAPA_5182
2192	240	426340	5821854	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	This is a mid-section of a tertiary flake, with well-defined conchoidal rings on the ventral surface. The dorsal surface also has a number of converging negative flake scars. It has a slightly dipping profile. These features, including the way in which it has broken, have been noted on hand axe thinning flakes. Vertebra. Fish. Salmonid?	T1_G22



2193	240	426244	5821816	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	Flake similar to that from sample T1_G22 (described above). This flake also lacks the proximal and distal ends, so valuable details of the technology are lost. However, the dorsal surface has a number of residual flake scars, which form a radial pattern. This flake is not as convincing as T1_G22, but is still a probability.	T1_G25
2194	240	426320	5821851	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	This is a stained and patinated primary, hard hammer struck flake. The most convincing feature that indicates human production is the clear striking platform and well positioned point of percussion well back from the edge of the core. Three small flakes, all open to some doubt.	T1_G23



2195	240	426491	5821890	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	<p>A very thin flake in mint condition and unstained. The point of percussion is located at the edge of the flake. It is possible that this flake was removed by natural processes, however the fact that there are apparent traces of platform preparation, that do not represent edge crushing, and other facets suggest that this is a product of debitage. Centrotarsal. Bovine/Cervid. Fossilised and Fossilised unidentifiable bone.</p>	T1_G5
2196	240	426493	5821897	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	<p>A heavily rolled flake with a glossy finish. It is naturally backed. The proximal end is missing, having been chipped by recent damage; however the presence of clear conchoidal rings on the ventral surface and similar well defined traces on the dorsal surface, indicating a previous removal, suggest that this flake is genuine. 2x unidentifiable small bone fragments. Fossilised.</p>	T1_G5a



2197	240	426361	5821859	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	This is an elongated hard hammer struck flake. It is unstained and unpatinated. The argument that it is a genuine artefact relates to the presence of other flake scars, which suggest that it is product of deliberate, systematic debitage.	T1_G21a
2198	240	426537	5821915	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	This is a primary flake that is both patinated and stained. It is hard hammer struck. There is always potential for doubt with a flake of this type; however the striking platform is plain and the point of percussion is well positioned on the striking platform and not a glancing blow.	T1_G6
2199	240	426529	5821916	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	Clearly hard hammer struck and is part of a 'compound' removal, where a flake was removed with this one at the same time and the same blow. While not certain, it is probably due to human workmanship. Small flint is principally cortical and not convincing.	T1_G9
2200	240	426286	5821832	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	A small patinated and rolled primary flake, open to some doubt.	T1_G7
2201	240	426299	5821840	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	Unidentifiable small bone fragments. Recent.	T1_G8
2202	240	426427	5821879	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	2x bone pieces. The internal structure is mammalian, possibly a terrestrial mammal.	T1_G27



2203	240	426178	5822054	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	Technically a flake, although open to some doubt.	T2_G1b
2204	240	426010	5821898	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	Small flake that may well be a product of gravel abrasion.	T2_G5
2205	240	426715	5823985	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	Vertebra. Aquatic mammal ?dolphin. Recent.	T3_G5
2206	240	426326	5821823	FINDSPOT	Centrepoint	Unit 3 grab sample	Unknown	During the East Coast REC survey (Limpenny et al. 2011) a flint artefact, identified as a broken secondary flake, was identified during onboard processing of a clamshell sample at station CG6, which is situated to the west of the HAML exclusion zone. The artefact is a broken secondary flake. The surviving dimensions of the piece are approximately 60 x 43 x 9 mm, although a transverse break means that the piece was originally considerably longer.	CG6
2207	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed wharf. Large, mainly cortical flake, unpatinated, unstained, 3 points of impact, hard, slightly rolled, 1 inverse removal; dubious piece primarily thermal and stained but with three negative alternate removals (probably regard as reject)	77860_0000
2208	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed. Cordiform on flake blank, ventral surface flaked sufficient to thin butt, dorsal covering flaking, lightly stained, sharp, 135x95x39mm	77860_1000



2209	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed. Large tertiary flake, hard hammer, plain butt, lightly stained, partially radial flake scars, possibly from Levallois flake core. 95x107x19mm	77860_1002
2210	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed. Large primary flake, unpatinated/unstained, mint/sharp, could be modern on condition but included due to well-placed point of impact 137x106x37mm	77860_1006
2211	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Trip 1 mixed Large flake, stained, sharp/slightly rolled, some modern edge damage. 102x103x23 mm	77860_1007
2212	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed. 1 large primary flake, thermal dorsal surface, cortical butt, stained, slightly rolled/rolled	77860_1008
2213	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed. Stained secondary, hard hammer struck flake, slightly rolled/rolled, cortical butt, clumsy crushed impact 86x82x23mm	77860_1009
2214	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed (wharf). Hand axe with plano-convex cross section, probably made on flake. Both sides with covering flaking. Lightly stained, slightly rolled, tip absent. 113x80x23mm	77860_1011



2215	240	426312	5821970	FINDSPOT	Approximate position: mixed load from transect 1A and 1B	Unit 3 target	Palaeolithic	Mixed wharf. Core fragment with a pot lid fracture, but with relict flake scars (2 deeply invasive and 1 alternate) that are rolled suggesting the recently formed pot lid may have come from a humanly modified block.	77860_1012
2216	240	426312	5821970	FINDSPOT	Centrepoint of track 1B	Unit 3 target	Palaeolithic	1 tertiary flake, punctiform butt, possibly natural; rolled secondary flake, butt damaged, rolled, stained, dist part broken; tertiary flake, cortical butt, lightly rolled/rolled, lightly patinated.	77860_1018
2217	240	426391	5821942	FINDSPOT	Approximate position: mixed load from transect 2A and 2B	Unit 3 target	Palaeolithic	Mixed wharf. Large tertiary flake, stained, slightly rolled/rolled, plain butt, uncertain mode, from flake core 77x114x55mm	77860_1038
2218	240	426391	5821942	FINDSPOT	Approximate position: mixed load from transect 2A and 2B	Unit 3 target	Palaeolithic	Mixed wharf. Large primary hard hammer struck flake, rolled stained, plain butt 97x112x21mm	77860_1039
2219	240	424933	5820703	FINDSPOT	Centrepoint of track 2A	Unit 3 target	Palaeolithic	Flake linear butt, mint ventral, unpatinated, unstained, modern; broken thinning/shaping flake, opposed scars, linear butt.	77860_1024
2220	240	426391	5821942	FINDSPOT	Centrepoint of track 2B	Unit 3 target	Palaeolithic	Both flakes might be anthropogenic	77860_1025



2221	240	424944	5820639	FINDSPOT	Centrepoint of track 4A	Unit 3 target	Palaeolithic	Large hard hammer secondary flake. Possibly represents a stage of hand axe roughing out/shaping. 3 unidirectional flake scars. Good flint, unstained, slightly rolled, unpatinated. Plain butt, no preparation	77860_1045
2222	240	426978	5823332	FINDSPOT	Approximate position: mixed load from transect 5A and 5B	Unit 3 target	Palaeolithic	Mixed oversize pile. Hand axe. Ovate/cordiform. Tip absent, well executed bifacial covering flaking, lightly stained, sharp, 87x92x23mm	77860_1085
2223	240	425017	5820908	FINDSPOT	Centrepoint of track 5A	Unit 3 target	Palaeolithic	Bulk. Tertiary, slightly rolled, lightly stained, no preparation, possible signs of soft percussion	77860_1054
2224	240	426978	5823332	FINDSPOT	Centrepoint of track 5B	Unit 3 target	Palaeolithic	Broken hard hammer secondary flake, light differential staining, sharp. Unidirectional flaking, plain butt 68x57x22mm; rolled primary flake, probably collision	77860_1058
2225	240	424979	5820780	FINDSPOT	Centrepoint of track 7A	Unit 3 target	Palaeolithic	Broken flake thermal dorsal, unconvincing butt, probable accidental impact; Flake stained sharp, opposing dorsal scar patterns; flake stained sharp clear butt, hinged dist end	77860_1087



2226	240	426632	5822423	FINDSPOT	Centrepoint of track 7B	Unit 3 target	Palaeolithic	Broken flake matt, near mint, smashed butt, accident; lightly stained flake, butt unclear, transverse dorsal scars may be anthropogenic; rolled flake with parallel flaking scars lightly patinated. Possibly represents hand axe thinning	77860_1088
2227	240	425915	5822227	FINDSPOT	Centrepoint of track 8B	Unit 5 target	Palaeolithic	Faceted butt, sharp, lightly patinated, hard, dist tip absent but almost certainly blade, possibly retouched	77860_1096
2228	296	430790	5832560	Faunal	Centrepoint of operational sampling dredge tracks	Reworked bank and Unit 8	Unknown	A fragment of probable red deer antler	
2229	240	424850	5820830	Worked flint	Centrepoint of operational sampling dredge tracks (May 2012)	Predominantly Unit 3b	Palaeolithic	Undiagnostic flake. Probably secondary context in gravels in Area 240	WA 1002
2230	240	424850	5820830	Worked flint	Centrepoint of operational sampling dredge tracks (May 2012)	Predominantly Unit 3b	Palaeolithic	Thick secondary flake with abrupt retouch and crushing. Originates from core preparation or maintenance. Undergone much disturbance.	WA 1003
2231	240	424850	5820830	Faunal	Centrepoint of operational sampling dredge tracks (May 2012)	Predominantly Unit 3b	Recent	The distal end of a cattle metacarpal. Recent.	WA 1001
2232	319	422950	5821540	Worked flint	Centrepoint of operational sampling dredge tracks	Unit 3b in within limits of Early Holocene channel	Lower Palaeolithic	Iron-stained tertiary flake struck with a hard hammer, which may derive from biface manufacture or trimming	



2233	319	422950	5821540	Worked flint	Centrepoint of operational sampling dredge tracks	Unit 3b in within limits of Early Holocene channel	Probably Holocene	A hard-hammer struck tertiary flake with considerable surface gloss (but no iron staining)	
2234	319	422950	5821540	Worked flint	Centrepoint of operational sampling dredge tracks	Unit 3b in within limits of Early Holocene channel	Holocene	thermal flake with direct semi-abrupt concave retouch on one end. Condition is fresh	
2235	319	422950	5821540	Faunal	Centrepoint of operational sampling dredge tracks	Unit 3b in within limits of Early Holocene channel	Unknown	Mammoth tooth	
2236	319	422950	5821540	Faunal	Centrepoint of operational sampling dredge tracks	Unit 3b in within limits of Early Holocene channel	Unknown	Distal end of a red deer right humerus	
2237	251	429812	5818604	Worked flint	Centrepoint of operational sampling dredge tracks	Unit 3b within the floodplain extent; to the west of the Middle Pleistocene channel	Lower Palaeolithic	Large scraper made on a secondary flake; limited post-depositional effects; probably in situ.	
2238	296	430871	5832625	Faunal	Centrepoint of operational sampling dredge tracks	Early transgression sand and gravel. Reworked deposit	Unknown	A fragment of unidentifiable large mammal bone	
2239	296	430871	5832625	Faunal	Centrepoint of operational sampling dredge tracks	Early transgression sand and gravel. Reworked deposit	Unknown	Single aurochs tooth	



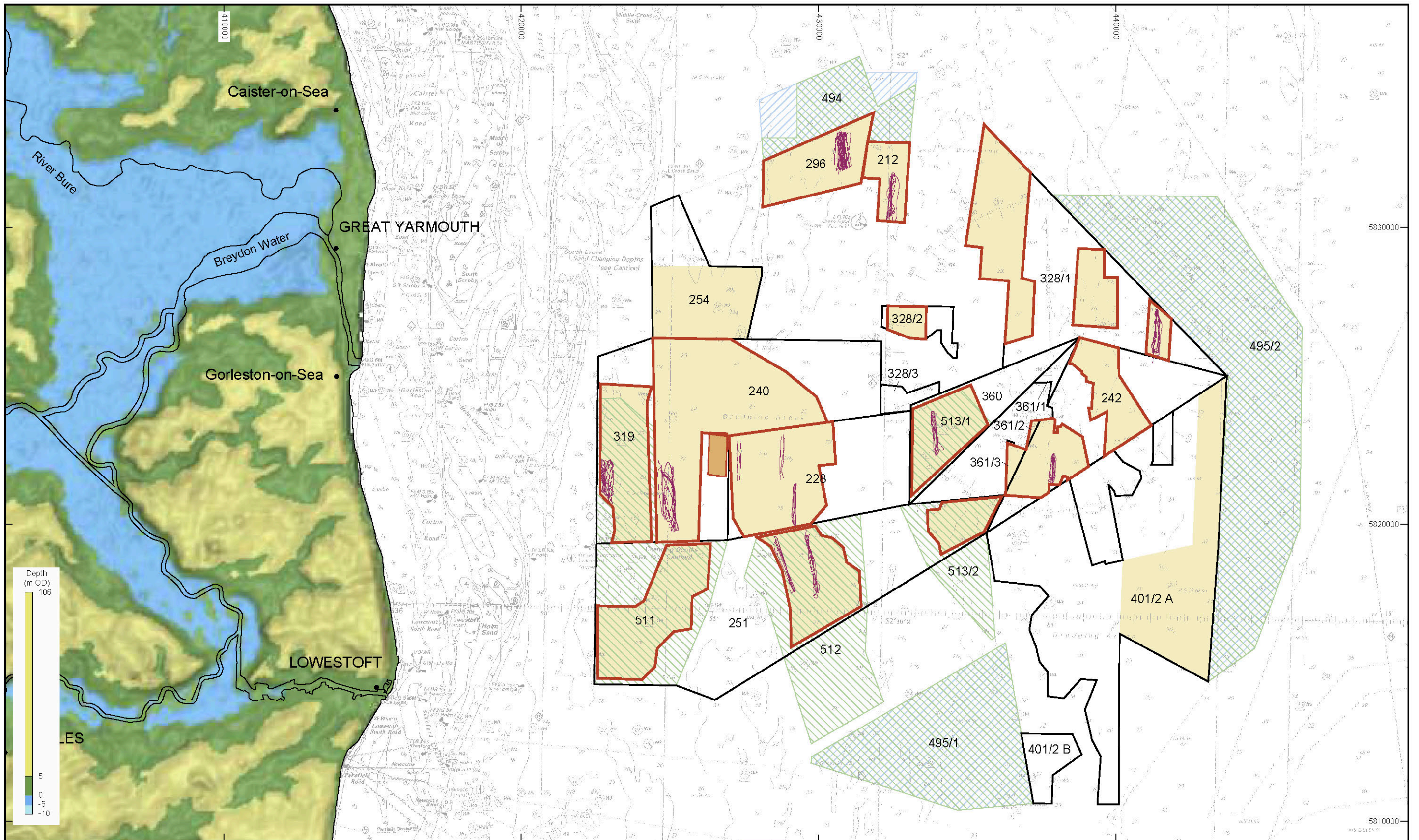
2240	360	433910	5823120	Faunal	Centrepoint of operational sampling dredge tracks	Possible Unit 3b/Unit 2	Unknown	Faunal remains, predominantly antler. Part of distal humerus of large mammal, mammal rin and skull fragment. Also, post-medieval cattle distal tibia	
2241	319	422790	5821620	Faunal	Centrepoint of operational sampling dredge tracks	Unit 3b in within limits of Early Holocene channel	Unknown	Abraded fragment of unidentified large mammal bone	
2242	319	422790	5821620	Faunal	Centrepoint of operational sampling dredge tracks	Unit 3b in within limits of Early Holocene channel	Unknown	Fragment of red deer antler	
2243	240	425110	5820840	Lithic	Centrepoint of operational sampling dredge tracks	Predominantly Unit 3b, some Unit 5	Early Middle Palaeolithic	Large Levallois point, <i>in situ</i>	
2244	240	425110	5820840	Lithic	Centrepoint of operational sampling dredge tracks	Predominantly Unit 3b, some Unit 5	Upper Palaeolithic (possibly Creswellian (13 - 11.5k BP))	Large bipolar blade core, poor condition, abraded.	
2245	240	425110	5820840	Faunal	Centrepoint of operational sampling dredge tracks	Predominantly Unit 3b, some Unit 5	Unknown	One mammoth tooth, fragment of rib of large mammal; fragment of red deer or cattle scapula; fragmetn of red deer antler	
2246	240	424990	5820800	Lithic	Centrepoint of operational sampling dredge tracks	Predominantly Unit 3b, some Unit 5	Early Middle Palaeolithic	Large tertiary flake of Levallois type. Probably in-situ prior to dredging recovery	
2247	240	424990	5820800	Faunal	Centrepoint of operational sampling dredge tracks	Predominantly Unit 3b, some Unit 5	Unknown	Mammoth tooth	



2248	242-361	437880	5821900	Faunal	Centrepoint of operational sampling dredge tracks	Unit 3b	Unknown	One mammoth tooth and five fragments of large mammal bone. Fragments abraded and/or mineralised	
2249	212	432520	5831000	Lithic	Centrepoint of operational sampling dredge tracks	Predominantly Unit 2/8	Probable Early Middle Palaeolithic	Flake showing signs of Levallois technique. Has 'chapeaux de gendarme' butt, and shows considerable patina and signs of rolling	
2250	212	432520	5831000	Lithic	Centrepoint of operational sampling dredge tracks	Predominantly Unit 2/8	Probable Early Middle Palaeolithic	The second flake appears considerably fresher and shows relatively little damage. It also has signs of convergent flaking technique.	
2251	212	432520	5831000	Faunal	Centrepoint of operational sampling dredge tracks	Predominantly Unit 2/8	Unknown	Single mammoth tooth, broken in two and not complete. Break occurred prior to dredging	
2252	240	425193	5821222	Lithic	Centrepoint of operational sampling dredge tracks	Predominantly Unit 3b, some Unit 2a	Probable Early Middle Palaeolithic	A flake from a flint axe, relatively fresh	
2253	251	428831	5818622	Faunal	Centrepoint of operational sampling dredge tracks	Unit 3b	Unknown	Pelvis fragment, cow or deer	
2258	228	428753	5822243	Lithic	Centrepoint of operational sampling dredge tracks	Unit 3b (part affected by prior dredging)	Palaeolithic	Large secondary flake, very rolled patinated and worn	
2259	228	428753	5822243	Lithic	Centrepoint of operational sampling dredge tracks	Unit 3b (part affected by prior dredging)	Palaeolithic	Tertiary flake, rolled and patinated but less so than WA-2258	


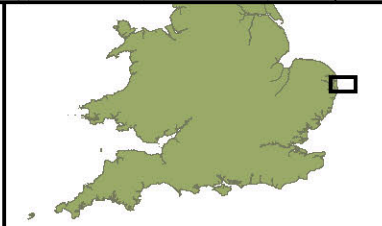
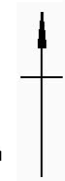


2260	228	428753	5822243	Faunal	Centrepoint of operational sampling dredge tracks	Unit 3b (part affected by prior dredging)	Unknown	?Red deer antler, mineralised	
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- Area 240 exclusion zone
- Active Dredging Areas under Short Term Licence Applications
- Active Dredging Areas
- Licence Application Areas
- Licence Option Areas
- Operational samples

Drawing projection: UTM WGS84 z31N.
Admiralty chart 1543 (dated 2000)

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SRTM data: Jarvis A., H.I. Reuter, A. Nelson, E. Guevara, 2008. Hole-filled seamless SRTM data, V4, International Centre for Tropical Agriculture (CIAT), available from <http://srtm.csi.cgiar.org>.
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East Anglia Dredging Block

Figure 1



Overview of Palaeo-Yare catchment assessment interpretation and known archaeology

Figure 2

Area 240 short-term licence area

Geophysics datasets:

- 2005
- East Coast REC
- Seabed Prehistory: Great Yarmouth

Geotechnical datasets:

- 1999
- 2000
- 2005
- 2007
- Seabed Prehistory: Area 240

Geology overview:

- Unit 3b is observed throughout the majority of the short-term licence area with exception of where Unit 3b has been removed, principally due to dredging activity
- Unit 2 is observed throughout the area and subcrops Unit 8 (modern marine sediments) where Unit 3b is absent.
- Units 4 is confined to the northeast associated with Late Anglian channel and comprises bank features and channel infill deposits.
- Isolated pockets of Unit 5 and 6 are observed infilling shallow seabed depressions.
- Unit 7, an early Holocene peat and transgression sequence is observed in the northwest associated with early Holocene channel.

Known Archaeology:

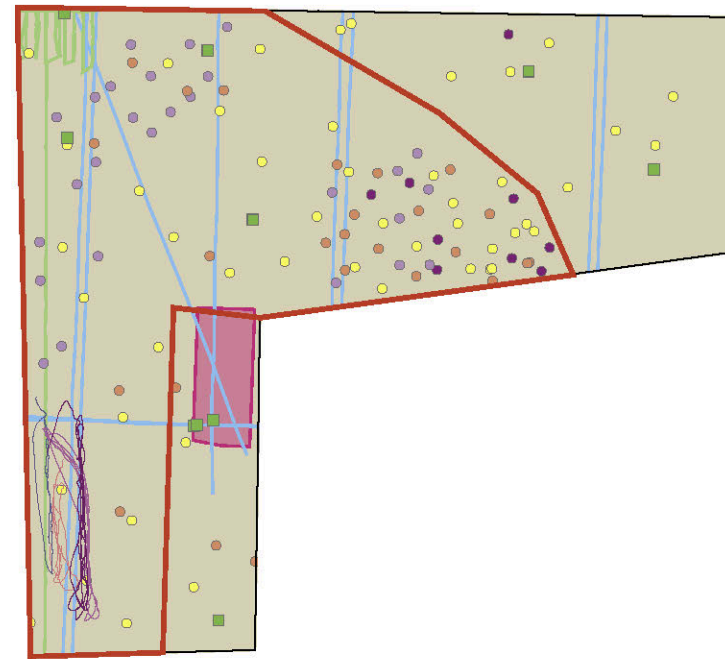
- Flint artefacts comprising the Middle Palaeolithic Assemblage (WA 2147, 2206, 2192 - 2200, 2203, 2204, 2207 - 2227).
- 16 additional reports through BMAPA Protocol for Reporting Finds of Archaeological Interest:
 - Flint (WA 2160)
 - Faunal remains (WA 2145, 2146, 2158, 2159, 2161)
 - Peat (WA 2148 - 2157)
- 5 faunal remains recovered during Seabed Prehistory project grab sampling (WA 2195, 2196, 2201, 2202, 2205).
- 2 worked flints (WA 2229 and 2230) in secondary context and 1 faunal remain fragment (WA 2231) recovered during operational sampling in May 2012.
- Early Middle Palaeolithic large Levallois point (WA 2243), Upper Palaeolithic large bipolar blade core (WA 2244), and faunal remains (WA 2245) recovered during operational sampling in April 2013.
- Early Middle Palaeolithic Levallois flake (WA 2246) and mammoth tooth (WA 2247) recovered during operational sampling in April 2013.

Dredging activity:

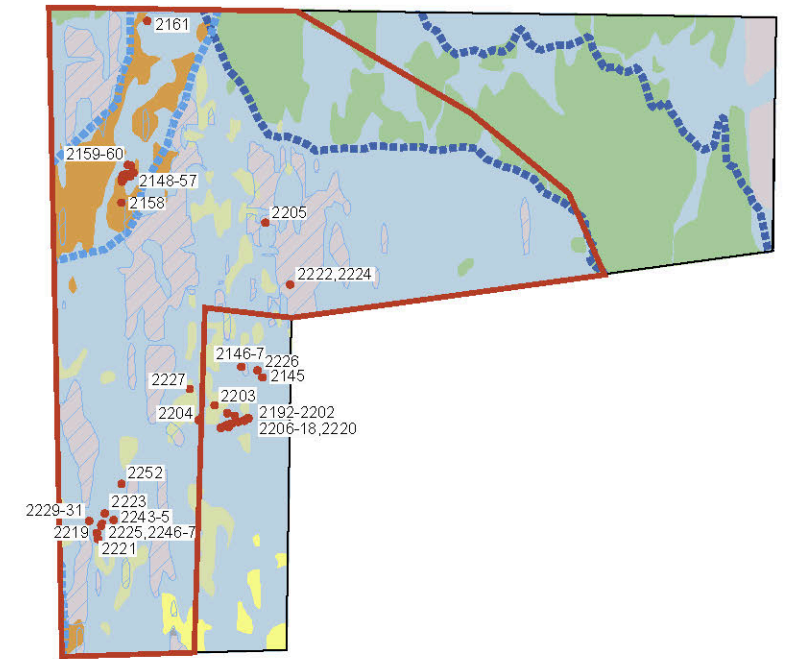
- Dredging activity has occurred throughout the area between 1993 and 2012 with exception of small areas at western edge and in the east.
- Geophysics data indicates areas of heavily dredged areas in areas of cumulative low, medium and high intensity dredging.
- Since 2005 data acquisition dredging has occurred in west and north indicating further removal of Units 3b, 5, 6, 7.

Principal hypotheses to be tested by operational sampling:

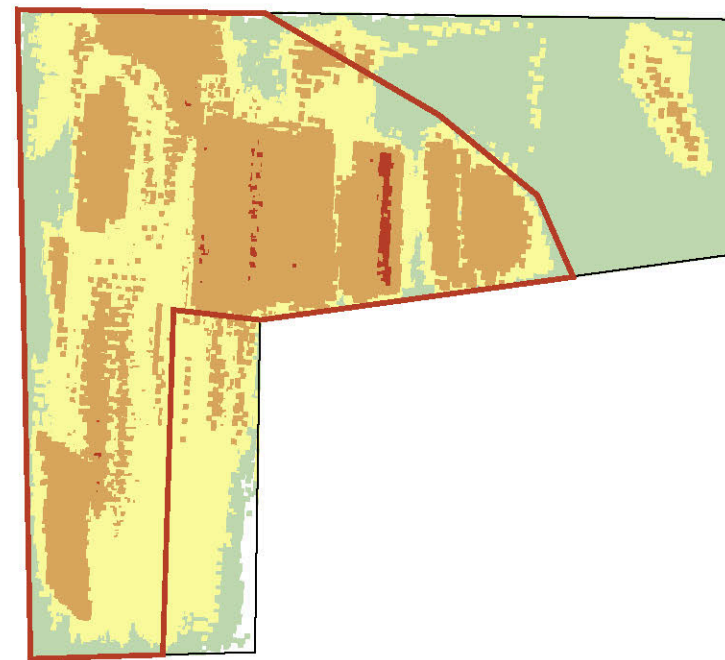
- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.
- H1b:** Palaeolithic material recovered from Unit 3b is predominantly *in situ*.
- H2a:** Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself.
- H2c:** The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.
- H3a:** The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.
- H3b:** Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.
- H4a:** Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS.
- H4b:** Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place.
- H5a:** Palaeolithic material is found at all wharves where Operational Sampling takes place.



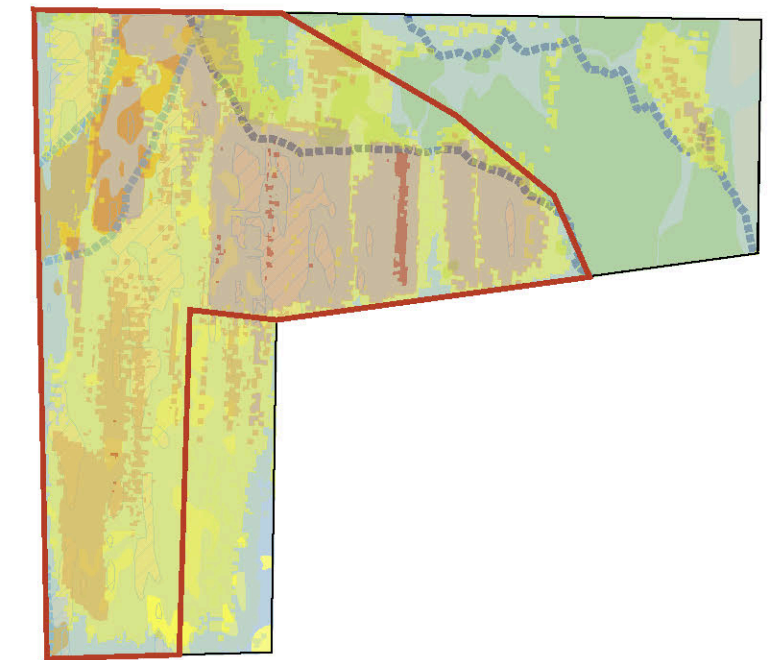
A. Assessed data



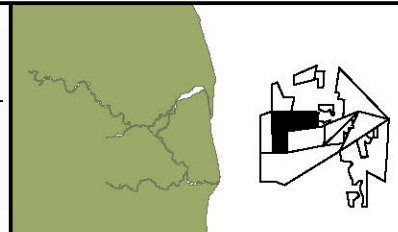
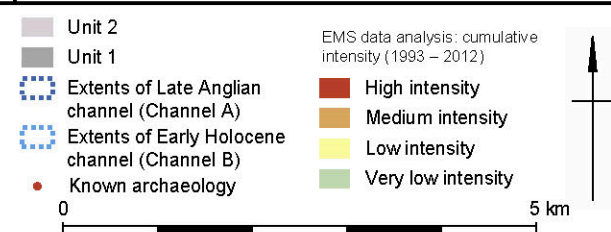
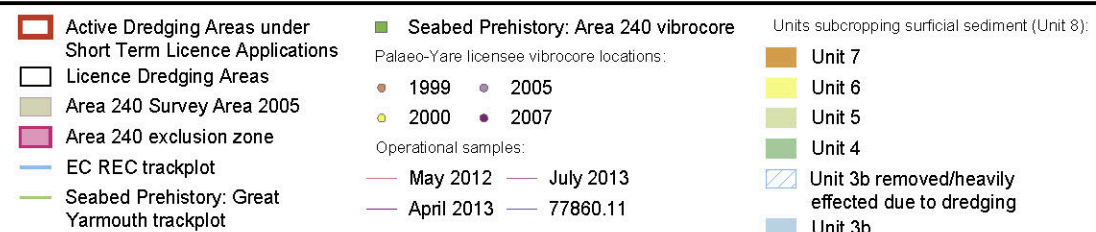
B. Interpretation and known archaeology



C. Dredging Activity (1993 - 2012)



D. Known aggregate dredging and palaeogeographic interpretation



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Area 319 short-term licence area

Geophysics datasets:

- 1989
- East Coast REC

Geotechnical datasets:

- 1991
- 1993
- 1999
- 2005
- 2008
- 2009
- East Coast REC

Geology overview:

- Area 319 is dominated by the meandering north-south channel (Channel B) which developed during the early Holocene. The channel cuts into Underlying Unit 3b sediments.
- Unit 3b sediments, generally comprising sands and gravels, are observed throughout the area with the exception of two areas within the channel where it appears that Unit 3b sediments have been completely removed and reworked.
- In the north the sediments are up to 4 m thick. To the east the thickness of Unit 3b sediments is unknown. Some evidence of previous dredging is observed in the geophysics data which obscures the base of Unit 3b sediments.

Known Archaeology:

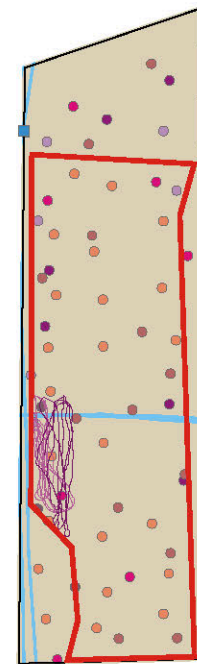
- Two reports of faunal remains (WA 2175, 2176) through the *Protocol for Reporting Finds of Archaeological Interest*.
- Operational Sampling was undertaken in February 2013. Two faunal remains (WA 2235 and 2236) were recovered (the distal end of a red deer right humerus and a mammoth tooth).
- Additionally, during operational sampling in February three lithics were recovered: a Lower Palaeolithic flake, a tertiary flake possibly Holocene age, and a thermal flake in fresh condition and of Holocene age (WA 2232 - 2234).
- During operational sampling in July 2013 faunal remains were recovered (WA 2241 and 2242).

Dredging activity:

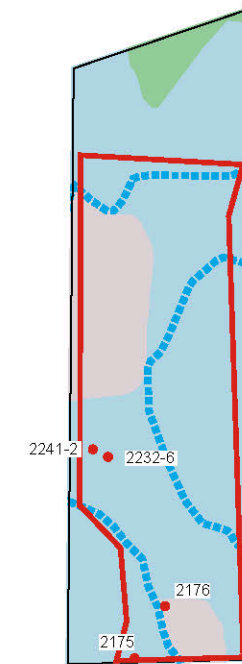
- Area 319 short-term licence area has been dredged over 18 of the 20 years since EMS recording (1993).
- The area has been dredged to low and medium cumulative intensity levels, with localised area of high intensity dredging in the north of the area.
- The aggregate target appears to be Unit 3b sediments and the reworked infill sediments from the early-Holocene channel.

Principal hypotheses to be tested by operational sampling:

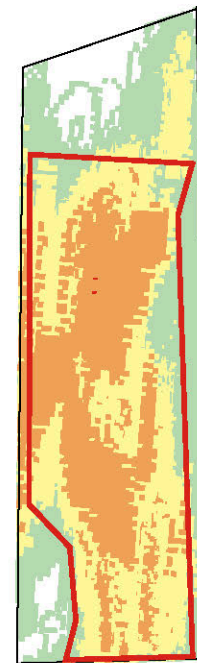
- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.
- H1b:** Palaeolithic material recovered from Unit 3b is predominantly *in situ*.
- H2c:** The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.
- H3a:** The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.
- H3b:** Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.
- H4a:** Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS.
- H5a:** Palaeolithic material is found at all wharves where Operational Sampling takes place.



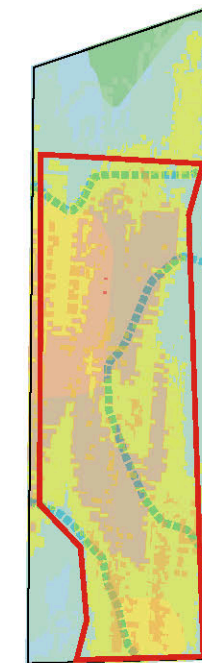
A. Assessed data



B. Interpretation and known archaeology



C. Dredging Activity (1993 - 2012)



D. Known aggregate dredging and palaeogeographic interpretation

<ul style="list-style-type: none"> Active Dredging Areas under Short Term Licence Applications Licence Dredging Areas Area 319 Survey Area 1989 EC REC trackplot ECREC vibrocore locations Operational sample February 2013 Operational sample July 2013 	<p>Palaeo-Yare licensee vibrocore locations:</p> <ul style="list-style-type: none"> 1991 1993 1999 2005 2008 2009 	<p>Units subcropping surficial sediment (Unit 8):</p> <ul style="list-style-type: none"> Unit 7 Unit 4 Unit 3b Unit 2 	<ul style="list-style-type: none"> Extents of Early Holocene channel (Channel B) Known archaeology 	<p>EMS data analysis: cumulative intensity (1993 - 2012)</p> <ul style="list-style-type: none"> High intensity Medium intensity Low intensity Very low intensity 			<p>Drawing projection: UTM WGS84 z31N. Contains Ordnance Survey data © Crown Copyright and database right 2012. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.</p>
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Area 251 short-term licence area

Geophysics datasets:

- 1989
- East Coast REC

Geotechnical datasets:

- 1991
- 1993
- 1999
- 2003
- 2005
- 2008
- 2009

Geology overview:

- The western short-term licence area generally comprises Unit 3b sediments overlying Unit 2 sediments. In the west Unit 3b sediments form a bank feature up to 5 m high and the bank is cut in the northwest by the early-Holocene channel. To the east Unit 3b sediments comprise up to 2 m coarse-grained sands and gravels overlying Unit 2. Elsewhere sediments probably comprise a veneer of recent sediment (Unit 8) overlying Unit 2.
- The central short-term licence area is dominated by floodplain deposits (Unit 3) which are situated to the west of Channel A. Unit 3 sediments generally comprise up to 3 m sand and gravel and form a cut and bank feature which thins to 1.5 m in the west.
- In the southwest the sediments comprise Unit 2 (fine grained sands and clays) overlain by a veneer of recent sediment (Unit 8).
- The eastern short-term licence area predominantly comprises channel deposits (Unit 3 and 4). Predominantly the sediments comprise up to 6 m fine-grained sands and gravels. Unit 4 sediments are observed and generally comprise up to 3 m fine-grained sediments (including sands, silts and clays) infilling cuts and forming bank features.

Known Archaeology:

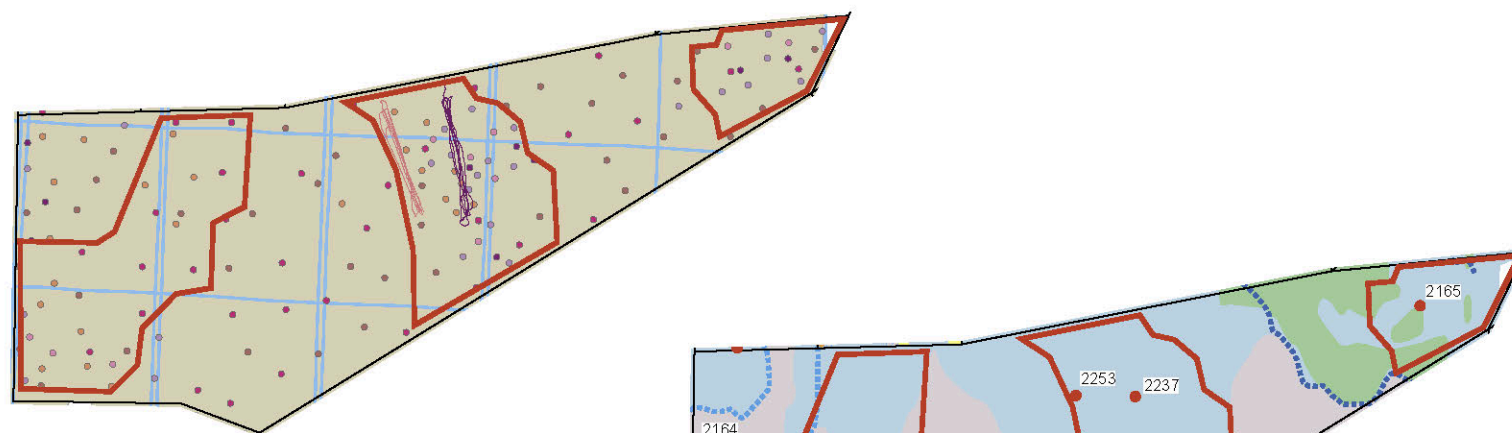
- Three finds reported through the *Protocol for Reporting Finds of Archaeological Interest*:
 - Faunal remains (WA 2163 and 2165) in the western and eastern area, respectively.
 - Environmental remains (WA 2164) situated to the northwest of the western short-term licence area.
- Operational Sampling was undertaken in March 2013. A single lithic was recovered and is a large scraper made on a secondary flake and is possible Lower Palaeolithic (WA 2237).

Dredging activity:

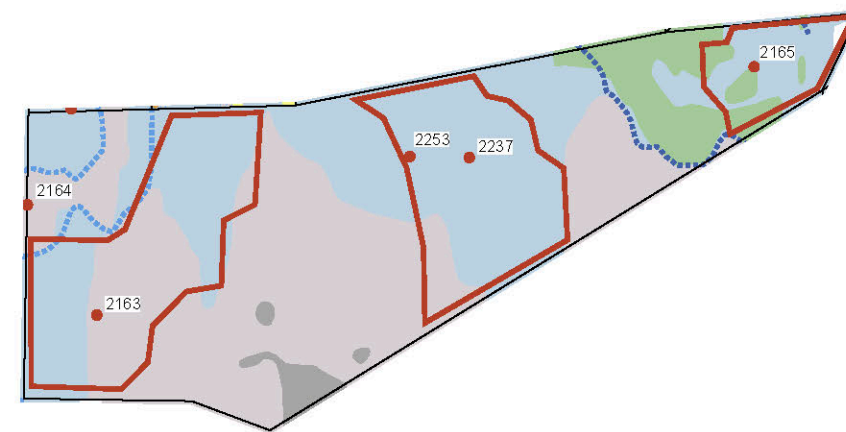
- The western short-term licence area has generally been dredged to low cumulative intensity with localised areas of very low and medium intensity. The target aggregate appears to be Unit 3b sediments and Unit 8 in the central area.
- The central short-term licence area has generally been dredged to low cumulative intensity with localised areas of very low and medium intensity. The target aggregate appears to be Unit 3b and Unit 8 sediments.
- The eastern short-term licence area has been dredged to low cumulative intensity with two areas of medium cumulative intensity. The target aggregate appears to be Unit 3b, however, the EMS data also indicates that Unit 4 sediments are also dredged.

Principal hypotheses to be tested by operational sampling:

- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian (all areas).
- H1b:** Palaeolithic material recovered from Unit 3b is predominantly *in situ* (all areas).
- H2c:** The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations (all areas).
- H3a:** The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b (all areas).
- H3b:** Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past (western and eastern areas only).
- H5a:** Palaeolithic material is found at all wharves where Operational Sampling takes place (all areas).



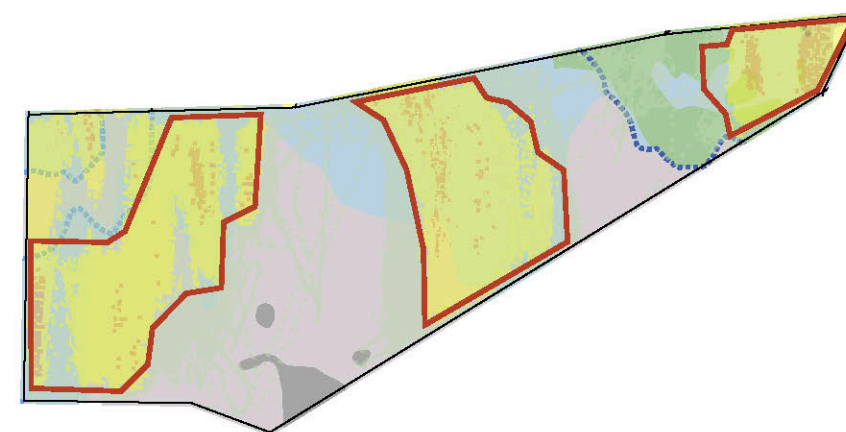
A. Assessed data



B. Interpretation and known archaeology



C. Dredging Activity (1993 – 2012)



D. Known aggregate dredging and palaeogeographic interpretation

<ul style="list-style-type: none"> Active Dredging Areas under Short Term Licence Applications Licence Dredging Areas Area 251 Survey Area 1989 EC REC trackplot Operational samples: <ul style="list-style-type: none"> March 2013 88250.07 	Palaeo-Yare licensee vibrocore locations: <ul style="list-style-type: none"> 1991 1993 1999 2003 2005 2008 	Units subcropping surficial sediment (Unit 8): <ul style="list-style-type: none"> Unit 4 Unit 3b Unit 2 Unit 1 	<ul style="list-style-type: none"> Extents of Late Anglian channel (Channel A) Extents of Early Holocene channel (Channel B) Known archaeology 	EMS data analysis: cumulative intensity (1993 – 2012) <ul style="list-style-type: none"> High intensity Medium intensity Low intensity Very low intensity 			Drawing projection: UTM WGS84 z31N. Contains Ordnance Survey data © Crown Copyright and database right 2012. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.
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Area 242/361 short-term licence area

Geophysics datasets:

- 1999 (Area 361)
- 2010 (Area 361/242)
- East Coast REC

Geotechnical datasets:

- 1999
- 2001
- 2003
- 2005
- 2007

Geology overview:

Western area:

- Area dominated by Unit 3b deposits up to 5 m thick representing the floodplain to the north of the channel.
- Some evidence of finer-grained sediments reworked from Unit 2 or nearby Unit 4.
- In the north fine-grained silty sand Unit 2 deposits are observed.
- Veneer of marine reworked sediments observed throughout the area.

Eastern area:

- Dominated by large reworked bank comprising sands, gravels and fine-grained sediments.
- Bank feature partially overlies and has eroded underlying Unit 3b sediments.
- Veneer of marine reworked sediments observed throughout the area.

Known archaeology:

- Western Area: three finds (WA 2188 - 2190) comprising mammoth teeth, mammoth bone and possible deer bone reported through the *Protocol for Reporting Finds of Archaeological Interest*. The findspot is 10 m north of the area but is most likely to be dredged from within the area.
- Operational sampling in July 2013 recovered numerous faunal remains (WA 2248)
- Eastern Area: Single faunal fragment (WA 2162) reported through the *Protocol for Reporting Finds of Archaeological Interest*.

Dredging activity:

Western Area:

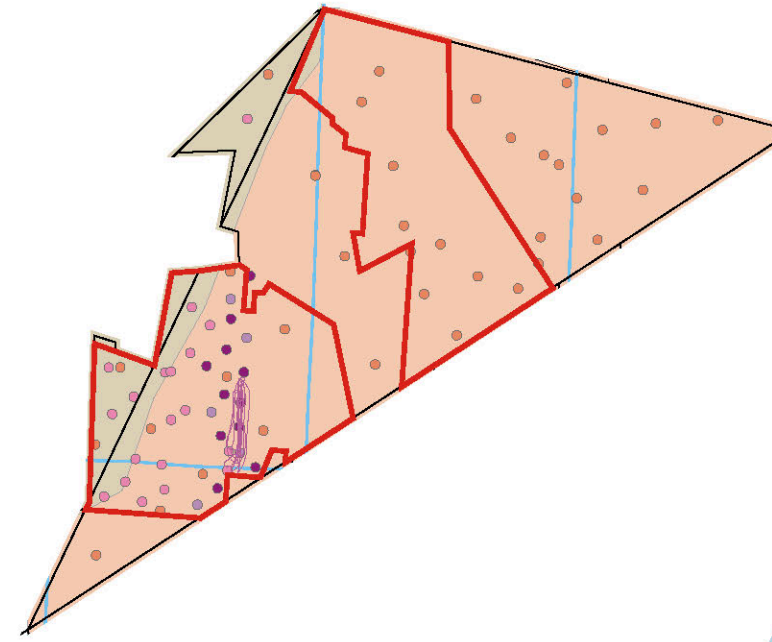
- Geophysics data indicates heavy dredging and Unit 3b mostly removed in the east
- Heavy dredging observed in east but remnants of Unit 3b are present
- EMS data indicates medium cumulative intensity in the west and low to medium in the west

Eastern Area:

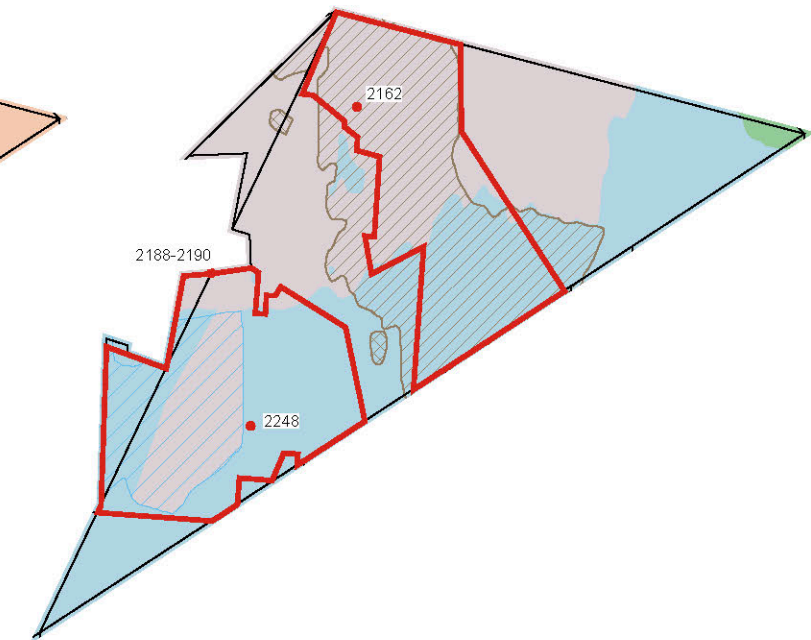
- Dredging target is the reworked bank and reworked marine sediments (Unit 8) and has been dredged to low - medium cumulative dredging intensity.
- Small area of Unit 3b may be a target.

Principal hypotheses to be tested by operational sampling:

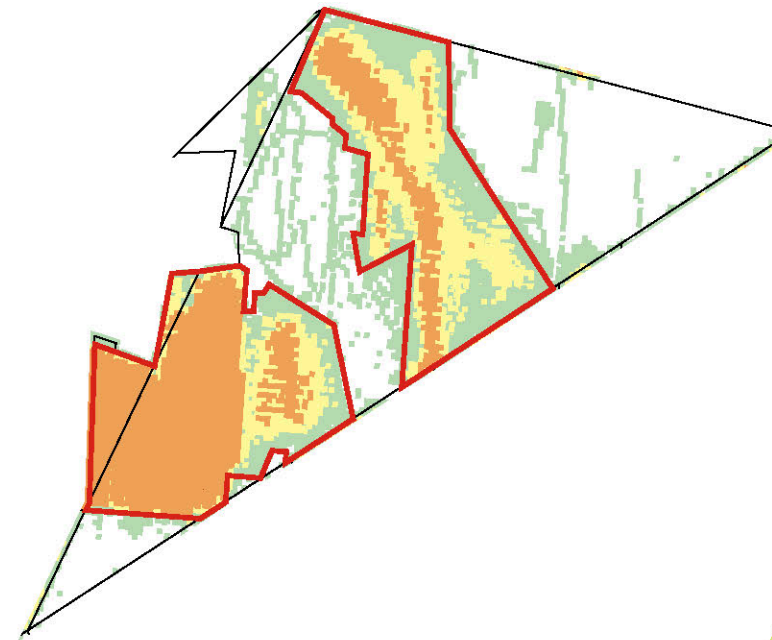
- H1a: Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian (all areas).
- H1b: Palaeolithic material recovered from Unit 3b is predominantly *in situ* (all areas).
- H2a: Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself (western area).
- H2c: The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations (all areas).
- H3a: The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b (all areas).
- H3b: Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past (eastern area).
- H3c: Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures (eastern area).
- H4b: Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place (eastern area).
- H5a: Palaeolithic material is found at all wharves where Operational Sampling takes place (all areas).



A. Assessed data



B. Interpretation and known archaeology



C. Dredging Activity (1993 - 2012)



D. Known aggregate dredging and palaeogeographic interpretation

- Active Dredging Areas under Short Term Licence Applications
- Licence Dredging Areas
- Area 361 Survey Area 1999
- Area 242 Survey Area 2010
- EC REC trackplot
- Operational sample July 2013

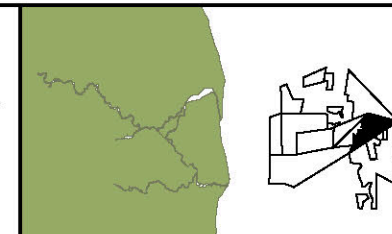
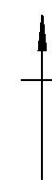
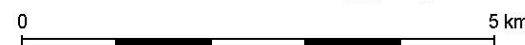
- Palaeo-Yare licensee vibrocore locations:
- 1999
- 2001
- 2003
- 2005
- 2007

- Reworked bank
- Bank feature (unknown age)
- Units subcropping surficial sediment (Unit 8):
- Unit 4
- Unit 3b removed/heavily effected due to dredging
- Unit 3b
- Unit 2

- Known archaeology

EMS data analysis: cumulative intensity (1993 - 2012)

- High intensity
- Medium intensity
- Low intensity
- Very low intensity



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Area 328 short-term licence area

Geophysics datasets:

- 1999
- 2010
- East Coast REC

Geotechnical datasets:

- 1999
- 2001
- 2003
- 2007

Geology overview:

- Western area comprises Unit 2 with a veneer of recent marine sediment (Unit 8) with a reworked bank feature up to 5 m high in the north.
- Western-central area generally comprises Unit 2 overlain by reworked deposits (Unit 8). To the south is a major, 3 m high bank structure comprising silt, shelly sands and gravels. To the north is a 3 m high reworked pro-grading bank.
- The eastern-central area is dominated by two reworked banks in the west and east and an outlier of Unit 3b channel infill sediments overlain by up to 3 m reworked sediments (Unit 8) in the north.
- Eastern area is dominated sediment up to 3 m thick interpreted as Unit 3 outlier deposits overlain by a veneer of recent sediment (Unit 8).

Known Archaeology:

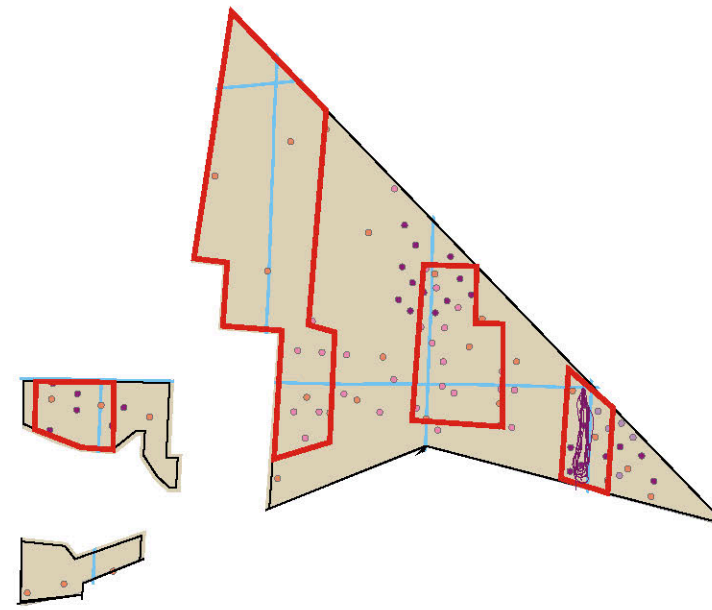
- No finds reported through the *Protocol for Reporting Finds of Archaeological Interest*.
- No material was recovered during operational sampling in September 2013.

Dredging activity:

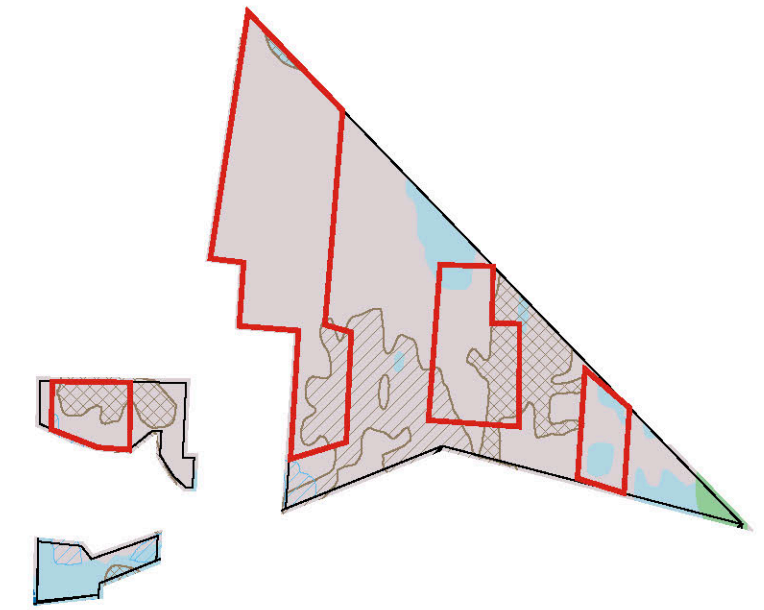
- Western area has been predominantly dredged to very low and low cumulative intensity and the aggregate target appears to be the recent reworked sediments and the reworked bank structure.
- Western-central area is generally low cumulative intensity dredging with localised areas of medium and high cumulative intensity. Aggregate target of large reworked bank in the south and reworked overburden (Unit 8) in the north.
 - In the eastern-central area dredging is classified as predominantly medium cumulative intensity and primarily targets reworked bank sediments and overburden (Unit 8). Channel infill deposits (possibly Unit 3b) are targeted in the northwest.
 - In the eastern area dredging is classified as predominantly medium cumulative intensity and primarily targets two possible outliers of Unit 3b sands and gravels. Elsewhere aggregate target comprises reworked overburden (Unit 8) deposits.

Principal hypotheses to be tested by operational sampling:

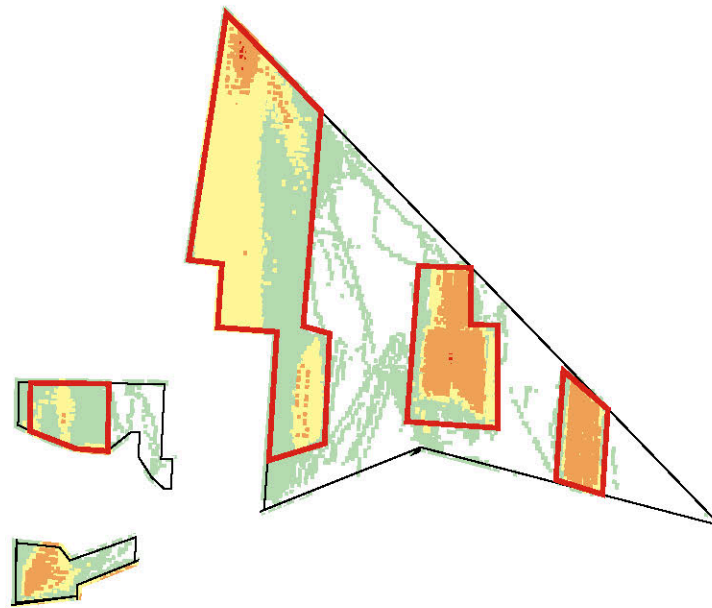
- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian (**all areas**).
- H1b:** Palaeolithic material recovered from Unit 3b is predominantly *in situ* (**east-central and east areas**).
- H2b:** Palaeolithic material is recovered only from Unit 3b deposits within the limits of the Palaeo-Yare floodplain, and not within the Unit 3b outliers to the north and south of the floodplain (**east-central and east areas**).
- H2c:** The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations (**all areas**).
- H3a:** The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b (**east-central and east areas**).
- H3b:** Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past (**west, west-central and east-central areas**).
- H3c:** Palaeolithic material is not recovered where Unit 3b appears to be covered by major bank structures (**west-central and east-central areas**).
- H4a:** Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS (**east-central area**).
- H4b:** Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place (**west area**).
- H5a:** Palaeolithic material is found at all wharves where Operational Sampling takes place (**all areas**).



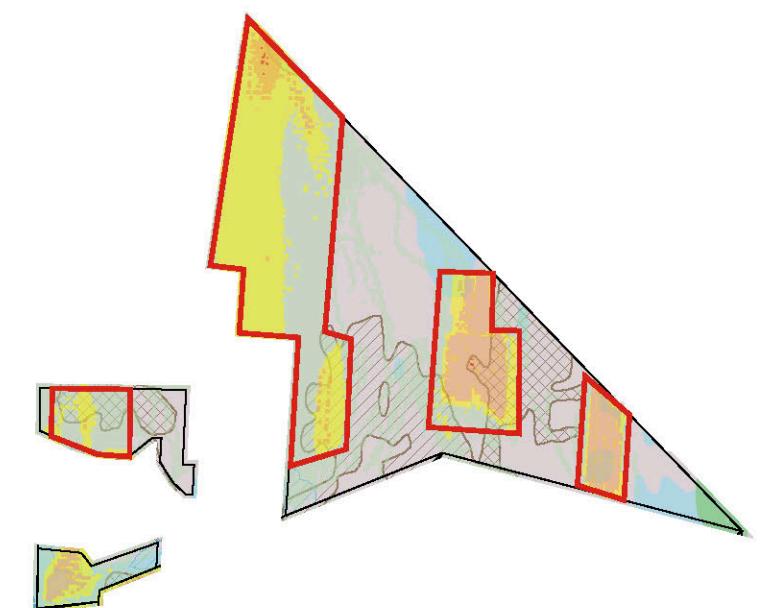
A. Assessed data



B. Interpretation and known archaeology



C. Dredging Activity (1993 - 2012)



D. Known aggregate dredging and palaeogeographic interpretation

- Red outline: Active Dredging Areas under Short Term Licence Applications
- Black outline: Licence Dredging Areas
- Light brown: Area 328 Survey Area 1999
- Blue line: EC REC trackplot
- Purple line: Operational sample September 2013

Palaeo-Yare licensee vibrocore locations:

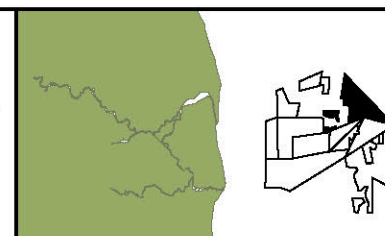
- Red dot: 1999
- Pink dot: 2001
- Purple dot: 2003
- Blue dot: 2005
- Green dot: 2007

- Hatched box: Reworked bank
- Diagonal lines box: Bank feature (unknown age)
- Green box: Unit 4
- Blue box: Unit 3b removed/heavily effected due to dredging
- Light blue box: Unit 3b
- Light brown box: Unit 2

EMS data analysis: cumulative intensity (1993 - 2012)

- Red: High intensity
- Orange: Medium intensity
- Yellow: Low intensity
- Green: Very low intensity

0 5 km



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Area 296 short-term licence area

Geophysics datasets:

- 1991
- 2007
- East Coast REC

Geotechnical datasets:

- 2000
- 2002
- 2008

Geology overview:

- The target aggregate in the area is a large sheet-like deposit comprising shelly sand and gravel which dominates the central area with smaller localised areas also observed.
- Generally this unit varies in thickness from less than 1m to 3.5m thick.
- This unit of slightly shelly sand and gravel has been interpreted as a reworked sediment unit possibly dating to the early transgression around 8000 BP.
- Throughout the area this unit is overlain by a veneer of recent (post-transgression) marine sediments generally comprising shelly sand. Occasional small sandwaves, generally up to 2m high, are observed throughout.
- In the northeast a large sandbank and large bedforms up to 8m high are observed.
- The target aggregate will not be necessarily be recovered where it is overlain by the seabed bedforms.

Known archaeology:

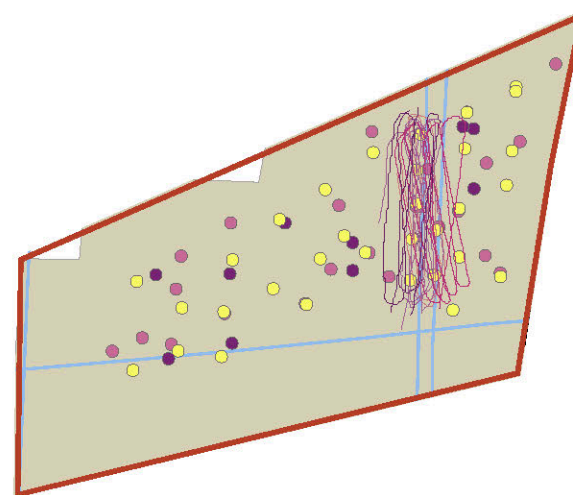
- Six reports of faunal remains through BMAPA *Protocol for Reporting Finds of Archaeological Interest (WA 2169 - 2174)*. Position provided is based on centre of the dredging area and is not an accurate recovery position.
- One faunal remain (WA 2228) was recovered in January 2013 and two fragments of faunal remains (WA 2238 and 2239) were recovered in April 2013 during operational sampling activities at Ridham Wharf.
- No Palaeolithic or faunal material was recovered during operational sampling in August or October 2013.

Dredging activity:

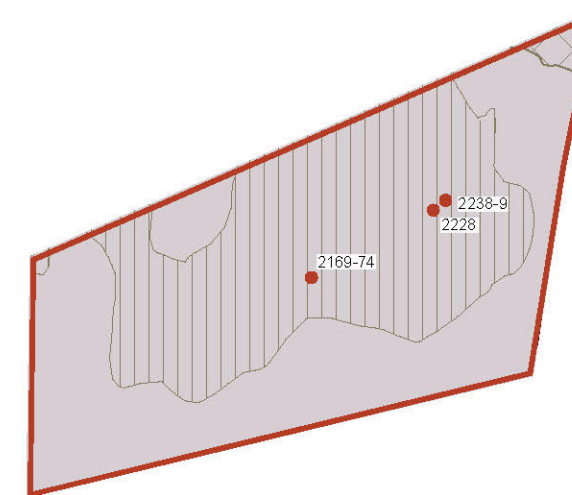
- The aggregate target in Area 296 is the shelly sand and gravel sheet-like deposit.
- Dredging activity has occurred in Area 296 every year since 1993 (to 2012) and has been dredged to medium cumulative intensity, with very localised high intensity areas.
- Dredging has continued since the acquisition of the 2007 dataset. Although subsequent aggregate removal is estimated by the licensee based on tonnage off take and dredging intensity, this is not reflected in this datasheet.

Principal hypotheses to be tested by operational sampling:

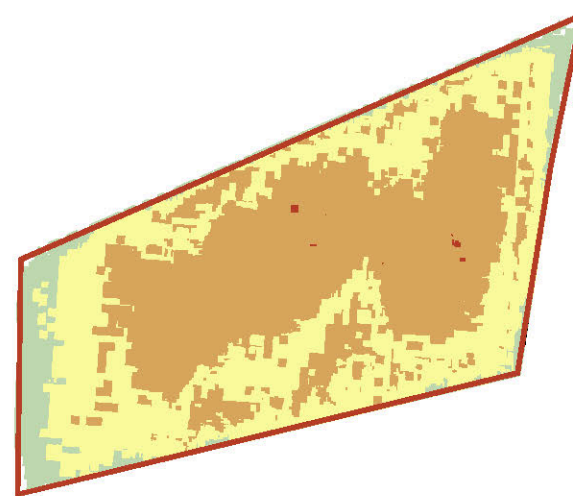
- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.
- H2c:** The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.
- H3b:** Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.
- H4a:** Palaeolithic material is not present where the dredging history indicates that a high level of dredging has taken place since the introduction of EMS.
- H5a:** Palaeolithic material is found at all wharves where Operational Sampling takes place



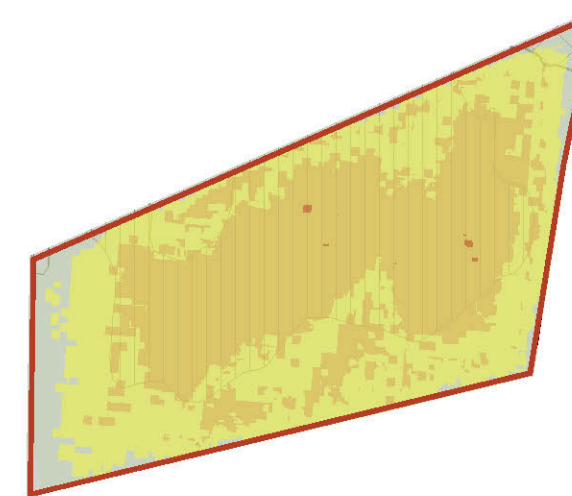
A. Assessed data



B. Interpretation and known archaeology



C. Dredging Activity (1993 - 2012)



D. Known aggregate dredging and palaeogeographic interpretation

- Active Dredging Areas under Short Term Licence Applications
- Licence Dredging Areas
- Area 296 Survey Area 1991
- EC REC trackplot

- Operational samples:
- January 2013
- April 2013
- August 2013
- October 2013

- Palaeo-Yare licensee vibrocore locations:
- 2000
- 2002
- 2008

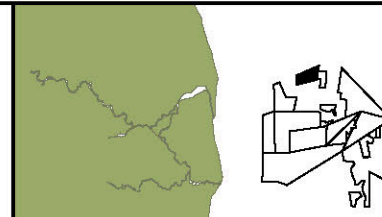
- Reworked bank
- Sheet deposit
- Units subcropping surficial sediment (Unit 8):
- Unit 2

- Known archaeology

EMS data analysis: cumulative intensity (1993 - 2012)

- High intensity
- Medium intensity
- Low intensity
- Very low intensity

0 2 km



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Area 212 short-term licence area

Geophysics datasets:

- 1999
- 2008
- East Coast REC

Geotechnical datasets:

- 1999

Geology overview:

- Generally, Unit 2 overlain by veneer of re-worked marine sediments (Unit 8).
- Occasional sediment unit up to 1 m thick comprising possible remnant deposit of Unit 3b (as observed in some vibrocores).
- Sheet-like deposit situated in the north up to 4 m thick possibly comprising reworked sands and gravels.
- Sandwaves comprising reworked, post-transgression sediments up to 5 m high are observed within the area.

Known archaeology:

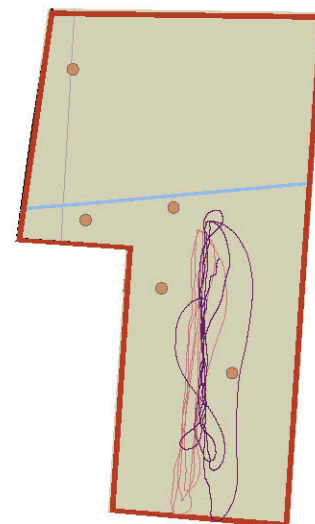
- No finds reported through the *Protocol for Reporting Finds of Archaeological Interest*.
- Two Early Middle Palaeolithic flakes (one showing signs of Levallois technique) were recovered during operational sampling in September 2013 (WA 2249, 2250). Additionally, a mammoth tooth was recovered (WA 2251).

Dredging activity:

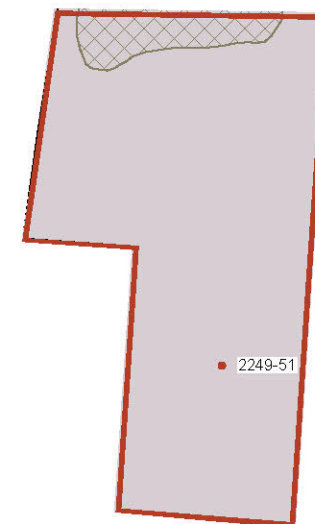
- Dredging has occurred within the area each year between 1993 and 2012 and is predominantly classified as low and medium cumulative intensity.
- Evidence of dredging is observed on both geophysical datasets.
- Dredging has continued in the centre of the area since the acquisition of the 2008 dataset
- The target aggregate appears to be the reworked lag deposits and overlying reworked marine sediments.

Principal hypotheses to be tested by operational sampling:

- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.
- H2c:** The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.
- H3b:** Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.
- H5a:** Palaeolithic material is found at all wharves where Operational Sampling takes place



A. Assessed data



B. Interpretation and known archaeology



C. Dredging Activity (1993 – 2012)



D. Known aggregate dredging and palaeogeographic interpretation

<ul style="list-style-type: none"> Active Dredging Areas under Short Term Licence Applications Licence Dredging Areas Area 212 Survey Area 1999 and 2008 EC REC trackplot 	<ul style="list-style-type: none"> Palaeo-Yare licensee vibrocore locations: 1999 	<ul style="list-style-type: none"> Reworked bank Units subcropping surficial sediment (Unit 8): Unit 2 Known archaeology 	<ul style="list-style-type: none"> EMS data analysis: cumulative intensity (1993 – 2012) High intensity Medium intensity Low intensity Very low intensity 				<p>Drawing projection: UTM WGS84 z31N. Contains Ordnance Survey data © Crown Copyright and database right 2012. This material is for client report only © Wessex Archaeology. No unauthorised reproduction.</p>
<p>Operational samples:</p> <ul style="list-style-type: none"> September 2013 November 2013 						<p>Date: 06/02/2015 Revision Number: 0</p> <p>Scale: 1:40,000 @A3 Illustrator: KMN/KJF</p> <p>Path: W:\Projects\83741\Drawing Office\Report figs\Technical report\2015_02_05</p>	

Area 228 short-term licence area

Geophysics datasets:

- 1989
- 2002 (report only)
- 2005 (report only)
- 2011
- East Coast REC

Geotechnical datasets:

- 1988
- 1996
- 2002
- 2004
- 2011

Geology overview:

- Area 228 short-term licence area is interpreted as predominantly comprising Unit 3b floodplain deposits. The geophysics data is heavily affected, partly due to dredging activity, and the thickness of the remnant Unit 3b deposits is unknown. Although, vibrocore data indicates the presence of sands and gravels in the area.
- In the central and west areas small isolated cuts and fills are observed and are interpreted as possible remnant overbank deposits or reworked sediments of Unit 4, or remnants of older, infilled sediments within Unit 3b.
- Throughout the area Unit 3b overlies Unit 2 sediments.
- To the extreme east of the area the edge of Channel A is observed and the channel is infilled with Unit 4 deposits comprising clays, silts and sands.
- Throughout the area the uppermost unit generally comprises a veneer to possibly 6 m thick where a large east-west trending sandwave is observed.

Known Archaeology:

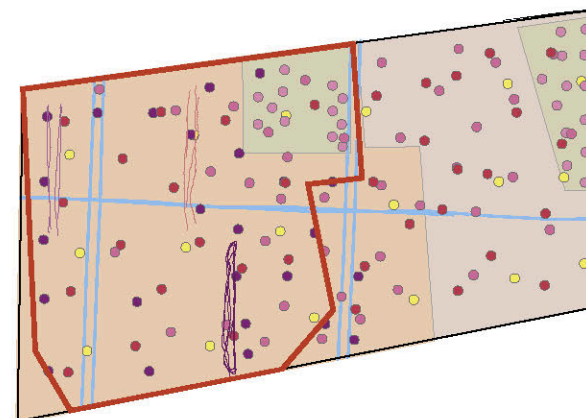
- No finds reported through the *Protocol for Reporting Finds of Archaeological Interest*.

Dredging activity:

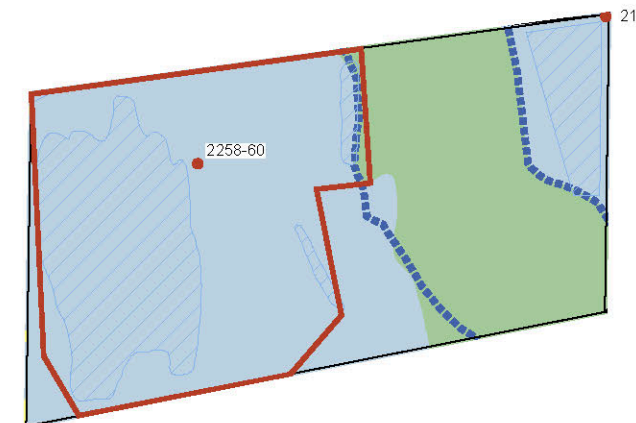
- Dredging has occurred throughout much of the area
- Localised areas have been dredged in all 20 years (1993 - 2012).
- Predominantly classified as low and medium cumulative intensity.
- Areas of medium cumulative intensity in the west and the east coincide with areas of heavy dredging observed in the geophysical data.
- Evidence of heavy dredging observed in the south in 1989 dataset.
- Target aggregate is interpreted to be Unit 3b. In the west it is difficult to estimate how much of coarse-grained target remains, due to dredging activity.

Principal hypotheses to be tested by operational sampling:

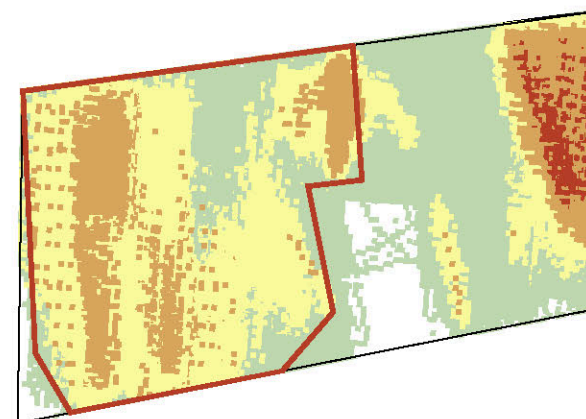
- H1a:** Palaeolithic material is recovered only from Unit 3b, which dates to the Wolstonian.
- H1b:** Palaeolithic material recovered from Unit 3b is predominantly *in situ*.
- H2a:** Palaeolithic material is recovered only from Unit 3b deposits on the margin of Channel A, not within the Channel itself.
- H2c:** The recovery of Palaeolithic material is clustered in relatively large quantities in discrete locations; material is not recovered from otherwise similar locations.
- H3a:** The distribution of recovered Palaeolithic material does not vary according to variations in the sediment structure of Unit 3b.
- H3b:** Palaeolithic material is not recovered where Unit 3b appears to have been reworked by natural processes in the past.
- H4b:** Palaeolithic material is not present where geophysical data indicates that a high level of dredging has taken place.
- H5a:** Palaeolithic material is found at all wharves where Operational Sampling takes place.



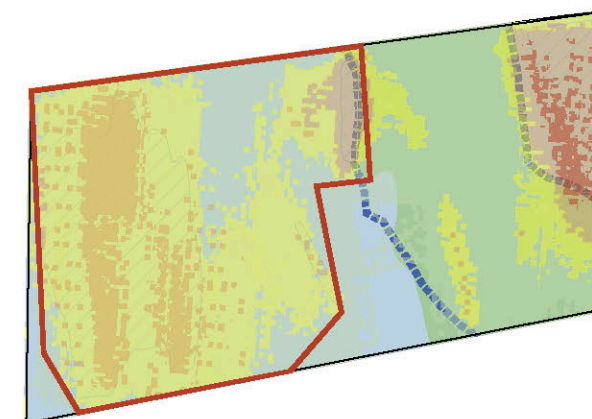
A. Assessed data



B. Interpretation and known archaeology



C. Dredging Activity (1993 - 2012)



D. Known aggregate dredging and palaeogeographic interpretation

- Active Dredging Areas under Short Term Licence Applications
- Licence Dredging Areas
- Area 228 Survey Area 2002
- Area 228 Survey Area 2005
- Area 228 Survey Area 2011
- EC REC trackplot

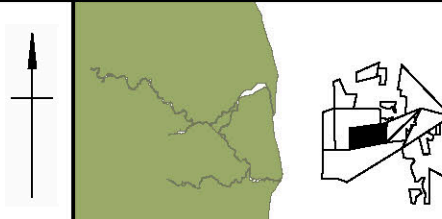
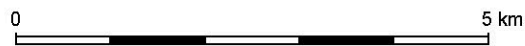
- Operational samples:
 - April 2014
 - 2014
 - November 2014
- Palaeo-Yare licensee vibrocore locations:
 - 1988
 - 1996
 - 1999
 - 2002
 - 2004
 - 2011

- Units subcropping surficial sediment (Unit 8):
 - Unit 4
 - Unit 3b removed/heavily effected due to dredging
 - Unit 3b

- Extents of Late Anglian channel (Channel A)
- Known archaeology

EMS data analysis: cumulative intensity (1993 - 2012)

- High intensity
- Medium intensity
- Low intensity
- Very low intensity



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Plate 1: Area 240: WA 2231 – faunal remains

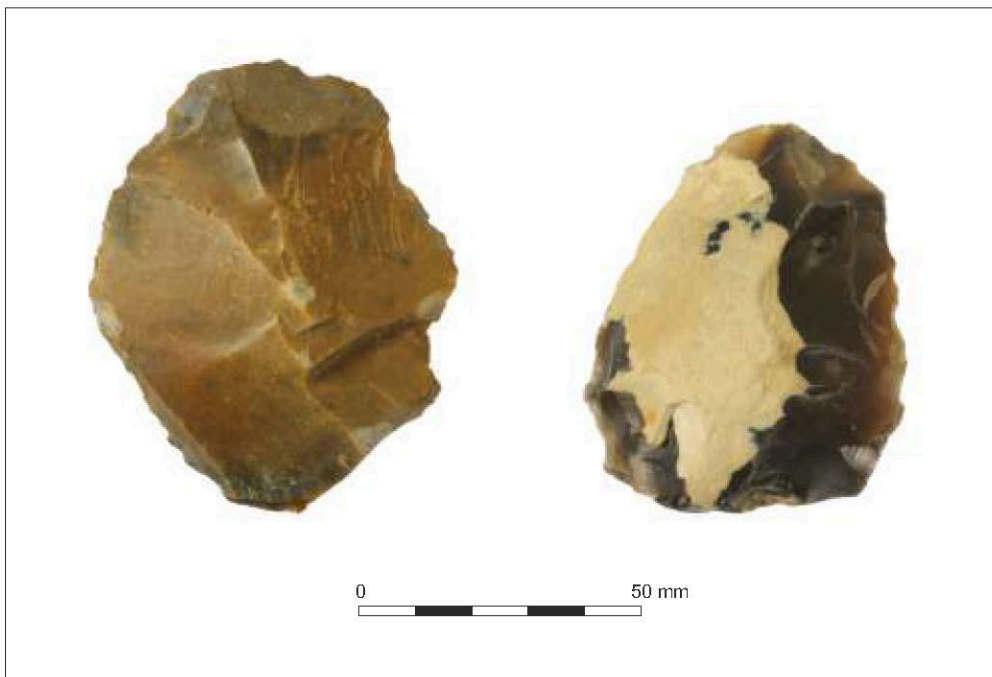


Plate 2: Area 240: WA 2229 and WA 2230 – lithics


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Plate 3: Area 240: WA 2243 and WA 2244 – lithics


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Plate 4: Area 240: WA 2245 – faunal remains


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Plate 5: Area 240: WA 2246 – lithics



Plate 6: Area 240: WA 2247 – faunal remains



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Plate 7: Area 240: WA 2252 – lithics

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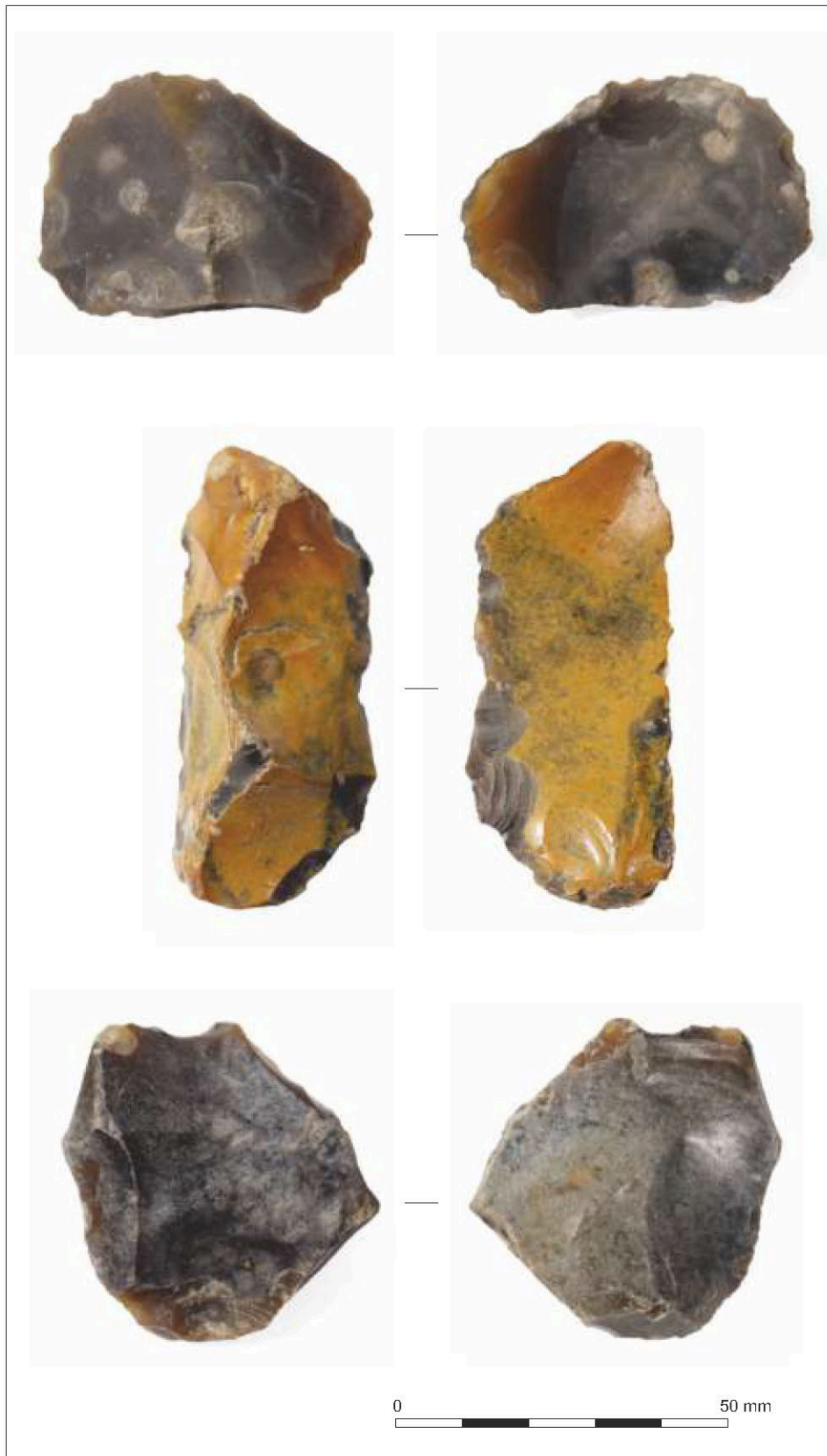



Plate 8: Area 319: WA 2234, 2232, 2232 – lithics

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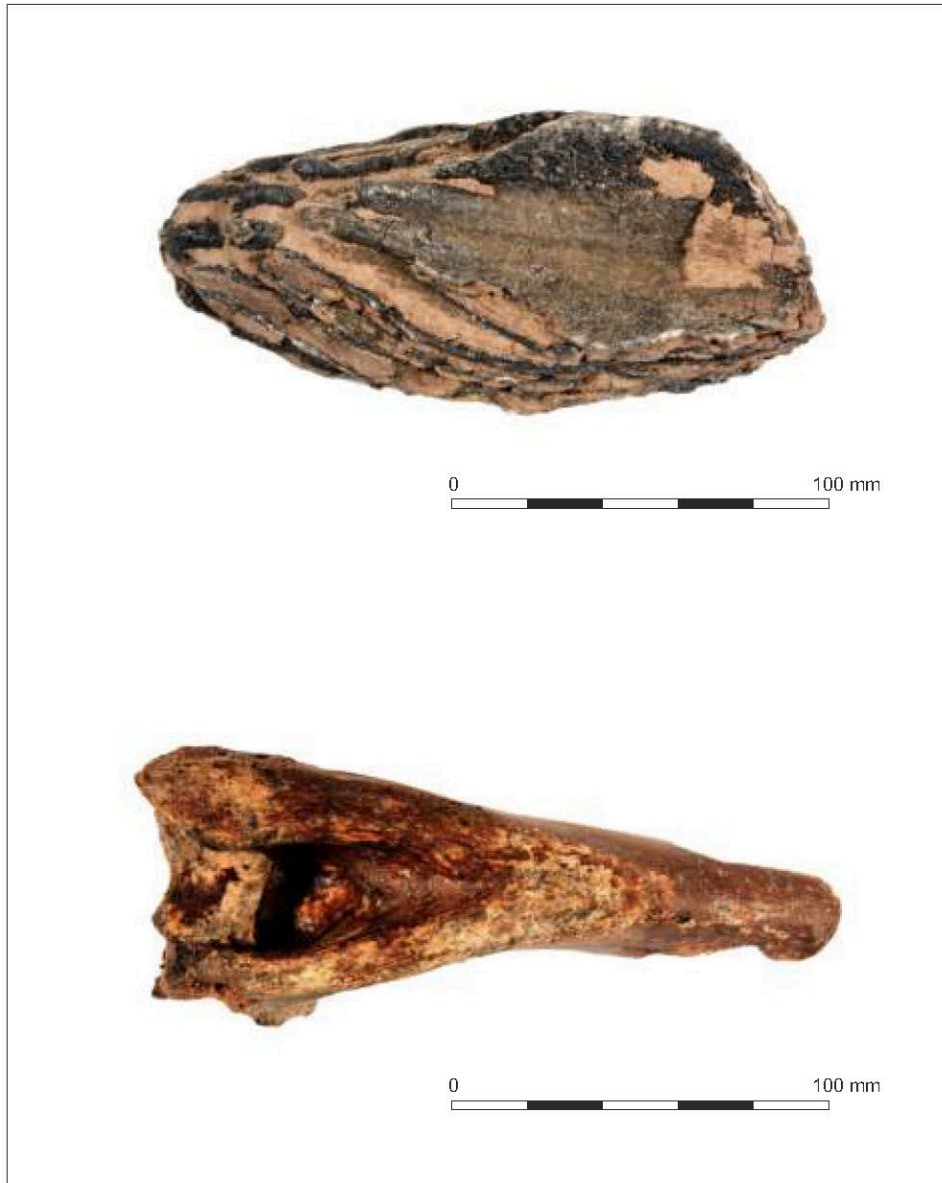


Plate 9: Area 319: WA 2235 and 2236 – faunal remains


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Plate 10: Area 319: WA 2241 and 2242 – faunal remains



Plate 11: Area 251: WA 2237 – lithic



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Plate 12: Area 360: WA 2240 – faunal remains

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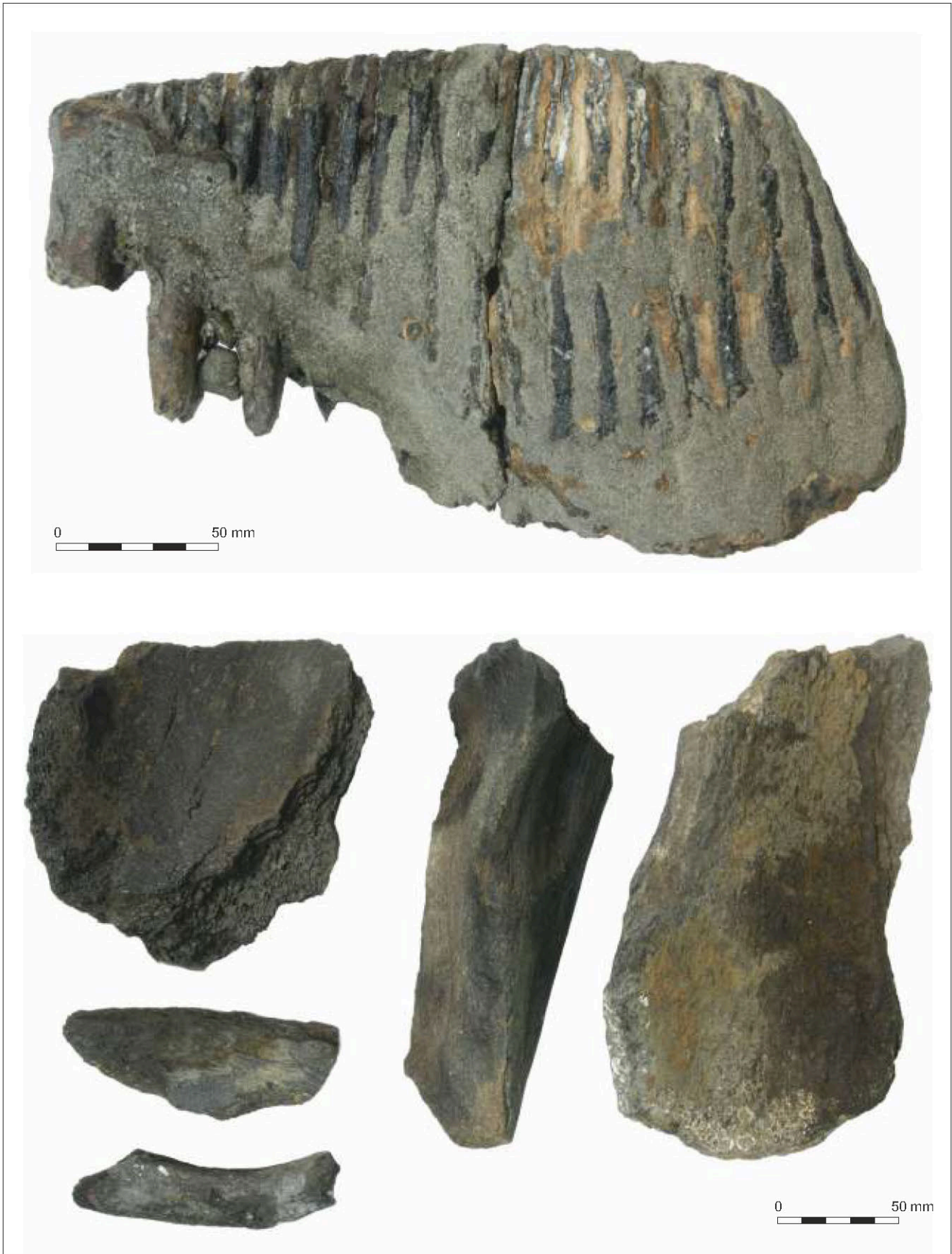


Plate 13: Area 361/242: WA 2248 – faunal remains


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Plate 14: Area 296: WA 2228 – faunal remains



Plate 15: Area 296: WA 2238 and WA 2239 – faunal remains


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Plate 16: Area 212: WA 2249 – lithic



Plate 17: Area 212: WA 2250 – lithic



Plate 18: Area 212: WA 2251 – faunal remains



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Plate 19: Area 228: WA 2258, 2259 and 2260 – lithics and faunal remains

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