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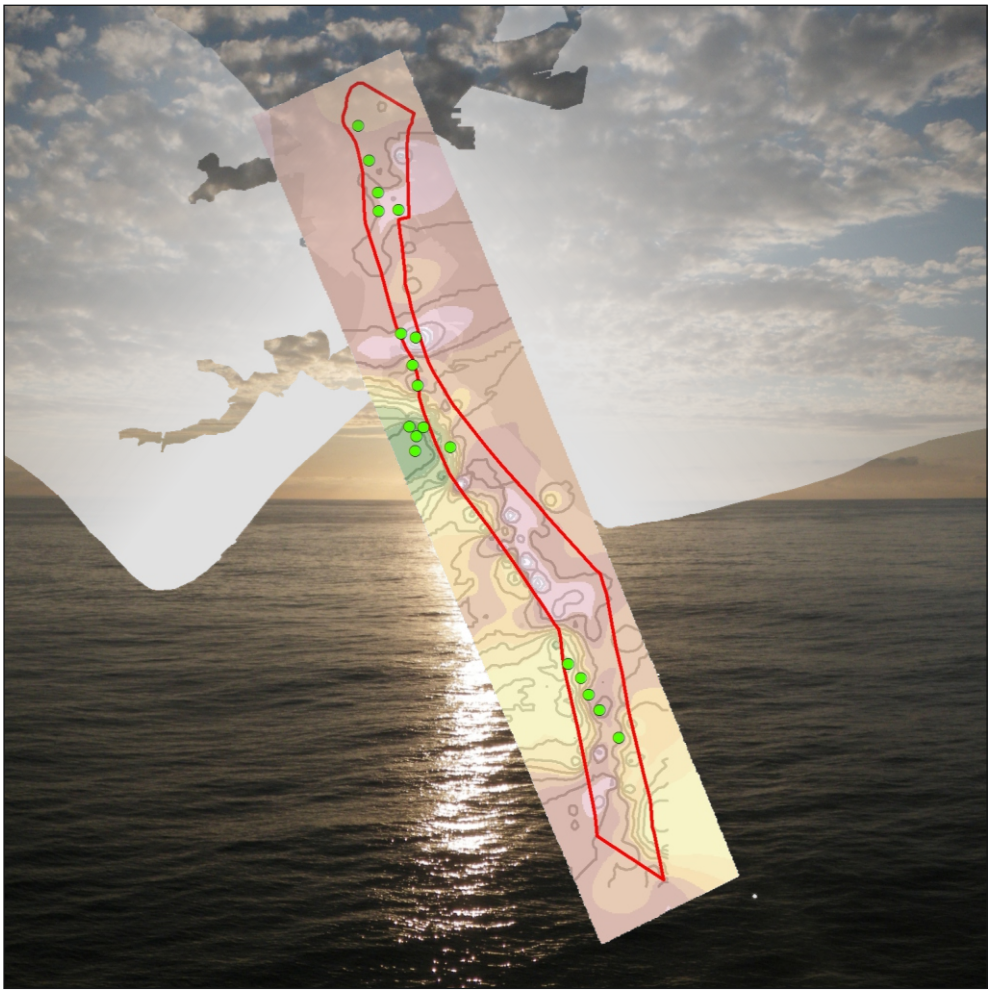
Stage 2 Geoarchaeological borehole recording and deposit modelling



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Queen Elizabeth Class Capital Dredge Project
Her Majesty's Naval Base Portsmouth

Stage 2 Geoarchaeological borehole recording and deposit modelling

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Stage 2 Geoarchaeological borehole recording and deposit modelling

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Summary

Wessex Archaeology was commissioned by Boskalis Westminster Limited, on behalf of the Defence Infrastructure Organisation, to undertake a Stage 2 investigation involving detailed recording and deposit modelling of geoarchaeological boreholes recovered during geotechnical investigations within the Portsmouth Harbour area and the approach channel. This assessment was undertaken in support of ongoing investigations related to a proposed scheme of dredging and development to be undertaken prior to the planned arrival of a Queen Elizabeth Class Aircraft Carrier at Portsmouth Harbour in 2016.

The Stage 2 geoarchaeological description of vibrocores and deposit modelling has recognised a complex sequence of sediments in the study area initially described during the Stage 1 geoarchaeological review of geotechnical logs. The Stage 1 geoarchaeological review divided these sediments into three units, conformed to in this report, comprising the underlying Eocene bedrock (**Unit 1**), a sequence of Pleistocene to early Holocene sands, gravels, clays and silts associated with the Palaeo-Wallington and Palaeo-Solent (**Unit 2**), and a sequence of intertidal clays and peats deposited during the Holocene under conditions of rising sea-levels following the end of the last (Devensian) ice age, sealed by modern sands and gravels (**Unit 3**). These units were divided into a series of sub-units in order to more clearly identify the specific geoarchaeological potential.

The study area has been divided into four separate areas defined by broad similarities in the dominant shallow geology and modern environment (**Areas A – D**). **Area A** is characterised by large Pleistocene palaeochannels, channel fills and overlying intertidal/estuarine sediment. **Area B** is characterised by river terrace gravels and sand and gravels associated with the Hamilton Bank. **Area C** is characterised by modern seabed sediment mixed with made ground deposited in and around the approach channel**. Area D** is characterised by shallow Eocene bedrock overlain by modern intertidal sediment, multiple peat layers and made ground.

Detailed geoarchaeological recording of sediments was undertaken on 19 vibrocore sequences acquired from Coastline Surveys, five each from **Areas A**, **B** and **D** and four from **Area C**. The cores do not contain any Bedrock (**Unit 1**) and predominantly contain **Units 2** and **3**, but particularly the latter unit, largely estuarine alluvium, marine sands, palaeobeach deposits and localised deposits of peat interbedded in alluvium.

Recommendations are made for Stage 3 geoarchaeological assessment, focusing on the palaeoenvironmental analysis of peat and over- and underlying alluvial deposits in three cores (**DT-10**, **026** and **029**) from **Area D**. The remaining cores from **Area D** and those from **Areas A-C** largely comprise marine sands and alluvium and thus have limited or no potential for further geoarchaeological assessment.

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The Stage 2 assessment report was compiled by Alex Brown, with geoarchaeological recording of vibrocores undertaken by Nicky and Holly Rodgers. Figures were created by Kitty Foster, quality control was provided by Jack Russell, and the project was managed for Wessex Archaeology by Jack Russell and Caroline Budd.

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Stage 2 Geoarchaeological borehole recording and deposit modelling

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) was commissioned by Boskalis Westminster Limited (BWL), the dredging contractor, on behalf of the Defence Infrastructure Organisation (DIO), to undertake a Stage 2 recording and deposit modelling of geoarchaeological boreholes. The samples (boreholes and vibrocores) were recovered during two programmes of geotechnical investigations within the Portsmouth Harbour area and its associated approach channel. This Stage 2 report was undertaken as part of ongoing investigations related to the proposed scheme of dredging and development to be undertaken within the study area.

1.1.2 In 2016, Her Majesty's Naval Base (HMNB) Portsmouth is set to receive the first of the Royal Navy's Queen Elizabeth Class Aircraft Carriers (QEC). THE QEC will be the largest ship to enter Portsmouth Harbour, and as such alterations to the port are required to accommodate the vessel. The planned alterations include the further dredging and expansion of the existing approach channel and berth pocket along with refurbishment works to the Middle Slip Jetty (MSJ). This report includes recording and modelling of geoarchaeological boreholes relating only to the proposed dredging program, not the MSJ refurbishment.

1.1.3 This report forms a part of ongoing assessments within the area associated with the proposed dredging and redevelopment within Portsmouth Harbour, and relates directly to the archaeological Written Scheme of Investigation (WSI) produced by WA (WA 2015a). Previous assessment work associated with the project has resulted in the production of the Proposed Dredged Channel Extents (Blue 2 Route) area and serves as a focus and general study area (**Figure 1**).

1.1.4 This report builds upon the Stage 1 review of geotechnical logs with detailed descriptions of selected geoarchaeological boreholes, production of sediment cross-section (transects) and elevation models and recommendations for further assessment as part of Stage 3.

1.2 Geoarchaeological Background

1.2.1 An outline of the solid and superficial geology of the study area has been described in detail in the Stage 1 assessment report (WA 2015b). The solid geology comprises London Clay Formation within the inner Portsmouth Harbour area with deposits of the Bracklesham Beds within the middle of the study area and Barton Beds to the south, all of Eocene age.

1.2.2 The bedrock is overlain by Pleistocene and early Holocene fluvial sediments relating to the courses of the Palaeo-Wallington and Palaeo-Solent. Previous interpretations of geophysical data by WA and Maritime Archaeology Limited (MAL), including sub-bottom

profiler (SBP) data, undertaken within the study area, have identified a series of buried palaeochannels associated within these river systems (WA 2004; MAL 2007).

1.2.3 Fluvial sediments will have been deposited during glacial periods when sea-levels would have been significantly lower. At this time the study area would have been terrestrial, dissected by a series of palaeochannels, forming an attractive landscape for past hominin communities, the earliest evidence for which in the UK has been identified at Happisburgh, Norfolk, and Pakefield, Suffolk, dating to 700,000 – 800,000 BP (Parfitt et al. 2005, 2010).

1.2.4 The Pleistocene deposits in Portsmouth Harbour form part of extensive quaternary sediments extending across the Hampshire and Sussex Coastal Plain, including the internationally significant middle Palaeolithic sites at Boxgrove, dating to 500,000 years ago (Roberts and Parfitt 1999).

1.2.5 The retreat of the icesheet at the end of last (Devensian) glaciation led to rising sea-levels and the deposition of Holocene estuarine alluvium, with interbedded peat deposits representing periods of falling or stable sea-levels. These Holocene deposits are now present sub-tidally as a consequence of continued Holocene sea-level rise and the effects of post-glacial isostatic rebound resulting in the sinking of southern England as the North rises.

2 GEOARCHAEOLOGICAL FRAMEWORK

2.1 Introduction

2.1.1 To help frame geoarchaeological investigations of this nature, Wessex Archaeology has developed a five stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results at the level achieved. The stages are summaries below in **Table 1**:

Table 1: Stages of Geoarchaeological assessment/recording

Stage	Method	Description
1	Assessment	Desk-based archaeological assessment of the borehole and vibrocores logs generated by geotechnical contractors. Aims to establish the likely presence of horizons of archaeological and geoarchaeological interest and broadly characterise them. Recommend what Stage 2 recording is required. The Stage 1 report will state the scale of Stage 2 work proposed.
2	Geoarchaeological recording	Recording of selected or retained new core samples undertaken. This entails the splitting of cores, with half of each core cleaned and recorded. The Stage 2 report will state the results of the recording and will indicate whether any Stage 3 work is warranted.
3	Sampling and assessment	Dependent on the results of Stage 2, sub-sampling and assessment of palaeoenvironmental remains (pollen, diatoms and foraminifera) may be required. Sub-samples will be taken from one core-half, with the other core-half retained intact for further sub-sampling, should it be required. Work will comprise laboratory-based assessment of samples to a level sufficient to enable the value of palaeoenvironmental material surviving in the core to be identified. Sub-samples will also be taken and retained at this stage in case radiocarbon dating is required during Stage 4. The Stage 3 report will set out the results of each laboratory assessment together with an outline of the archaeological

		implications of the combined results, and will indicate whether any Stage 4 is warranted.
4	Analysis and dating	Full analysis of pollen, diatoms and/or foraminifera assessed during Stage 3 will be undertaken. Typically, Stage 4 will be supported by radiocarbon dating of suitable sub-samples. Stage 4 will result in an account of the successive environments within the coring area, a model of environmental change over time, and an outline of the archaeological implications of the analysis.
5	Final Report	If required Stage 5 will comprise the production of a final report of the results of the previous phases of work for publication in an appropriate journal. This report will be compiled after the final phase of archaeological work, whichever phase that is.

2.1.2 This report comprises Stage 2 of the above described approach, with recommendations made for further Stage 3 work if deemed necessary.

2.2 Aims and objectives

2.2.1 The aim of this assessment is to undertake a detailed recording of acquired geotechnical cores in order to identify deposits of geoarchaeological potential and inform further Stage 3 assessment. This is to be undertaken in accordance with the previous WSI and Stage 1 report associated with the proposed dredging and development scheme (WA 2015a & b). The objectives are as follows:

- Undertake a detailed recording of geotechnical cores identified in Stage 1, characterise and identify suitable deposits for future Stage 3 assessment.
- Undertake geoarchaeological deposit modelling where feasible.
- Report the results as part of ongoing geoarchaeological assessment for the proposed scheme.

3 METHODOLOGY

3.1 Aims and objectives

3.1.1 The Stage 1 report detailed the assessment of geological logs from within and around the study area, comprising 27 boreholes acquired by Fugro Seacore Limited (Fugro) and 176 vibrocores acquired by Coastline Surveys (WA 2015b). As a result of Stage 1 assessment, recommendations were made for further Stage 2 geoarchaeological recording of 19 vibrocores acquired from Coastline Surveys and described by Wessex Archaeology (**Figure 1**). The logs were provided to Wessex Archaeology and the selected cores were collected from HMNB Portsmouth. The 19 selected vibrocores form the basis for this Stage 2 report and the subsequent recommendations for Stage 3 assessment.

3.1.2 Of most interest during the recording of the vibrocores are sediments deposited within terrestrial/semi-terrestrial environments (peat, organic clays and fine-grained alluvium) or that were formed of deposited within defined features with a clear geoarchaeological potential, such as palaeochannels.

3.1.3 The Coastline Survey vibrocores logs were used to develop digital elevation models (DEMs) and stratigraphic sections through the study area.

3.2 Sediment recording

3.2.1 The cores were opened in the Wessex Archaeology laboratory and described by a suitably experienced geoarchaeologist following Hodgson (1997), to include information such as:

- *Depth*
- *Texture*
- *Composition*
- *Colour*
- *Inclusions*
- *Structure (bedding, ped characteristics etc)*
- *Contacts between deposits*

3.3 Deposit modelling

3.3.1 The deposit records from the geotechnical logs were entered into industry standard software (Rockworks™ v17.0).

3.3.2 In total 176 records (representing the individual vibrocores) were entered into the Rockworks database. Each identified lithological unit (gravel, sand, silt etc.) was given a unique colour and pattern allowing cross correlation of the different sediment and soil types across the study area.

3.3.3 Where suitable contexts were present, a sequence of stratigraphic units representing defined depositional environments and/or landforms could be reconstructed and displayed in the form of Digital Elevation Models (DEMs) and transects.

3.3.4 However, the geotechnical logs do not lend themselves well to modelling individual sedimentary units in plan as the logs are distributed within the study area along a thin linear south-north transect. Any west-east lateral variation in sediments would therefore not be apparent due to a lack of data points. Many of the vibrocores were also small and disturbed. Instead the logs were used to develop a surface elevation model and four south-north cross-sectional transects showing the sediments along the route corresponding to **Areas A–D (Figures 2–6)**.

4 RESULTS

4.1 Stage 2 geoarchaeological recording of vibrocores

4.1.1 Nineteen vibrocores acquired by Coastline Surveys between December 2011 and January 2011 were selected for further detailed geoarchaeological recording. Based on the results of work a series of recommendations are set out below in **Section 5**.

4.1.2 Stage 1 Assessment of geotechnical logs identified a complex sequence of geological units which were divided into three basic units by time period, as follows below in **Table 2**, with **Unit 2** and **3** subsequently divided into a series of sub-units. This division and description of units/sub-units is adhered to in this report.

4.1.3 **Unit 1** sediments are not encountered within the selected vibrocores that form the basis of this report, with the majority of deposits conforming to **Units 2** and **3**, with **Unit 3** deposits, particularly the peat and estuarine alluvium, of greatest palaeoenvironmental potential.

4.1.4 Due to the complex nature of the shallow geology represented within the reviewed borehole logs, and due to the fact that it has been created by assessing geotechnical logs only and not physical samples, this more detailed stratigraphy is only tentative and is subject to alteration and update should new information be obtained (e.g. radiocarbon dates allowing correlation of sedimentary units).

Table 2: Broad Geological Units and Sub-Units Observed within the Study Area

Unit	Age	Unit / Sub-Unit Description	
Unit 3	Early Holocene to Recent	A sequence of soft clays, peat, coarse sand and gravel and made ground. Represents the Holocene marine transgression and a range of deposits associated with the modern environment – intertidal, sand banks, seabed sediment and anthropogenic made ground.	
		Sub-Unit 3e	Peat
		Sub-Unit 3d	Sandy gravel and gravelly sand, mixed with brick and glass fragments and metal pipework
		Sub-Unit 3c	Loose gravelly sand and sandy gravel, modern seabed sediment and sand bank deposits.
		Sub-Unit 3b	Soft clay containing organic material, intertidal deposits.
		Sub-Unit 3a	Gravelly sand and sandy gravel, possible marine transgression deposit.
Unit 2	Pleistocene to Early Holocene	A complex sequence of coarse sandy gravel, gravelly sand, silts and and soft clays. Interpreted as channel fill and terrace deposits, and rapid lateral changes over small distances indicate a braided channel system. Represents the deposits associated with the Palaeo-Wallington and Palaeo-Solent rivers.	
		Sub-Unit 2c	Coarse sandy gravel and gravelly sand, often clayey, possible Pleistocene river terrace deposits.
		Sub-Unit 2b	Interbedded soft laminated clay and silt, often with organic matter, roots and burrows. Pleistocene channel fill deposits.
		Sub-Unit 2a	Coarse gravelly sand and sandy gravel, Pleistocene channel lag deposits.
Unit 1	Eocene	Tertiary bedrock characterised by dense clayey sands and stiff sandy clays. Upper clay layer often softer (presumably weathered). Clay often contains pockets of organic matter (possibly peat) and mottlled colouring. Comprises a number of geological formations, namely the London Clay Formation, Bracklesham Beds and Barton Beds. Represents the bedrock in the study area.	

4.1.5 None of the assessed boreholes logs contain a full sequenced as described in **Table 2**, and, as such, some of the units are difficult to place relative to each other within the sequence.

4.1.6 This complexity and difficulty with correlation is due to three main factors: the original complex nature of the braided river system, the differences in present-day environments

within the study area, and the alterations made to the shallow geology by the development of Portsmouth Harbour (i.e. dredging and made ground deposition).

4.1.7 For the ease of discussion the study area has been divided approximately into four separate areas (A–D) defined by similar dominant shallow geology, modern environmental processes, and recent anthropogenic influence. The selected nineteen cores come from across these four areas. These areas are illustrated in **Figure 1** and briefly summarised below in **Table 3** as follows.

4.1.8 Deposit modelling was restricted to a digital surface elevation model, using the local Chart Datum heights from the tops of each core to show changes in the elevation of the seabed. These show a relatively uniform surface profile (**Figure 2**) with the greatest variation in elevation seen in **Area A**. There is no correlation between the surface elevation and the course of the interpreted palaeochannels (**Figure 1**).This might be expected where a palaeochannel has been buried by a deep sequence of Holocene sediments, but it may equally reflect damage, truncation or removal of palaeochannels resulting from dredging and anthropogenic activity related to the construction and use of Portsmouth Harbour.

Table 3: Summary of Interpreted Geological Areas and location of selected vibrocores

Area	Description	Vibrocores (DT-)
Area A	Southern most area, contains numerous large, deep palaeochannels and associated fills overlain by estuarine/intertidal sediment and a thin layer of modern seabed sand.	10, 20, 26, 29, 30A
Area B	Approximately around Hamilton Bank and the Portsmouth Harbour entrance, dominated by sands and gravels – mostly Pleistocene terrace gravels, sands and gravels associated with Hamilton Bank, and modern mobile seabed sediment.	48, 49, 51A, 52
Area C	Approximately the entrance to Portsmouth Harbour, approach channel in most areas dredged down to the Eocene bedrock with some overlying intertidal sediment in some areas, overlain by sea bed sediment including reworked made ground material.	64, 66, 69A, 71A, 72
Area D	Portsmouth Harbour area, shallow Eocene bedrock overlain by relatively modern intertidal sediments, made ground and peat layers of unknown age.	123, 127, 131A, 137, 141

Area A

4.1.9 **Area A** is the southernmost and the largest of the four areas as illustrated in **Figure 2**. Previous SBP interpretations indicate this area is where the Palaeo-Wallington once joined the Palaeo-Solent (WA 2004, MAL 2007), and as such the shallow geology of this area is dominated by large buried palaeochannels; descriptions of geotechnical logs confirm this interpretation (WA 2015b).

4.1.10 The vibrocore records from **Area A** vary in length from 2.03–4.3 m, and comprise sequences of estuarine/intertidal alluvium (silty-clay) and marine sands (**Figure 3**). In the case of the estuarine alluvium there are often thin lenses of fine sand, whilst the marine sands often contain fine clay lenses.

4.1.11 Fine grained alluvium is present in boreholes and vibrocores across the study area where it has previously been interpreted both as later channel fill of Pleistocene date (**Sub-Unit 2b**) and Holocene intertidal/estuarine sediments (**Sub-Unit 3b**) overlying the former course of the channels (WA 2015b).

4.1.12 Stage 1 assessment recommended detailed description of selected cores from **Area A** in order to distinguish between **Sub-Units 2b and 3b** (**Table 2**). In practice the similarities between the two sub-units make it very difficult to distinguish between the two types of alluvium, particularly between different areas.

4.1.13 However, there is very little observable difference between alluvium recorded in vibrocores from **Areas A–C** and those recorded from **Area D** where they overlie Holocene peats. This could be taken to suggest the alluvium in **Area A** is of a similar later Holocene date.

4.1.14 No organic deposits (peat) were recorded in any of the vibrocores.

Area B

4.1.15 **Area B** is a relatively small area, the shallow geology of which is dominated by sands and gravels associated with river terraces, the Hamilton Bank sand bank, and the modern seabed sediments (**Figure 4**).

4.1.16 No definite palaeochannel deposits were identified during Stage 1 work, despite an interpreted channel being present (**Figure 1**). The thickness of sandy sediments overlaying any channel in the area was argued to have resulted in boreholes not achieving sufficient penetration into the seabed to sample any underlying channel deposits that may be present.

4.1.17 Vibrocores selected from **Area B** for further description varied in length from 0.9–4.5 m. The shortest of these cores (**DT-071A**) contained only gravelly sands interpreted as palaeobeach deposits comparable to **Sub-Unit 3c** (**Table 2**). In core **DT-069A** identical gravelly sands overlie estuarine alluvium and emphasise their relative recent date. The gravelly sands are likely to be composed at least in part of reworked underlying sediment, including material from gravel terraces.

4.1.18 Vibrocores **DT-64, 69A** and **72** both contain sequences of estuarine silty clay alluvium of varying hue. The alluvium typically contains occasional marine shells, though locally abundant in **DT-069A** between 2.5–2.6 m. Lenses of fine, medium and coarse sand were also recorded within the alluvium, with occasional flint gravel clasts <5 cm recorded in the upper alluvium in **DT-064 and 069**. Patches of iron-staining was also recorded from the alluvium, present in **DT-072** as horizontal laminations, suggests periods of alternate wetting and drying, most probably where the saltmarsh surface was tidally exposed.

4.1.19 The alluvium is likely to correspond with **Sub-Unit 3b** (**Table 2**). No organic deposits were recorded in any of the cores, although the lowest alluvium in **DT-072** (5.8–5.9 m) partly comprised a thin black soft silty-clay oxidising to olive brown.

4.1.20 Vibrocore **DT-066** differed significantly from the other cores in containing unconsolidated and disturbed silty-clays with occasional gravels that are likely to represent locally thick deposits of recent marine muds.

4.1.21

Area C

4.1.22 **Area C** is the smallest of the four described areas and is almost exclusively dominated by anthropogenic effects associated with the development of the entrance to Portsmouth Harbour.

4.1.23 In general, the dredged approach channel has removed all Quaternary sediment down to the Eocene bedrock (**Unit 1**), although some pockets of intertidal sediment (**Sub-Unit 3b**) remain in some locations (**Figure 5**).

4.1.24 Vibrocores **DT-049** and **051A** only contained rounded flinty gravel in a silty-clay matrix, interpreted as beach deposits accumulated in more recent centuries. **DT-048** and **052** likewise contain flinty gravels, although in a sandy matrix, but in both cases overlying estuarine alluvial deposits of **Sub-Unit 3b**. The alluvium in both cores contains zones with coarse silt and fine sand laminations, with iron staining recorded along these laminations in **DT-052**. The alluvium is comparatively thin in comparison to **Areas A** and **B**, contains no organic deposits, and is of low geoarchaeological potential.

Area D

4.1.25 **Area D** is the northernmost of the interpreted areas and comprises the section of the study area within Portsmouth Harbour, both around HMNB Portsmouth and further inland. As with **Area C**, it is strongly influenced by anthropogenic activity, but contains additional layers not present in **Areas A–C** of which peat deposits are the most significant **(Figure 6)**.

4.1.26 Palaeochannels have also previously been interpreted within this area (MAL 2007, **Figure 2**) but, as with **Area C**, no definitive evidence for these channels has been identified within the geotechnical logs

4.1.27 Vibrocores within **Area D** contain variable sequences of marine sands with gravels, estuarine alluvium and thin deposits of peat and peat with clay. **DT-030A** comprises estuarine alluvium (**Sub-Unit 3b**), containing occasional marine shells, overlying marine sands (**Sub-Unit 3a**); in places the marine sands contain silty laminations. **DT-020** is entirely composed of estuarine alluvium.

4.1.28 Thin deposits of peat and peat with clay (**Sub-Unit 3e**) were recorded from **DT-010**, **026** and **029**. These peats are thin and highly compressible, particularly from the weight of overlying sediment and water, with the peat in **DT-029** thickest at 0.45 m. Single peat units are present in **DT-026** and **029** with the peat in **DT-026** containing a significant clay content and sand grains, suggesting regular in-wash of the peat surface. The peat is typically over and underlain by estuarine alluvium (**Sub-Unit 3b**) with a thin unit of marine sands at the top of **DT-026** (**Sub-unit 3c**).

4.1.29 **DT-010** contains two distinct but relatively thin peat units (2.6–2.78 and 3.12–3.30 m) separated by estuarine alluvium. The peats represent terrestrial/semi-terrestrial land-surfaces that contain significant potential for the survival of environmental remains and are of high geoarchaeological potential.

4.1.30 The Stage 1 report identified a peat overlying made ground containing metal piping, and therefore likely to be fairly recent or redeposited. No such peats were recorded from any of the cores described as part of the Stage 2 assessment.

4.1.31 Radiocarbon dating will be required to determine the date and contemporaneity of the peat deposits described in the vibrocores.

5 DISCUSSION AND RECOMMENDATIONS

5.1 Recommendations

5.1.1 Detailed geoarchaeological descriptions of vibrocores have revealed a complex sequence of deposits within the study area. These deposits have been divided into three broad time periods and further sub-divided into a series of units of the basis of their sedimentological properties. The study area has also been divided into four separate areas based on similar geology and environment.

5.1.2 The generalised stratigraphy of the study area records a Pleistocene terrestrial environment dissected by a braided river system that was subsequently submerged during the Holocene transgression following the melting and retreat of the last (Devensian) icesheet.

5.1.3 Detailed description of vibrocores was recommended in the Stage 1 report to distinguish between soft clay/silty-clay sediments of **Sub-Units 2b** and **3b** – of Pleistocene and Holocene date respectively. In practice this has not been entirely possible primarily because of the similarity of these two Sub-Units, and the difficulty of contrasting similar sediments across close but relatively unconnected areas of complex stratigraphy.

5.1.4 The detailed recording of vibrocores has identified select vibrocore sequences that have high geoarchaeological potential and a series of recommendations are made for further targeted Stage 3 geoarchaeological assessment.

5.1.5 Targeted Stage 3 geoarchaeological assessment is recommended only on those vibrocores containing organic horizons (e.g. peat) and the immediate overlying and underlying alluvial sediments. These sediments have the highest geoarchaeological potential in terms of suitable deposits for dating and likely to contain the widest range of well-preserved palaeoenvironmental indicators. The peat/organic sediments, and the interface with the alluvium, represent specific marine transgressive-regressive episodes, and are best placed to consider questions of human activity and land-use in the context of processes of riverine, estuarine and coastal change occurring across the study area over time.

5.1.6 Further targeted geoarchaeological assessment is therefore recommended on the following vibrocores from **Area D** (**DT-10**, **DT-026** and **DT-029**). The remaining cores from **Area D**, along with those from **Areas A – C** almost exclusively contain estuarine alluvium and marine sand deposits and have limited or no further geoarchaeological potential. The number and type of samples to be assessed from each borehole is listed below in **Table 3**.

5.1.7 Palaeoenvironmental sampling is not recommended through deep sequences of alluvium and marine sands. The formation process and environmental context of these sediments is well-understood, deposited under rising sea-levels.

5.1.8 More importantly, however, the lack of securely datable organic horizons through the majority of the vibrocores across the study area severely limits the chronological resolution of any associated palaeoenvironmental data.

5.1.9 Peat and highly organic deposits offer the best opportunity for reconstructing past environments, human activity and land-use, reflecting periods of marine regression where conditions may have provided opportunities for human communities to exploit new

environmental niches, along with an indication of the contemporary environment, human activity and land-use regime occurring on the adjoining dry ground.

5.2 Sampling strategy and research questions

5.2.1 Stage 3 geoarchaeological assessment will involve a suite of complementary techniques, comprising pollen, diatoms, foraminifera and ostracods, supported by radiocarbon dating of suitable organic deposits. Multiple techniques are typically assessed in accordance with Historic England guidelines on good practice in environmental archaeology (Historic England, 2011), providing a comprehensive understanding of the depositional and environmental context of the sediments.

5.2.2 Vibrocores are currently stored at the Wessex Archaeology offices where sub-samples can be extracted for palaeoenvironmental assessment. The sediments are currently in moderate to good condition. However, sub-sampling is recommended sooner rather than later as the sediment and palaeoenvironmental remains will naturally continue to degrade.

5.2.3 Pollen is the principal technique used in environmental archaeology to investigate past vegetation environments and the impact of human communities on the landscape, and is best preserved in waterlogged organic and oxygen-free sediment, such as peat, where the pollen grains are most representative of the surrounding vegetation at the time of deposition. Marine sediments are not ideal for pollen assessment as the grains may be transported over long distances of suspended in the water column for significant periods of time.

5.2.4 Diatoms (unicellular algae), foraminifera (marine protozoa) and ostracods (bivalve Crustacea) occur in a wide range of marine and semi-terrestrial environments and provide important indicators on past coastal and riverine change.

5.2.5 Peat and highly organic deposits will be sampled for pollen assessment, focusing on the preservation and concentration of palynomorphs and to examine the evidence for local environmental conditions, vegetation, human activity and land-use.

5.2.6 Pollen will be supported by diatom, foraminifera and ostracod assessment on the alluvium overlying and underlying the peat units and the transition with the alluvium. This will investigate sea-level change and the influence of marine environments (e.g., evidence for in-wash of palaeolandsurfaces during storms, flood events) during periods of transgressive-regressive tendencies. Such periods offer particular opportunities for human exploitation of a range of specialised environmental niches, and are of primary importance here for assessment.

5.2.7 Radiocarbon dating on peat deposits will provide a baseline chronological context for the targeted palaeoenvironmental assessment, and help to establish the timing and extent of anthropogenic activity, and establish the contemporaneous or asynchronous nature of the organic sediments encountered in the vibrocores.

6 REFERENCES

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7 APPENDICES

7.1 Appendix 1: Vibrocore descriptions (provisional units and sub-units based on Table 2)

Location:		462294.49 101256.28	**Mono:**	DT-010	**Comments: 111320 Portsmouth Dredge** **VC DT-010** **Described by NM**		
Level (top):		-10mCD	**Drg:**				
Depth		**Unit or sub-unit (see Table 2)**	**Samples (if taken)**	**Sediment description**	**Interpretation**		
Mono	mCD						
0.78-0.95	-10.78- -10.95	3b		2.5Y 3/2 very dark greyish brown silty clay with moderate sub rounded and linear iron stain and concretions. Occasional marine shells. No apparent horizontal banding. 0.1% fine pores and occasional <1mm small burrows. Sharp boundary.	Estuarine alluvium.	Estuarine alluvium with an inundation of marine sand due to fluctuating water levels	
0.95-1.13	-10.95- -11.13	3c		2.5Y 3/3 dark olive brown medium sand with some clay and moderate small gravel and possible clinker <5mm. Sand becomes slightly finer and with more clay content from 1.07 to base. Sharp boundary.	Marine sands.		
1.13-1.78	-11.13- -11.78	3b		2.5Y 3/2 very dark greyish brown soft buttery silty clay with abundant marine shells. No obvious horizontal banding. (No boundary, end of core)	Estuarine alluvium with marine shell.		

Location:		462294.49 101256.28	**Mono:**	DT-010	**Comments: 111320 Portsmouth Dredge** **VC DT-010** **Described by NM**	
Level (top):		-10mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples (if taken)**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.78-2.60	-11.78- -12.60	3b		10YR 3/1 very dark grey stiff and compact clay with occasional patches of organics and some waterlogged roots. Faintly horizontally banded. From 2.48-2.60 the deposit is clearly banded with 10YR 2/1 black very humic silty clay. Bands of freshwater/brackish water molluscs at 2.55m ant at base. Mollusc assemblage includes *Bithynia tentaculata, Planorbis planorbis* and *Hydrobia* spp. Indicating well vegetated tidal estuarine conditions. Sharp boundary.	Estuarine alluvium choking off peat below. Mollusc assemblage indicates well vegetated tidal estuarine conditions.	Well vegetated tidal estuarine conditions with fluctuations in water level. Alluvium choking off peat below.
2.60-2.78	-12.60- -12.78	3e		10YR 2/2 very dark brown peat with slightly interleaved bands of 10YR 2/2 very dark brown and 10YR 4/3 brown very humic silty clay. Clearly horizontally banded. Occasional pieces of wood/woody roots with a larger piece of wood from 2.73 to base. (No boundary, end of core)	Peat and estuarine alluvium being choked off	Peat
2.78-3.12	-12.78- -13.12	3b		7.5 YR 2.5/1 black soft silty clay with occasional lumps of waterlogged organics. 0.2% fine pores. Faintly horizontally banded. Sharp boundary.	Estuarine alluvium with occasional organics choking off peat below.	Estuarine alluvium
3.12-3.30	-13.12- -13.30	3e		7.5YR 2.5/2 very dark brown peat oxidising to 10YR 2/1 black. Soft and very organic with some visible plant remains. Piece of wood at top boundary.	Peat.	Peat

Location:	462380.94 100971.95	**Mono:**	DT-020	**Comments: 111320 Portsmouth Dredge** **VC DT-020** **Described by NM**		
Level (top):	-10.44mCD	**Drg:**				

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
0.72-1.53	-11.16- -11.97	3b		10YR 3/2 very dark greyish brown silty clay becoming slightly siltier and more compact with depth. Sample quite dried out but still has a vague blocky structure. Occasional small patches of iron stain, some linear suggesting possible root voids. 0.1% fine pores. Very faint horizontal banding.	Estuarine alluvium	Estuarine alluvium that had been subject to occasional wetting and drying (redoximorphism)
1.53-1.75	-11.97- -12.19			GAP	GAP	
1.75-2.10	-12.19- -12.54	3b		10YR 3/3 dark brown very silty clay (noticeably siltier than above). Very dried out and fairly compact but crumbly with pressure. No visible horizontality. Rare small iron mottles <2mm, rare fragments of shell (too small for identification) End of core, no boundary to record.	Estuarine alluvium	
2.10-2.67	-12.54- -13.11	3b		10YR 3/2 very dark greyish brown fairly silty clay. Slightly blocky in structure but again, very dried out. Faint horizontal banding. Occasional 10YR 3/6 dark yellowish brown iron subrounded iron mottles. Occasional fragments of shell (too small for identification)	Estuarine alluvium	

Location:	462457.69 100709.34	**Mono:**	DT-026	**Comments: 111320 Portsmouth Dredge** **VC DT-026** **Described by NM**	
Level (top):	-11.09mCD	**Drg:**			

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
0.53-0.57	-11.62- -11.66	3c		2.5Y 4/4 olive brown medium to coarse sand with rounded to sub rounded small gravel <5mm and frequent marine shell fragments. Sharp boundary	Marine sands.	Marine sands
0.57-1.65	-11.66- -12.74	3b		2.5Y 3/2 very dark greyish brown soft buttery silty clay with fine horizontal banding. Occasional heavily iron stained roots and root voids, especially at 1.20-1.65m. Some lateral cracking and occasional waterlogged plant remains. Becomes slightly darker in colour from 1.52m and appears to have a bit more structure. (Gap at 1.44-1.52 – top of core) Clear boundary.	Estuarine alluvium with occasional plant remains. Iron stain suggests wetting and drying (redoximorphism) indicating fluctuating water levels.	Estuarine alluvium – fluctuating water levels.
1.65-1.79	-12.74- -12.88	3b		5Y 2.5/1 black silty clay oxidising to 5Y 6/4 pale olive. Thinly laminated with common iron stained roots and root voids. Clear boundary.	Estuarine alluvium with reducing conditions and redoximorphism. Choking off peat below.	Estuarine alluvium choking off peat due to rise in water level.
1.79-1.97	-12.88- -13.06	3e		10YR 2/2 very dark brown peat with clay and some fine quartzy sand grains. No horizontal banding visible, no distinct structure. Occasional plant remains and some iron stain that increases with depth. Becomes more minerogenic towards base. Clear boundary	Peat with clay – subject to regular tidal inwashes	Peat that is subject to regular tidal inwashes

Location:	462457.69 100709.34	**Mono:**	DT-026	**Comments: 111320 Portsmouth Dredge** **VC DT-026** **Described by NM**	
Level (top):	-11.09mCD	**Drg:**			

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.97-2.25	-13.06- -13.34	3b or 2b		10YR 3/2 very dark greyish brown finely laminated silty clay. Fairly plastic with some lateral cracking suggesting structure. Rare waterlogged plant remains. Becomes slightly darker with depth- 10/YR 2/1 black. Clear boundary.	Estuarine alluvium	Estuarine alluvium
2.25-2.45	-13.34- -13.54	3b or 2b		7.5YR 3/3 dark brown silty clay with indistinct mottles of 10YR 4/4 dark yellowish brown to 2.33m. Occasional iron stained root voids, especially towards the base. 0.1% fine pores. Blocky structure- fine to medium peds.	Salt marsh/tidal mudflats.	Salt marsh/tidal mudflats.

Location:	462462.83 100559.33	**Mono:**	DT-029	**Comments: 111320 Portsmouth Dredge** **VC DT-029** **Described by HR**	
Level (top):	-10.98mCD	**Drg:**			

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.04- 2.28	-12.02- -13.26	3b		Gley 1 4/1 dark greenish grey clayey silt with fine-medium sand and very common (30%) marine shell throughout (incl. oyster + cockle). Sand becoming slightly coarser with depth. Sharp lower boundary. 1.04-1.09m compression gap due to the coring process. (Gap at 1.71-1.81m – sample removed for contamination testing).	Estuarine alluvium/sea bed	Estuarine alluvium/sea bed
2.28-2.43	-13.26- -13.41	3b		Gley 1 3/1 very dark grey clayey silt with fine-medium sand and oxidising to 2.5Y 4/3 olive brown throughout. Sparse (5%) marine shell. Sharp L/B.	Estuarine alluvium/sea bed	
2.43-2.88	-13.41- -13.86	3e		2.5YR 2.5/1 reddish black fine crumbly peat with faint horizontal banding visible. Peat becomes slightly minerogenic with depth and 2.5YR 3/1 dark reddish grey between 2.76-2.88m. Sharp L/B.	Peat	Peat

Location:	462623.61 100567.99	**Mono:**	DT-030A	**Comments: 111320 Portsmouth Dredge** **VC DT-030A** **Described by NM**	
Level (top):	-11.70mCD	**Drg:**			

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
0.20-0.67	-11.90- -12.37	3d		(Gap from 0.00-0.20) 10YR 3/2 very dark greyish brown silty clay with common marine shell and occasional metal and coal fragments. Becomes slightly siltier with depth. Sharp boundary	Estuarine alluvium/sea bed.	Estuarine alluvium/marine sands. Sea bed at the top.
0.67-2.30	-12.37- -14.00	3c		(Gap at 1.45-1.75 - sample removed for contamination testing) 10YR 3/3 dark brown sandy clay. Medium sand with common rounded to sub rounded flinty gravel <6cm, poorly sorted. Occasional iron staining around the larger pieces of gravel. Occasional marine shell.	Estuarine alluvium/marine sand	
2.30-2.70	-14.00- -14.40			GAP – sample removed for contamination testing	GAP	
2.70-3.30	-14.40- -15.00	3c		2.5Y 5/2 greyish brown fine to medium sand. Homogenous and stone free. Clear boundary.	Fine marine sand	Fine to medium marine sand with occasion pockets of silt. Indicates fluctuations in water level and speed of current.
3.30-3.58	-15.00- -15.28	3c		5Y 5/4 olive sand oxidising to 5Y 6/4 pale olive with fine horizontal banding. Layer of horizontally banded 2.5Y 2.5/1 black slightly clayey silt at 3.43-3.55m. Thin (1mm) piece of wood at 3.43, probably washed in. Clear boundary	Marine sands with silty inwashes.	

Location:		462623.61 100567.99	**Mono:**	DT-030A	**Comments: 111320 Portsmouth Dredge** **VC DT-030A** **Described by NM**	
Level (top):		-11.70mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
3.58-3.83	-15.28- -15.53	3c		5Y 5/1 grey fine sand oxidising to 2.5Y 5/6 light olive brown. Fine and clear horizontal banding throughout. Stone free. Clear boundary	Marine sands	
3.83-4.20	-15.53- -15.90	3c		5Y 6/1 grey fine sand with faint horizontal banding. Darker band at 3.92 containing possible charcoal flecks. Sharp boundary.	Marine sands with possible charcoal flecks.	Fine to medium marine sand with occasion pockets of silt. Indicates fluctuations in water level and speed of current.
4.20-4.78	-15.90- -16.48	2b or 3b		2.5Y 5/1 grey fine sand oxidising to 5Y 6/6 olive yellow. Fine horizontal banding throughout. From 4.20-4.30 banding is darker (2.5Y 3/1 very dark grey) with a thin lamination of very dark grey silty clay in the top 1cm.	Marine sands with inwashes of silty clay.	

Location:	462763.68 99520.68	**Mono:**	DT-048	**Comments: 111320 Portsmouth Dredge** **VC DT-048** **Described by HR**
Level (top):	-16.8mCD	**Drg:**		

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.05-1.23	-17.85- -18.03	3c		2.5Y 4/1 dark grey firm silty clay with fine-medium sand and common (30%) sub rounded – sub angular gravel inclusions <0.06m throughout. Sharp lower boundary.	Palaeo-beach deposits.	Palaeo-beach deposits
1.23-2.03	-18.03- -18.83	3b		2.5Y 4/2 very dark greyish brown firm silty clay with regular horizontal banding of 5Y 7/2 light grey coarse silt – very fine sand throughout. Banding becomes slightly less fine with depth. Clear lower boundary. 1.58-1.75 disturbed due to the coring process.	Estuarine alluvium	Estuarine alluvium
2.03-2.11	-18.83- -18.91	3b		5Y 4/1 dark grey silty clay with fine-medium sand. Sharp lower boundary.	Estuarine alluvium	
2.11-2.40	-18.91- -19.20	3c		5Y 5/3 olive fine-medium sand – mostly disturbed by the coring process. Sharp lower boundary.	Marine sand	Marine sand

Location:	462646.72 99551.27	**Mono:**	DT-049	**Comments: 111320 Portsmouth Dredge** **VC DT-049** **Described by NM**		
Level (top):	-11.11mCD	**Drg:**				
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.84-3.35	-12.95- -14.46	3c		Rounded to sub rounded flinty gravel <5cm with a 10YR 4/2 dark greyish brown wet silty clay matrix. Clast supported. Poorly sorted to 2.40 then becomes moderately well sorted with depth.	Palaeobeach deposits.	Palaeobeach deposits

Location:	462741.57 99295.24	**Mono:**	DT-051A	**Comments: 111320 Portsmouth Dredge** **VC DT-051A** **Described by NM**		
Level (top):	-9.52mCD	**Drg:**				
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.90-2.80	-11.42- -12.32	3c		Poorly sorted sub rounded flinty gravel with a 10YR 4/2 dark greyish brown silty clay matrix. Clast supported. Gravel <8cm. Very compact.	Palaeobeach deposits.	Palaeobeach deposits.

Location:	462784.07 99124.88	**Mono:**	DT-052	**Comments: 111320 Portsmouth Dredge** **VC DT-052** **Described by NM**	
Level (top):	-11.49mCD	**Drg:**			

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
0.55-0.70	-12.04- -12.19	3c		Rounded to sub rounded gravel <10cm with a 10YR 4/4 dark yellowish brown silty clay matrix. Matrix and clast 50/50 proportion. Gravel is poorly sorted. Sharp boundary.	Palaeobeach deposit/estuarine alluvium	Palaeobeach deposit/estuarine alluvium
0.70-1.38	-12.19- -12.87	3b		**(Gap at 0.75-0.90 - sample removed for contamination testing)** 10YR 3/3 dark brown finely laminated (<2mm) silty clay. Common iron staining along laminations throughout. Stiff and compact with occasional pockets and laminations of 10YR 7/2 light grey very fine sand. Sharp boundary.	Finely laminated estuarine alluvium that has been subject to wetting and drying as indicated by iron stain (redoximorphism)	Estuarine alluvium with iron staining to 1.38m indicating fluctuations in water level.
1.38-2.15	-12.87- -13.64	3b		10YR 3/2 very dark greyish brown finely laminated silty clay (<2mm) with occasional bands of 10YR 7/2 light grey very fine sand, especially at 1.47-1.50m. Very similar to the deposit above but with no iron staining observed. Very stiff and compact	Finely laminated estuarine alluvium.	

Location:	462715.08 98790.13	**Mono:**	DT-064	**Comments: 111320 Portsmouth Dredge** **VC DT-064** **Described by HR**	
Level (top):	-0.67mCD	**Drg:**			

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.75 – 2.25	-2.42- -2.92	3c		2.5Y 7/6 yellow medium – coarse sand with moderate (10%) sub rounded – sub angular gravel <0.04m throughout. Sharp lower boundary.	Marine sands	Marine sands
2.25 – 2.37	-2.92- -3.04	3b		2.5Y 6/2 light brownish grey very fine – fine silty sand with sparse (5%) iron staining. Sharp lower boundary.	Estuarine alluvium	Estuarine alluvium
2.37 – 3.47	-3.04- -4.14	3b		10YR 4/1 dark grey firm sandy silty clay interleaved with 2.5Y 6/2 light brownish grey sandy silt horizontal lenses throughout. Clear lower boundary.	Estuarine alluvium – with fluctuating current speeds.	
3.47 – 4.85	-4.14- -5.52	3b		2.5Y 4/2 dark greyish brown firm silty clay. Clear lower boundary.	Estuarine alluvium	
4.85 – 5.90	-5.52- -6.57	3b		10YR 4/3 brown sandy silty clay becoming sandier with depth. Sand is fine-medium. Sparse (3%) marine shell throughout (including cockle <0.01m). Sharp lower boundary.	Estuarine alluvium with marine shell.	Estuarine alluvium with marine shell.

Location:		462829.66 98786.08	**Mono:**	DT-066	**Comments: 111320 Portsmouth Dredge** **VC DT-066** **Described by NM**	
Level (top):		-2.11mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
2.10-2.50	-4.21- -4.61	3c		2.5Y 5/4 light olive brown fine silty clay with some medium to coarse sand grains. Occasional sub angular to sub rounded flint gravel <5cm. This is a very soft and unconsolidated fine grained sediment that only partially fills the tubes. Non laminated and fairly disturbed.	Fine grained marine silt/mud	Fine grained marine silt /mud
2.50-4.10	-4.61- -6.21			GAP	GAP	
4.10-4.50	-6.21- -6.61	3c / 3b		2.5Y 5/4 light olive brown fine silty clay with some medium to coarse sand grains. Occasional sub angular to sub rounded flint gravel <5cm. This is a very soft and unconsolidated fine grained sediment that only partially fills the tubes. Non laminated and fairly disturbed.	Fine grained marine silt/mud	
4.50-5.35	-6.61- -7.46			GAP	GAP	
5.35-5.50	-7.46- -7.61	3c / 3b		2.5Y 5/4 light olive brown fine silty clay with some medium to coarse sand grains. Occasional sub angular to sub rounded flint gravel <5cm. This is a very soft and unconsolidated fine grained sediment that only partially fills the tubes. Non laminated and fairly disturbed.	Fine grained marine silt/mud	

Location:	462770.98 98712.7	**Mono:**	DT-069A	**Comments: 111320 Portsmouth Dredge** **VC DT-069A** **Described by NM**	
Level (top):	-0.84mCD	**Drg:**			

Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.60-1.90	-2.44- -2.74	3c		Sub rounded to sub angular flinty gravel with some coarse sand in a 2.5Y 4/3 olive brown silty clay matrix. Clast supported, moderately well sorted. Clast size <6cm. Sharp boundary	Palaeobeach deposit	Palaeobeach deposit
1.90-2.20	-2.74- -3.04	3b		Gley 1 4/1 dark greenish grey soft silty clay with occasional marine shell and sub rounded to sub angular flinty gravel <5cm. Soft and sticky with no obvious horizontal banding	Estuarine alluvium.	Estuarine alluvium / salt marsh with fluctuations in water level as indicated by iron stain and fluctuations in water current as indicated by sand lenses.
2.20-2.50	-3.04- -3.34			Gap – sample removed for contamination testing	GAP	
2.50-3.30	-3.34- -4.14	3b		Gley 1 3/1 very dark greenish grey silty clay oxidising to 10YR 3/2 very dark greyish brown. Finely horizontally laminated throughout. Fairly abundant marine shell and marine shell fragments at 2.50-2.60m and a band of medium to coarse sand at 2.80m. Sharp boundary.	Estuarine alluvium with oxidising conditions.	
3.30-5.60	-4.14- -6.44	3b		2.5Y 3/3 dark olive brown slightly clayey silt. Compact and finely horizontally laminated throughout. Occasional lenses of fine to medium sand and moderate lenses of iron stain. Sharp boundary.	Estuarine alluvium with sand lenses.	
5.60-5.90	-6.44- -6.74	3b		10YR 4/1 dark grey slightly silty clay oxidising to 10YR 3/3 dark brown. Faintly horizontally laminated (less so than above) with a slight blocky structure. Rare marine shell, 0.1% fine pores.	Salt marsh/mudflats.	

Location:		463051.59 98622.01	**Mono:**	DT-071A	**Comments: 111320 Portsmouth Dredge** **VC DT-071A** **Described by NM**		
Level (top):		-7.95mCD	**Drg:**				
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**		**Interpretation**	
Mono	mCD						
3.91-4.80	-11.86- -12.75	3c		Moderately well sorted rounded to sub rounded gravel <8cm and coarse sand with a 2.5Y 4/3 olive brown silty clay matrix. Clast supported with hardly any matrix present. Becomes predominantly small gravel and coarse sand at about 1cm from base, only just observed.		Palaeobeach deposits	Palaeobeach deposits

Location:		462759.62 98592.23	**Mono:**	DT-072	**Comments: 111320 Portsmouth Dredge** **VC DT-072** **Described by NM**		
Level (top):		-0.87mCD	**Drg:**				
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**		**Interpretation**	
Mono	mCD						
1.41-4.29	-2.28- -5.16	3b		Bands of 2.5Y 3/3 dark olive brown and 2.5Y 3/2 very dark greyish brown silty clay. Finely horizontally laminated throughout with occasional marine shell. Lenses of medium to coarse 2.5Y 5/4 light olive brown sand at 1.55m and 2.47m. Fairly stiff and compact with rare patches of iron stain. Band of 10YR 4/1 dark grey homogenous clay at 4.19-4.28m. Very rare sub rounded gravel <2cm. Clear boundary.		Estuarine alluvium with sand lenses.	Estuarine alluvium / salt marsh with fluctuations in water level as indicated by iron stain and fluctuations in water current as indicated by sand lenses.

Location:		462759.62 98592.23	**Mono:**	DT-072	**Comments: 111320 Portsmouth Dredge** **VC DT-072** **Described by NM**	
Level (top):		-0.87mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
4.29-5.80	-5.16- -6.67	3b		2.5Y 4/3 olive brown finely horizontally laminated silty clay with occasional fragments of marine shell. Moderate horizontal laminations of iron stain throughout. Stiff and compact. Clear boundary.	Estuarine alluvium/salt marsh subject to wetting and drying as indicated by iron stain.	
5.80-5.90	-6.67- -6.77	3b		10YR 2/1 black soft silty clay oxidising to 2.5Y 4/3 olive brown. Horizontally laminated.	Estuarine alluvium with reducing conditions.	

Location:		464018.42 96846.76	**Mono:**	DT-123	**Comments: 111320 Portsmouth Dredge** **VC DT-123** **Described by NM**	
Level (top):		-5.38mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.70-1.86	-7.08- -7.24	3b / 3c		2.5Y 3/2 very dark greyish brown clayey silt with fine sand and occasional horizontal bands of iron stain. Rare small fragments of coal and marine shell. Clear boundary.	Estuarine alluvium with some marine sand.	Estuarine alluvium with marine sand

Location:		464018.42 96846.76	**Mono:**	DT-123	**Comments: 111320 Portsmouth Dredge** **VC DT-123** **Described by NM**	
Level (top):		-5.38mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.86-2.70	-7.24- -8.08	3c		2.5Y 4/3 olive brown fine to medium sand with some clay content and occasional clay banding. Fairly heavily iron stained to 2.26m then iron stain practically disappears. Finely horizontally banded with marine shell frags increasing in number down profile.	Marine sands subject to fluctuating water levels as indicated by iron staining and clay banding.	Marine sand with clay banding and iron stain. Indicates fluctuations in water level and speed of current.
2.70-2.95	-8.08- -8.33			GAP	GAP	
2.95-3.52	-8.33- -8.90	3c		2.5Y 4/4 olive brown fine to medium sand with some iron stain and occasional thin laminations of 2.5Y 4/1 dark grey silty clay. Rare small rounded stones <1.5cm and occasional marine shell fragments. Clear boundary.	Marine sands subject to fluctuating water levels as indicated by iron staining and clay banding.	Marine sand with clay banding and iron stain. Indicates fluctuations in water level and speed of current.

Location:		464018.42 96846.76	**Mono:**	DT-123	**Comments: 111320 Portsmouth Dredge** **VC DT-123** **Described by NM**	
Level (top):		-5.38mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
3.52-4.02	-8.90- -9.40	3b / 3c		2.5Y 2.5/1 black soft silty clay oxidising to 2.5Y 3/3 dark olive brown. Fairly compact with occasional marine shell and fine to medium thin sandy lenses <2mm. Becomes slightly siltier down profile. Gradual boundary.	Estuarine alluvium with inwashes of marine sand	Estuarine alluvium with sandy inwashes indicating fluctuating current speed.
4.02-6.00	-9.40- -11.38	3b / 3c		2.5Y 3/3 dark olive brown clayey silt with moderate thin laminations of 2.5Y 6/2 light brownish grey very fine sand/coarse silt throughout. Sand lenses decrease down profile and are not present from 5.35 to base. Very rare marine shell fragments.	Estuarine alluvium with fine sand laminations.	Estuarine alluvium with sandy inwashes indicating fluctuating current speed.

Location:		464121.08 96729.31	**Mono:**	DT-127	**Comments: 111320 Portsmouth Dredge** **VC DT-127** **Described by NM**	
Level (top):		-8.28mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.10-2.24	-9.38- -10.52	3c		2.5Y 4/4 olive brown horizontally banded fine sand with occasional lenses of 2.5Y 3/2 very dark greyish brown silty clay. Some iron stain at the top to 1.50M. Horizontal banding becomes less visible from 2.00m. Clear boundary.	Marine sands.	Marine sands overlying estuarine alluvium indicating fluctuating water

Location:		464121.08 96729.31	**Mono:**	DT-127	**Comments: 111320 Portsmouth Dredge** **VC DT-127** **Described by NM**	
Level (top):		-8.28mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
2.24-2.55	-10.52- -10.83	3c		2.5Y 4/4 olive brown fine sand with clay. Quite compact with common marine shell throughout and occasional sub rounded gravel <2cm.	Marine sands.	depth and current speeds.
2.55-3.00	-10.83- -11.28			GAP	GAP	
3.00-4.00	-11.28- -12.28	3b		10YR 3/2 very dark greyish brown clayey silt with occasional thin lenses of fine sand. Faintly horizontally banded with a slight blocky structure. Rare marine shell. Becomes slightly darker in colour down profile.	Estuarine alluvium, fluctuating current speeds.	

Location:		464188.81 96593.91	**Mono:**	DT-131A	**Comments: 111320 Portsmouth Dredge** **VC DT-131A** **Described by NM**	
Level (top):		-10.82mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.25-1.74	-12.07- -12.56	3c		2.5Y 5/3 light olive brown fine sand with occasional pockets of 2.5Y 4/4 olive brown silty clay. Fine sub circular bands of iron stain. Rare marine shell. Clear boundary.	Marine sand.	Marine sand overlying estuarine alluvium indicating fluctuations in water

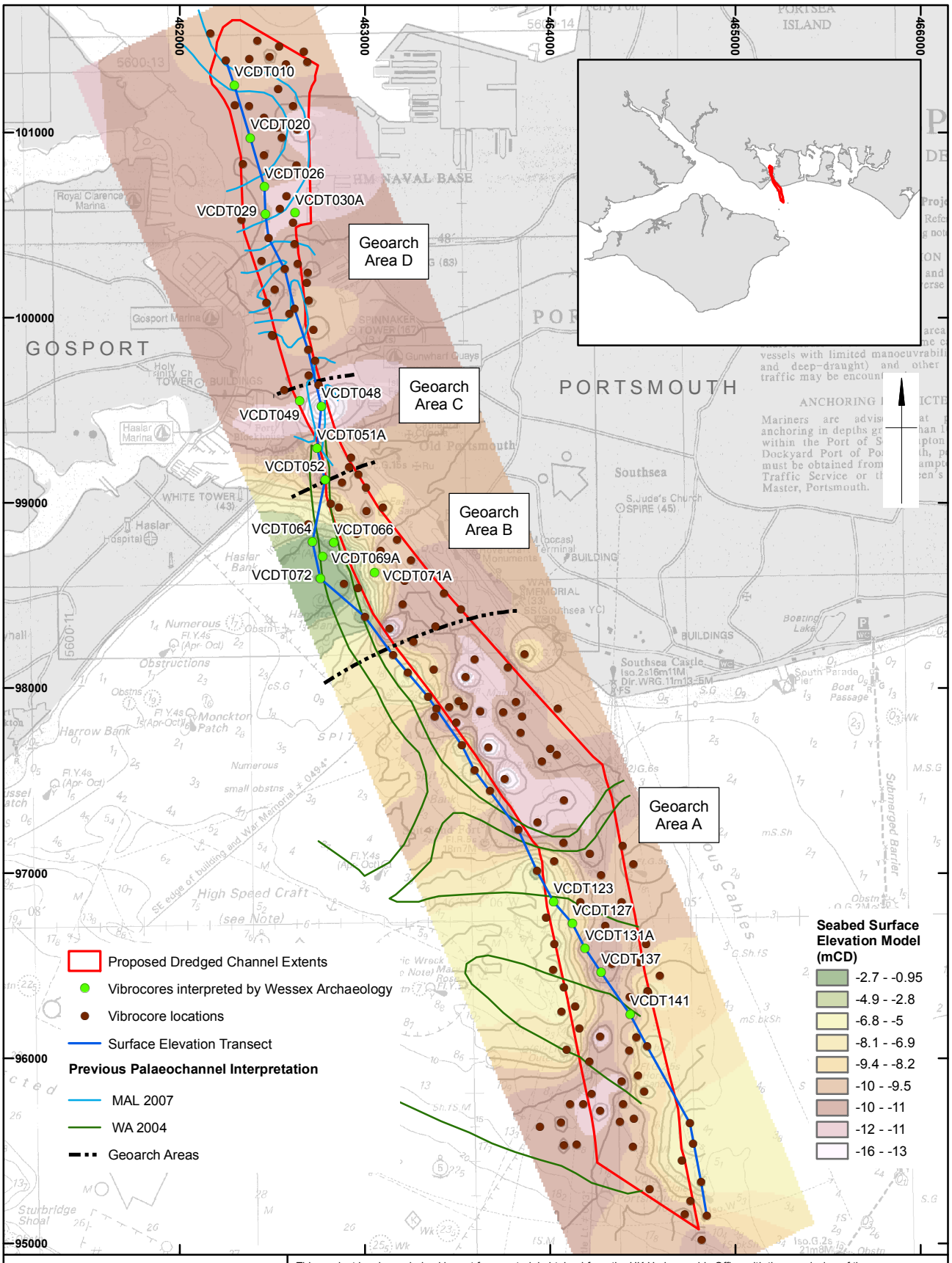
Location:		464188.81 96593.91	**Mono:**	DT-131A	**Comments: 111320 Portsmouth Dredge** **VC DT-131A** **Described by NM**	
Level (top):		-10.82mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.74-1.88	-12.56- -12.70	3b		Bands of 2.5Y 3/1 very dark grey and 2.5Y 3/3 dark olive brown slightly silty clay. Fairly compact with some lateral cracking. (No boundary, end of core)	Estuarine alluvium.	level and current speed.
1.88-4.25	-12.70- -15.07	3b		2.5Y 4/3 olive brown clayey silt with common thin laminations of 2.5Y 6/2 light brownish grey very fine sand/coarse silt throughout. Fairly hard and compact with a blocky structure.	Estuarine alluvium with fine sand laminations.	

Location:		464273.91 96464.45	**Mono:**	DT-137	**Comments: 111320 Portsmouth Dredge** **VC DT-137** **Described by NM**	
Level (top):		-11.94mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.07-1.75	-13.01- -13.69	3c		2.5Y 4/4 olive brown fine clayey sand. Faint horizontal banding with some iron stain, especially at 1.42-1.55m. Mottles of paler 2.5Y 5/3 light olive brown throughout. Sharp boundary.	Marine sands/estuarine alluvium. Fluctuating water levels as indicated by iron stain.	Fine marine sands with estuarine alluvium
1.75-1.78	-13.69- -13.72	3c		2.5Y 4/3 olive brown medium sand.	Marine sand.	Marine sand

Location:		464273.91 96464.45	**Mono:**	DT-137	**Comments: 111320 Portsmouth Dredge** **VC DT-137** **Described by NM**	
Level (top):		-11.94mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.78-2.28	-13.72- -14.22	3c		2.5Y 4/3 olive brown very slightly clayey fine to medium sand slightly coarsening down profile. Finely horizontally laminated with occasional fragments of marine shell. Narrow (1cm) bands of 10YR 3/3 dark brown slightly silty clay at 2.10 and 2.15 with thin (1mm) bands of iron staining at the boundaries. Very sharp boundary	Marine sands subject to fluctuating sea levels as indicated by iron staining and clay banding.	Marine sands, sharp boundary indicates very fast inundation.
2.28-3.10	-14.22- -15.04	3b		2.5Y 3/2 very dark greyish brown clay. Heavily iron stained throughout with both indistinct mottles and linear stained root voids. Blocky structure to 2.90 then deposit becomes very stiff and compact. Concentration of iron staining at 2.70-2.82 with very distinct iron stained root voids.	Tidal mudflats with frequent wetting and drying as indicated by the abundant iron staining.	Tidal mudflats subject to frequent wetting and drying (redoximorphism)

Location:		464431.67 96237.49	**Mono:**	DT-141	**Comments: 111320 Portsmouth Dredge** **VC DT-141** **Described by NM**	
Level (top):		-10.6mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
0.78-1.00	-11.38- -11.60	3b		10YR 4/3 brown fairly soft silty clay with occasional patches of 5Y 2.5/1 black. Moderate marine shell and sparse patches of iron stain. 0.2% fine pores. Clear boundary.	Efstuarine alluvium with marine shell.	Estuarine alluvium with plant remains and iron staining

Location:		464431.67 96237.49	**Mono:**	DT-141	**Comments: 111320 Portsmouth Dredge** **VC DT-141** **Described by NM**	
Level (top):		-10.6mCD	**Drg:**			
Depth		**Unit or sub-unit (see Table 2)**	**Samples**	**Sediment description**	**Interpretation**	
Mono	mCD					
1.00-2.88	-11.60- -13.48	3b		2.5Y 4/3 olive brown silty clay with faint horizontal banding and lateral cracking. Occasional waterlogged organics and frequent faint horizontal bands of iron stain. Fairly stiff and compact.	Estuarine alluvium with waterlogged plant remains.	indicating fluctuating water levels.



0 1 km

Drawing projection: OSGB National Grid
Admiralty chart no. 5600.12 (dated 2007)

Date:	03/06/2016	Revision Number:	0
Scale:	1:30,000 at A4	Illustrator:	KJF
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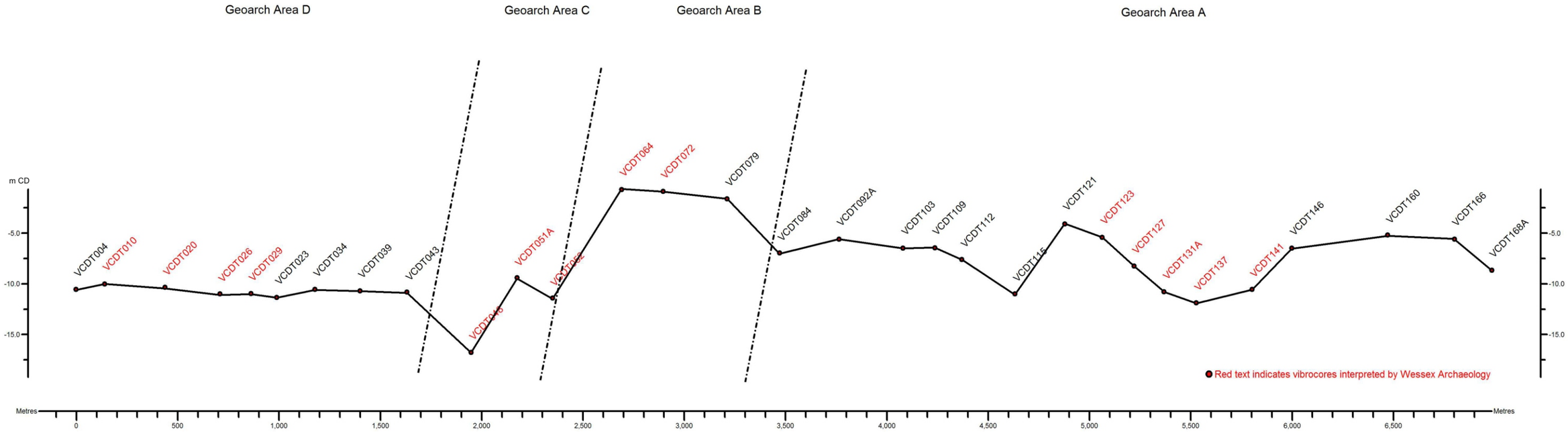
Study area, borehole locations and palaeogeographic location

Figure 1



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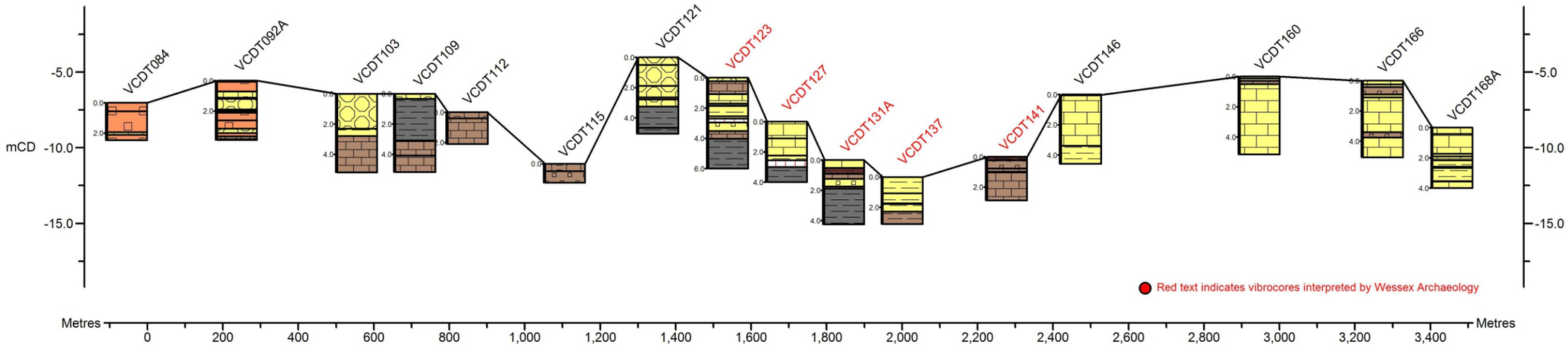
Digital surface elevation model

Figure 2



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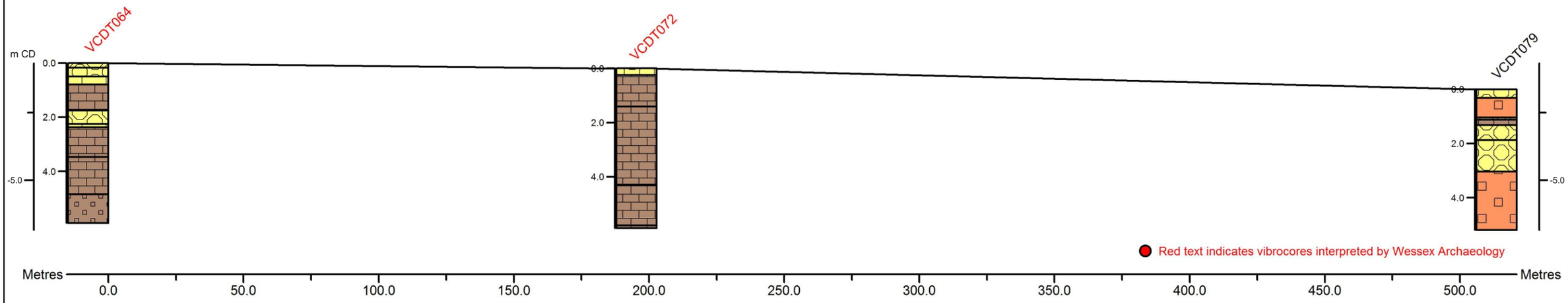
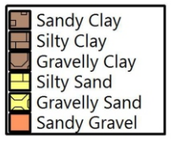
Area A, coring transect

Figure 3





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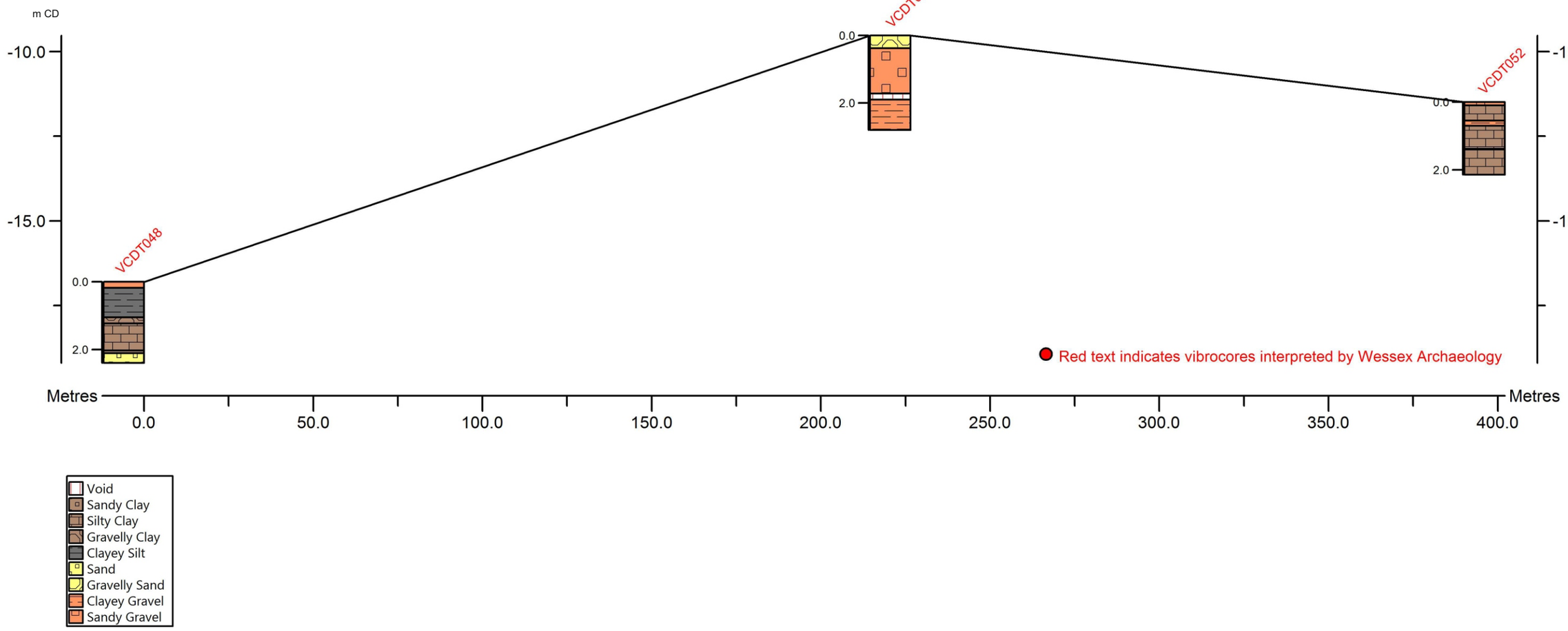
Area B, coring transect

Figure 4



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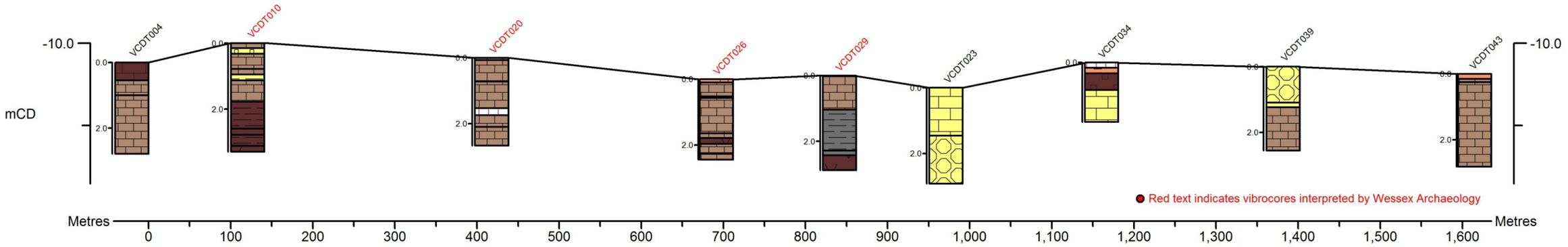
Area C, coring transect

Figure 5



Date:	03/06/2016	Revision Number:	1
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Path:	W\Projects\111320\Graphics_Office\Rep figs\Geoarch\2016_06_03		

Area D, coring transect

Figure 6

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