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

Stage 1 Geoarchaeological Review of Geotechnical Logs and Preliminary Recording of Geotechnical Samples

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DISCLAIMER

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Stage 1 Geoarchaeological Review of Geotechnical Logs and Preliminary Recording of Geotechnical Samples

Summary

Wessex Archaeology was commissioned by Boskalis Westminster Limited, on behalf of the Defence Infrastructure Organisation, to undertake a Stage 1 geoarchaeological review of a series of geotechnical logs recovered during two programmes of geotechnical investigations within the Portsmouth Harbour area and in and around its approach channel. This assessment was undertaken as part 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 Her Majesty's Naval Base Portsmouth in 2016.

The Stage 1 review, in conjunction with the results of previous geophysical data interpretations, has revealed the presence of a complex sequence of sediments around the area of the current and proposed approach channel. These sediments can broadly be divided into three units – 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 rivers (**Unit 2**), and a sequence of intertidal clays, peats and modern sands and gravels deposited since the Holocene transgression (**Unit 3**).

The principal aim of this review is to identify the prehistoric archaeological and geoarchaeological potential of the sedimentary units so as to inform further geoarchaeological assessment and analysis. These units have been tentatively divided into a series of sub-units in order to ascribe more specific potential, although this sub-division is subject to change should further evidence be acquired. However, it is recognised that individual sub-units may have potential for maritime and aviation remains irrespective of the prehistoric archaeological potential of the sediments that is the focus of this review.

As the study area is so complex, it has been approximately divided into four separate areas defined by broad similarities in the dominant shallow geology and modern environment. **Area A** is characterised by large Pleistocene palaeochannels, channel fills and overlying intertidal/estuarine sediment. **Sub-Units 2a**, **2b** and **3b** are considered of archaeological potential in this area, samples of which are recommended for Stage 2 geoarchaeological recording.

Area B is characterised by river terrace gravels and sand and gravels associated with Hamilton Bank. **Sub-Units 2c** and **3a** are considered of archaeological potential in this area, samples of which are recommended for Stage 2 geoarchaeological recording.

Area C is characterised by modern seabed sediment mixed with made ground deposited in and around the approach channel**.** **Sub-Unit 3b** is considered to be of possible but uncertain archaeological potential within this area, and samples are recommended for Stage 2 geoarchaeological recording to aid ascertain whether the unit represents relative modern intertidal or older channel sediments.

Area D is characterised by shallow Eocene bedrock overlain by modern intertidal sediment, multiple peat layers and made ground. **Sub-Units 3b** and **3e** are considered of archaeological

potential within this area, samples of which are recommended for Stage 2 geoarchaeological recording.

A site visit was undertaken by Wessex Archaeology to determine the condition of the stored borehole and vibrocore samples and assess their suitability for further geoarchaeological assessment and analysis. It was found that the remains of the borehole samples solely consist of small, disturbed samples in tubs which are considered unsuitable for further geoarchaeological work.

Some of the vibrocores, however, were deemed to be suitable for further geoarchaeological assessment and analysis, despite the samples suffering various degrees of drying out and organic decay. As such, it is appropriate that the recommended Stage 2 recording be undertaken using vibrocore samples only.

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The Stage 1 assessment was undertaken, and the report compiled by, David Howell. Figures were created by Kitty Foster, quality control was provided by Jack Russell, and the project was managed for Wessex Archaeology by Caroline Budd.

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

Stage 1 Geoarchaeological Review of Geotechnical Logs

1 INTRODUCTION

1.1 Study Area 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 1 geoarchaeological review of a series of geotechnical logs. The samples (boreholes and vibrocores) were recovered during two programmes of geotechnical investigations within the Portsmouth Harbour area and in and around its associated approach channel. This assessment was undertaken as part of ongoing investigations related to a 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 ever enter Portsmouth Harbour, and as such alterations are planned to be made to the port in order to accommodate the vessel. These alterations include further dredging and expansion of the existing approach channel and berth pocket, and refurbishment works to the Middle Slip Jetty (MSJ). This report includes an assessment relevant to only the proposed dredging program, not the MSJ expansion.

1.1.3 This report forms a part of ongoing assessments within the area associated with the proposed dredging and redevelopment, and relates directly to the archaeological Written Scheme of Investigation (WSI) produced by WA (WA 2015). 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**), although a number of the assessed geotechnical logs were acquired from on the edge or outside of this boundary.

1.2 Geoarchaeological Background

1.2.1 British Geological Survey (BGS) information indicates the solid geology beneath the study area comprises the London Clay Formation within the inner Portsmouth Harbour area, changing to the Bracklesham Beds towards the middle of the study area and finally the Barton Beds in the south (BGS 2015a). These are a series of fully marine/shallow marine deposits of lower to middle Eocene age which are located at shallow depth within the Portsmouth region.

1.2.2 These sediments are overlain by alluvium and other fluvial deposits relating to the Palaeo-Wallington River and its confluence with the Palaeo-Solent. Previous interpretations of geophysical data by WA and Maritime Archaeology Limited (MAL), including sub-bottom profiler (SBP) data, have been undertaken from within the study area and immediate surroundings, and have identified a number of buried palaeochannels associated with these river systems (WA 2004, MAL 2007).

1.2.3 Fluvial sediments such as these will have been deposited at times of relatively low sea level, created due to sea water being locked up in continental ice sheets during glacial periods, when the study area was exposed as a terrestrial landscape. During these periods the study area would have formed an attractive and habitable environment for Hominin communities, the earliest evidence for which in the UK has been identified at Happisburgh, on the Norfolk coast, and Pakefield, on the Suffolk coast, dating from *c.* 8000,000 and 700,000 BP respectively (Parfitt et al. 2005; 2010).

1.2.4 This suggests the possible presence of Pleistocene river gravels and Holocene alluvium/intertidal deposits that could be of archaeological potential within the study area. A more detailed outline of the geological history of the study area and associated archaeological potential is provided in the WSI and reports associated with previous phases of work (Royal HaskoningDHV (RHDHV) 2012, MAL 2007, WA 2004; 2015).

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 summarised below:

Table 1: Stages of Geoarchaeological Assessment/Recording

Stage	Method	Description
1	Assessment	A desk-based archaeological assessment of the borehole and vibrocore logs generated by geotechnical contractors aims to establish the likely presence of horizons of archaeological interest and broadly characterise them, as a basis for deciding whether and what Stage 2 archaeological recording is required. The Stage 1 report will state the scale of Stage 2 work proposed.
2	Geoarchaeological Recording	Archaeological recording of selected retained or new core samples will be undertaken. This will entail the splitting of the cores, with half of each core being cleaned and recorded. The Stage 2 report will state the results of the archaeological recording and will indicate whether any Stage 3 work is warranted.
3	Sampling and Assessment	Dependent upon the results of Stage 2, sub-sampling and palaeoenvironmental assessment (pollen, diatoms and foraminifera) may be required. Subsamples will be taken from one core-half, with the other core-half retained intact for further sub-sampling, should it be required. Assessment will comprise laboratory analysis of the samples to a level sufficient to enable the value of the palaeoenvironmental material surviving within the cores to be identified. Subsamples 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 work is warranted.

Stage	Method	Description
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 subsamples. 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 assessment comprises Stage 1 of the above described approach, with recommendations made for any further Stage 2 work if deemed necessary. Due to the previous work undertaken within the study area (e.g. SBP interpretation), the assessment here is taken a little further than usual for a Stage 1 assessment and also includes an outline of the possible stratigraphy of the area.

2.1.3 In addition, a site visit was also undertaken by WA to determine the general condition of both the stored borehole and vibrocore samples and their suitability for further geoarchaeological assessment. During this site visit, a limited amount of Stage 2 recording was also undertaken on a selection of samples.

2.2 Aim and Objectives

2.2.1 The aim of this assessment is to carry out a geoarchaeological assessment of the acquired geotechnical logs in order to identify any deposits of prehistoric archaeological potential and inform any further Stage 2 assessment. This is to be done in accordance with the previous WSI associated with the proposed dredging and development scheme (WA 2015). The objectives are as follows:

- Assess the provided geotechnical logs for any deposits of geoarchaeological potential;
- Cross-reference the vibrocore logs with the previous geophysical interpretation results and with historic boreholes to aid determine the extents of any identified deposits;
- Identify deposits potentially suitable for future Stage 2 geoarchaeological recording;
- Assess the condition of the stored borehole and vibrocore samples, and their suitability for further geoarchaeological assessment; and
- Report the results as part of the ongoing geoarchaeological assessment for the proposed scheme.

3 METHODOLOGY

3.1.1 A total of 27 boreholes were acquired by Fugro Seacore Limited (Fugro) during February and March 2012. These boreholes were situated both in and around the study area, and their locations are listed in **Appendix I** and illustrated in **Figure 1**.

3.1.2 The borehole logs were provided to WA for desk-based assessment and identification of samples containing deposits of possible geoarchaeological potential, and form the main basis for the interpretation in this report.

3.1.3 Of greatest interest are sediments from former terrestrial depositional environments, as well as certain features or inclusions of possible prehistoric archaeological and palaeoenvironmental interest, specifically:

- Peat layers;
- Deposits containing other organic material such as wood fragments, roots, dark organic staining etc.;
- Clay or silt deposits, especially those containing laminated features such as lacustrine varves or tidal rhythmites;
- Inorganic fossils (such as molluscs);
- Concentrations of charcoal;
- Individual artefacts such as pieces of flint or pottery (though finding these within core samples is unusual);
- Any other feature thought to indicate a terrestrial depositional environment.

3.1.4 Of particular interest within the current study area are the previously identified fluvial and associated deposits previously identified associated with the Palaeo-Wallington and Palaeo-Solent rivers (WA 2004, MAL 2007).

3.1.5 In addition to these boreholes, 176 vibrocores were previously acquired from within and around the study area by Coastline Surveys between December 2011 and January 2012, the logs of which were also provided to WA. Due to the large number of vibrocores and their relatively shallow depth of sediment recovery (up to 5.5m) relative to the boreholes, these logs were not geoarchaeologically assessed in detail. However, they were used to supplement the borehole assessment where necessary, and the locations of selected vibrocores mentioned in the text are listed in **Appendix I** and illustrated in **Figure 2**.

3.1.6 In addition to the provided geotechnical logs, a number of other sources were used as part of this assessment, including:

- Background BGS data of the region (Hamblin *et al.* 1992, BGS 2015a);
- Previous geophysical and geotechnical reports from the study area (WA 2004, MAL 2012);
- The associated WSI and Environmental Statement (ES), along with previous archaeological work undertaken within and around the study area (RHDHV 2012, WA 2003; 2015);
- Soils information from borehole and vibrocore testing, provided to WA by BWL.

3.1.7 These sources were all used in conjunction with the geotechnical logs used to undertake the assessment, understand the general background stratigraphy of the study area, and select samples and deposits suitable for further Stage 2 geoarchaeological assessment.

3.1.8 Additionally, a site visit was undertaken by WA on the 22nd October 2015 to the borehole storage unit at HMNB Portsmouth and to the Boskalis site office at Portsmouth

International Port. This was done to determine the current condition of the stored borehole and vibrocore samples and assess their suitability for further geoarchaeological assessment. This was deemed necessary due to the age of the samples and the fact that a large number of sub-samples appear to already have been removed for geotechnical testing (Terra-Tek 2012).

3.1.9 During the site visit, a selection of samples were opened and assessed for condition and a rapid Stage 2 recording was also undertaken. These samples comprised six borehole samples and eight vibrocore samples, selected to cover a range of depths and identified sediments of interest.

4 RESULTS

4.1 Stage 1 Assessment

4.1.1 Geoarchaeological assessment of the geotechnical logs, alongside the background geological information and previous geophysical interpretation, has revealed a complex sequence of deposits within and around the study area.

4.1.2 These deposits represent the basal Tertiary geology overlain by a complex sequence of Quaternary terrestrial and marine deposits, which records the history of the lower part of the Palaeo-Wallington River up to its confluence with the Paleo-Solent, and the eventual drowning of this section of both rivers during the Holocene marine transgression.

4.1.3 It also, in part, records the development of Portsmouth Harbour; specifically episodes of dredging and creation of made ground related to the development of the port and naval base.

4.1.4 This complex sequence can initially be broadly divided into three basic units by time period, as follows (derived partially from soils information provided by BWL):

Table 2: Broad Geological Units Observed within the Study Area

Unit	Age	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.
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.
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 Within this broad stratigraphy, **Unit 1** represents the regional Tertiary bedrock. This is known to comprise shallow marine sediments dating from the Eocene period (Hamblin *et al.* 1992) which pre-dates the earliest known human occupation of the UK. As such, **Unit 1** is considered too old to be of archaeological potential.

4.1.6 **Unit 1** has generally been distinguished from the rest of the units within the geotechnical logs by the relative stiffness of the clays and, in places, by the recorded greenish colour of the sediments known to be a distinguishing feature of part of the Eocene Barton Beds in the area (BGS 2015b).

4.1.7 Due to previous geoarchaeological work along the Solent, it is also known that the Eocene units in the area, especially the Barton Beds, can also contain pieces of decomposed plant matter and some thin lenses of peat (WA 2014). Such preserved organic material is generally considered of high archaeological and palaeoenvironmental potential, but in this case, since the remains come from a deposit interpreted as being Eocene in age, the associated organic remains are not considered to be of archaeological interest.

4.1.8 The deposits represented by **Unit 2** and **Unit 3**, however, do contain sediments of possible prehistoric archaeological potential. **Unit 2** contains fluvial and related sediments associated with the Palaeo-Wallington and Palaeo-Solent rivers, which were potentially deposited during a time when Hominin communities were living in and utilising the surrounding landscape.

4.1.9 **Unit 3** records the final drowning of this landscape during the Holocene transgression, and, although the environment changed from terrestrial to marine during this period, the lower intertidal deposits and peat layers may still be of archaeological and palaeoenvironmental potential.

4.1.10 As **Unit 2** and **Unit 3** contain deposits of possible archaeological potential, and because they each contain a number of different deposits in the broad stratigraphy described in **Table 2**, they have been tentatively divided into sub-units as follows:

Table 3: Interpreted Sub-Units Observed within the Study Area

Unit	Sub-Unit	Description	Prehistoric Archaeological Potential
Unit 3	Sub-Unit 3e	Peat layers visible at a number of levels within the Unit 3 stratigraphy.	Medium/High
	Sub-Unit 3d	Sandy gravel and gravelly sand, mixed with brick and glass fragments and metal pipework. Modern made ground.	Low
	Sub-Unit 3c	Loose gravelly sand and sandy gravel, modern seabed sediment and sand bank deposits.	Low
	Sub-Unit 3b	Soft clay containing organic material, intertidal deposits.	Medium/High
	Sub-Unit 3a	Gravelly sand and sandy gravel, possible marine transgression deposit.	Medium
Unit 2	Sub-Unit 2c	Coarse sandy gravel and gravelly sand, often clayey, possible Pleistocene river terrace deposits.	High
	Sub-Unit 2b	Interbedded soft laminated clay and silt, often with organic matter, roots and burrows. Pleistocene channel fill deposits.	High
	Sub-Unit 2a	Coarse gravelly sand and sandy gravel, Pleistocene channel lag deposits.	Medium

Unit 1	N/A	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 mottled colouring. Comprises a number of geological formations, namely the London Clay Formation, Bracklesham Beds and Barton Beds. Represents the bedrock in the study area.	Low

4.1.11 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.

4.1.12 None of the assessed boreholes logs contain a full sequenced as described in **Table 3**, and, as such, some of the units are difficult to place relative to each other within the sequence. Some will have been deposited at the same time but in different environments, e.g. modern intertidal sediments (**Sub-Unit 3b**) nearshore, and seabed sediments (**Unit 3c**) offshore.

4.1.13 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).

4.1.14 For ease of discussion within such a complex area, the study area has been approximately divided into four separate areas defined by similar dominant shallow geology, modern environmental processes, and recent anthropogenic influence. These areas are illustrated in **Figure 2** and fully described below, although they can briefly be summarised as follows:

Table 4: Summary of Interpreted Geological Areas

Area	Description
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.
Area B	Approximatley 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.
Area C	Approximately the entrance to Portsmouth Harbour, approach channel often dredged down to the Eocene bedrock with some overlying intertidal sediment in some areas, overlain by sebed sediment including reworked made ground material.
Area D	Portsmouth Harbour area, shallow Eocene bedrock overlain by relatively modern intertidal sediments, made ground and peat layers of unknown age.

Area A

4.1.15 **Area A** is the southernmost and largest of the four areas as illustrated in **Figure 2**. Previous SBP interpretations indicate it is the point 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.

4.1.16 The geotechnical logs generally support the previous palaeochannel interpretation (**Figure 2**), with samples acquired from the centre or on the edges of interpreted channel features (e.g. **LCP15**, **LCP20**, **DT-123**) recording deep sequences of interpreted Quaternary deposits, whilst samples acquired between the channels (e.g. **LCP25**, **DT-119**) contain relatively thin Quaternary sediments.

4.1.17 The exception to this is borehole **LCP14**, which potentially contains a relatively thick sequence of Quaternary deposits despite being outside of an interpreted channel. However, it was noted in the original report (WA 2004) that the location of the palaeochannel in this area was only estimated, and so it is likely that it actually extends further east and is wider than originally thought.

4.1.18 The Quaternary sequence within the palaeochannels in **Area A** generally comprises a basal fill of gravelly sand and sandy gravel (**Sub-Unit 2a**), interpreted as a lag deposit, overlain by a sequence of soft clays and silts (**Sub-Unit 2b**), interpreted as later channel fill sediments. As an interpreted braided river system, it is likely that the locations of these two units changes over short distances due to the number of filled, abandoned channel features that may have been created in the area over time.

4.1.19 Some samples of **Sub-Unit 2b**, especially on the edges of the palaeochannels (e.g. **LCP21**, **DT-136A**) contain rootlets and evidence of burrows, suggesting sediments associated with past land surfaces may survive on the palaeochannel edges. The unit appears to contain organic matter, and gas blanking observed within the palaeochannels during the previous SBP interpretation suggests preserved organic material is present within the fill sediments.

4.1.20 As such, **Sub-Unit 2b** is considered of high archaeological and palaeoenvironmental potential with the possibility to contain *in-situ* archaeological artefacts and preserved organic material, especially where located on the edges of palaeochannel features. As a fluvial deposit, **Sub-Unit 2a** is considered of medium archaeological potential, and could contain derived artefacts in a secondary context.

4.1.21 No boreholes were acquired from within the currently dredged approach channel, but vibrocore evidence, combined with the interpreted thickness of the Quaternary sediments (up to 23m BSB) relative to the maintained depth of the dredged channel (-9.5m CD) indicates that some sediments may also still exist beneath the area previously dredged to create the current approach channel.

4.1.22 The sediments overlying the channel fill deposits within **Area A** are less consistent throughout the area. Towards the south, a series of interpreted intertidal/estuarine soft organic clays (**Sub-Unit 3b**) directly overlies the channel deposits, and is in turn occasionally overlain by a thin layer of modern seabed sand (**Sub-Unit 3c**). The similarities in log descriptions between **Sub-Unit 2b** and **Sub-Unit 3b** mean it is difficult to definitively determine a boundary between the two.

4.1.23 **Sub-Unit 3b** within **Area A** is potentially relatively old compared with similar deposits identified in **Area D** (described later). It is also recorded as containing organic matter, and as such is considered of high palaeoenvironmental potential in this area as it could contain preserved organic material.

4.1.24 Further north in **Area A**, **Sub-Unit 2b** and **Sub-Unit 3b** are occasionally separated by a relatively thin sand deposit, interpreted as a transgression layer (**Sub-Unit 3a**). In some areas, a possible gravel terrace deposit (**Sub-Unit 2c**) is also present. This is a transition

area between the channel fill dominated shallow geology **of Area A**, and the sand and gravel dominated geology of **Area B** (described below).

Area B

4.1.25 **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.

4.1.26 No definite palaeochannel deposits have been identified within the borehole logs of this area, despite an interpreted channel being present **(Figure 2)**. This is probably due to the thickness of sandy sediments overlaying any channel in the area around the region of Hamilton Bank, resulting in the boreholes not achieving enough penetration into the seabed to sample any channels that may be present.

4.1.27 The different sub-units in **Area B** are very difficult to distinguish within the logs, but are interpreted to comprise Pleistocene terrace gravels (**Sub-Unit 2c**), a transgression surface (**Sub-Unit 3a**) and modern seabed sand (**Sub-Unit 3c**). The difficulty in distinguishing between the different units arises from both the similarities in their lithologies and the fact that overlying units are likely to be at least in part comprised of reworked underlying prehistoric sediment; the gravel terraces will have been reworked during marine transgression to partially form the transgression layer, and then both gravel terrace and transgression layers will have been reworked to form Hamilton Bank and the recent mobile seabed sediment.

4.1.28 However, some differences between units are visible. **Sub-Unit 2c** is often very clayey, and in places (e.g. **LCP13**, **LCP19**) has been found to be topped by a layer of gravelly clay (also included within **Sub-Unit 2c**). This has been found from previous studies within the wider Solent region to potentially be an indicator of river terrace gravel (WA 2014).

4.1.29 As a river terrace gravel, and of interpreted Pleistocene age, **Sub-Unit 2c** is considered of high archaeological potential and could possibly contain both *in-situ* and derived archaeological artefacts, most notable lithic artefacts such as hand axes. The presence of possible **Sub-Unit 3c** sediments within borehole **LCP13** indicates some river terrace sediments may still survive beneath the seabed within the current dredged channel.

4.1.30 **Sub-Unit 3a** and **Sub-Unit 3c** are much more similar in composition, and comprise a mixture of gravelly sand and sandy gravel. However, for the purposes of this assessment, it has been interpreted that any layer described as ‘dense’ within the logs be ascribed to the older **Sub-Unit 3a** (including the main bulk of Hamilton Bank), and any ‘loose’ sediments be ascribed to the modern mobile seabed sediment (**Sub-Unit 3c**).

4.1.31 This is a generalised interpretation, and it is likely that the real definition is much more complex. However, it is in part reinforced by fragments of glass found mixed in with the loose upper sediments of **LCP16**, suggesting a modern mobile layer on top of the bank.

4.1.32 **Sub-Unit 3a** is interpreted as being of medium archaeological potential. The potential for *in-situ* deposits within this layer is low, but the likelihood of it being created partially due to reworking of **Sub-Unit 2c** creates the potential for it to contain reworked lithic and other artefacts. **Sub-Unit 3c**, as a modern seabed sediment, is interpreted to be of low prehistoric archaeological potential.

Area C

4.1.33 **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.

4.1.34 In general, the dredged approach channel has removed all Quaternary sediment down to the Eocene bedrock (**Unit 1**), although some pockets of overlying intertidal sediment (**Sub-Unit 3b**) may remain in some areas (e.g. **LCP01**, **LCP02**). However it is uncertain whether this does represent intertidal sediment, or the weathered top layer of the underlying Eocene clay (**Unit 1**). Previous SBP interpretation indicates the presence of palaeochannels in this area (MAL 2007, **Figure 2**), but no definitive evidence of such channels have been identified within the geotechnical logs.

4.1.35 Overlying this is a deposit of sandy gravel, often found to contain pieces of brick or concrete (e.g. **LCP01**, **LCP02**). This is likely to represent the modern mobile seabed sediment incorporating anthropogenic material from the surrounding built up area, but, due to this consistent inclusion of modern materials, the unit here is interpreted to be at least partially made ground, and so part of **Sub-Unit 3d**. As such a modern sediment, this is deemed to be of low archaeological potential.

Area D

4.1.36 **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 with some additional layers.

4.1.37 The dominant unit within **Area D** is the Eocene bedrock (**Unit 1**), and it is unclear as to whether this is solely due to past dredging activity or that the overlying Quaternary sediments are much thinner.

4.1.38 Interpreted intertidal sediments (**Sub-Unit 3b**) have been observed directly overlying **Unit 1** in **LCP06**. As with elsewhere in the study area, these comprise soft organic clays and are likely to contain preserved organic material. However, here they are likely to relate to the current intertidal regime present at the location of **LCP06**, and as such **Sub-Unit 3b** here is likely to be more recent than its counterpart further offshore. As such, it is considered to be of medium archaeological and palaeoenvironmental potential within **Area D**.

4.1.39 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.

4.1.40 Sample **LCP24** is recorded to contain a layer of peat (**Sub-Unit 3e**), present between two layers of gravel. Peat is an indicator of terrestrial environments and in general can contain both *in-situ* archaeological artefacts and well preserved organic material. As such, it is generally considered to be of high archaeological potential.

4.1.41 However, the gravel underlying the peat is recorded to contain metal piping, suggesting it is made ground (**Sub-Unit 3d**). This is also the case with the overlying gravel, which is recorded to contain fragments of glass and rope. The presence of peat on top of made ground such as this unusual, as it suggests it is relatively modern or redeposited.

4.1.42 A number of vibrocore samples acquired from within **Area D** have also recorded peat, with some samples containing two distinct layers (e.g. **DT-018**, **DT-029**). Due to the presence in the stratigraphy of the peat within **LCP24**, the age of these peats and their archaeological potential is currently unknown. However, they have been classified as High to Moderate potential for the purposes of this report, due to their indication of terrestrial land surfaces and potential to preserve organic material. Their precise archaeological potential will depend on their age which can only be determined by further work.

4.2 Site Visit

4.2.1 Both the borehole and vibrocore samples are currently being stored inside a container within HMNB Portsmouth. Upon visiting the container to determine the condition of the samples, a number were selected to be assessed and recorded as follows:

Table 5: List of Assessed and Recorded Geotechnical Samples (*metres below seabed)

Sample Number	Sample Type	Depth From (mBSB)*	Depth To (mBSB)*
LCP01	Borehole (Tub D6)	4.45	4.50
	Borehole (Tub D8)	5.50	5.95
LCP02	Borehole (Tub D7)	5.00	5.45
LCP06	Borehole (Tub D2)	1.50	1.95
LCP15	Borehole (Tub D5)	3.00	3.45
LCP21	Borehole (Tub D9)	6.00	6.45
DT-018	Vibrocore (Liner)	0.00	1.06
		1.06	2.10
DT-026	Vibrocore (Liner)	0.00	1.00
DT-034	Vibrocore (Liner)	0.00	1.00
		1.00	1.80
DT-123	Vibrocore (Liner)	2.70	3.70
		4.70	5.35
DT-136A	Vibrocore (Liner)	4.02	5.02

4.2.2 The conditions of the vibrocores and boreholes, and their suitability for further geoarchaeological assessment, differed. As such, the results of the assessment of both the borehole and vibrocore samples shall be summarised separately.

Boreholes

4.2.3 The borehole samples present within the container consisted solely of numerous small tubs, presumably the remains of sections extruded and subjected to geotechnical testing. The recording results from the assessed samples are presented in **Appendix II**, and their locations illustrated in **Figure 2**.

4.2.4 In general, the borehole samples assessed were relatively small and disturbed, with no stratigraphic relationships retained and possible contamination resulting from their removal, testing, and subsequent deposition within the tubs. Most samples also had small traces of mould on their surfaces, visible as small white patches, which indicates degradation and possible further environmental contamination of the samples.

4.2.5 As such, the borehole tub samples are considered unsuitable for further geoarchaeological assessment and analysis. However, if other sealed, un-extruded samples are stored elsewhere, then these may be suitable depending on the depths of individual samples.

Vibrocores

4.2.6 The vibrocore samples present within the container consisted of samples still within their liners and stacked, in order, on a rack for easy identification and selection of individual sections. The samples have previously been split and sub-sampled, some of them apparently on numerous occasions, although they have been properly re-sealed with tape and cling film.

4.2.7 The vibrocore samples themselves were of varying quality. Some (e.g. **DT-136A**) were very dried out, and sections of clay originally reported in the logs as being soft now appear hard, dry and cracked. Others, however (e.g. **DT-034**), appeared relatively intact and of good quality with moisture being retained within the sediments.

4.2.8 However, most samples did appear to be detrimentally affected by their time in storage by a number of factors, such as differing degrees of drying out, salt crystals forming on the surface due to evaporation, degradation (possibly oxidation) of exposed organic matter, and small patches of mould/surface discoloration.

4.2.9 These effects are only known to directly impact the surface of the samples, i.e. where the cores have been split and sub-sampled. It is likely that they do not penetrate completely into the areas of the cores not directly exposed to the atmosphere, and, as such, it is likely that the internal sediments of these samples may be suitable for further geoarchaeological assessment and analysis.

4.2.10 Additionally, this preliminary investigation indicates that the vibrocores generally correlate with the stratigraphy outlined in **Section 4.1**. This suggests sediments of prehistoric archaeological potential are present within the surviving vibrocore samples and that the stratigraphy can be used as a basis for selecting those vibrocores with most potential and from which further sub-samples can be selected.

4.2.11 Vibrocores **DT-018** and **DT-016** were found to contain highly organic clay, possibly peat, which could represent intertidal deposits (**Sub-Unit 3b**) and possible buried soils/land surfaces (**Sub-Unit 3e**). Vibrocores **DT-123** and **DT-136A** contained silty, sandy clays and clayey sands, often with rootlets, burrows and other organic remains which could represent palaeochannel and/or overbank deposit fill (**Sub-Unit 2b**).

4.2.12 It should be noted that there appears to be a discrepancy between the depths marked on the vibrocore sample caps and those reported in the vibrocore logs. The difference does not seem consistent enough to be a datum shift. However, it is most likely that the depths reported on the vibrocore logs result from a tidal correction of raw depths recorded on-site from the vessels echo sounder. The measurements recorded on the vibrocore logs, as the most recent record, are provided in **Appendix II**, and are considered to reflect an accurate representation of the sub-surface geology.

5 DISCUSSION AND RECOMMENDATIONS

5.1.1 Geoarchaeological assessment of the geotechnical logs, alongside the background geological information and previous geophysical interpretation, has revealed a complex sequence of deposits within and around the study area.

5.1.2 The complexity of the deposits, in particular the incompleteness of some geotechnical logs, the lack of stratigraphic relationship in boreholes and the varying quality of the vibrocores has made it difficult to precisely correlate the deposits. Consequently, a full deposit model of the sediments has not been possible. However, the identified deposits have been split into three broad time units, which have again been sub-divided into a number of different sub-units. The study area has also been divided into four separate areas based on similar geology and current environment.

5.1.3 The generalised stratigraphy of the study area records a Pleistocene terrestrial environment dominated by braided river systems which was eventually submerged during the Holocene transgression. However, the specific division of sub-units beyond this is tentative and should be treated with caution, as there are a number of uncertainties within the interpretation.

5.1.4 Some of these uncertainties have arisen due to this assessment being based purely on geotechnical logs and not on analysis of physical samples. As such, it is recommended that Stage 2 geoarchaeological recording be undertaken on a number of samples in order to increase confidence in the proposed stratigraphy and help ascertain the archaeological potential of individual units.

5.1.5 It is recommended that this be done by taking representative samples from each of the described areas, as described below. The specific depths and number of samples subject to Stage 2 recording within each borehole will be subject to sample availability and condition/suitability for geoarchaeological assessment, and as such the specific samples and target depths are not proposed at this time.

5.1.6 It is also recommended that the Stage 2 recording be undertaken on the vibrocore samples rather than the borehole samples, as they appear to be of a better quality and are more suitable for geoarchaeological assessment.

5.1.7 As such, it is recommended that the samples be made available to WA to take away for recording and assessment once necessary testing and analysis has been completed by all relevant parties associated with the wider project. The results of the Stage 2 recording will be interpreted and entered into a Rockworks database in order to create a deposit model.

Area A

5.1.8 **Area A** contains the thickest sequence of Quaternary deposits and some deposits of high archaeological potential, although some questions do remain about the stratigraphy in this area.

5.1.9 The basal sand and gravel deposits within interpreted palaeochannel features have been interpreted as Pleistocene channel lag (**Sub-Unit 2a**). However, some Eocene deposits within the area are also known to be sandy and, as such, it is possible that these have been misidentified. It is recommended that samples be recorded in order to help determine the nature of these sediments.

5.1.10 It is also difficult to definitively determine the difference between the channel fill clays and silts (**Sub-Unit 2b**) and the overlying intertidal deposits (**Sub-Unit 3b**) by assessing logs alone, and so it is recommended that samples be recorded in order to determine the difference between these sub-units.

5.1.11 **Sub-Units 2b** and **3b** are also considered to be of high archaeological potential, and so samples where organic material is recorded are of particular interest for geoarchaeological recording.

5.1.12 It is recommended that vibrocores **DT-123**, **DT-127**, **DT-131A**, **DT-137** and **DT-141** be subject to Stage 2 geoarchaeological recording, which should provide a transect across a large interpreted palaeochannel.

Area B

5.1.13 **Area B** is dominated by different sandy units, the distinction between which is unclear. Within this area, the possible Pleistocene terrace gravels (**Sub-Unit 2c**) are of high archaeological potential, and so distinguishing these from the overlying transgression and modern sand bank deposits is important.

5.1.14 As such, it is recommended that vibrocores **DT-064**, **DT-066**, **DT-069A**, and **DT-072** be subject to Stage 2 geoarchaeological recording to try and ascertain a difference between these sub-units, as these sample should provide a transect across Hamilton Bank and include all of the sub-units, including the underlying finer grained sediments.

Area C

5.1.15 **Area C** mainly contains sediments associated with the modern seabed and made ground, although some intertidal/estuarine deposits (**Sub-Unit 3b**) may be present. However, it is uncertain whether **Sub-Unit 3b** within **Area C** represents intertidal deposits, channel fill deposits (as interpreted by MAL 2007), or the upper weathered surface of **Unit 1**.

5.1.16 Because of this, it is recommended that vibrocores **DT-048**, **DT-049**, **DT-051A** and **DT-052** be assessed from **Area C** in order to determine the true nature of the unit and so ascertain its archaeological potential. These vibrocores should give a sample of the sediments both in and out of the dredged channel, and in and out of previously interpreted palaeochannels.

Area D

5.1.17 **Area D** is dominated by **Unit 1** at shallow depth, although this is overlain by sediments of possible archaeological potential, namely intertidal deposits (**Sub-Unit 3b**) and peat layers (**Sub-Unit 3e**).

5.1.18 It is recommended that vibrocores **DT-001A**, **DT-010**, **DT-020**, **DT-026**, **DT-029** and **DT-030A** be geoarchaeologically recorded from within **Area D**. This should provide a transect from as close to **LCP06** as possible, to ascertain within **Sub-Unit 3b** recorded in this borehole is modern, across previously interpreted palaeochannels and samples containing peat deposits, to the made ground (**Sub-Unit 3d**) and associated deposits adjacent to borehole **LCP24**.

5.1.19 Including all of the recommended samples from within the four geological areas, a total of 19 vibrocores are recommended for Stage 2 geoarchaeological recording, which are as follows:

Table 6: Samples Recommended for Stage 2 Geoarchaeological Recording

Sample No.	Easting (BNG)	Northing (BNG)	Sample Type
DT-001A	462165	101534	Vibrocore
DT-010	462295	101256	Vibrocore
DT-020	462381	100972	Vibrocore
DT-026	462458	100709	Vibrocore
DT-029	462463	100559	Vibrocore
DT-030A	462624	100568	Vibrocore
DT-048	462764	99521	Vibrocore
DT-049	462647	99551	Vibrocore
DT-051A	462742	99295	Vibrocore
DT-052	462784	99125	Vibrocore
DT-064	462715	98790	Vibrocore
DT-066	462830	98786	Vibrocore
DT-069A	462771	98713	Vibrocore
DT-072	462760	98592	Vibrocore
DT-123	464018	96847	Vibrocore
DT-127	464121	96729	Vibrocore
DT-131A	464189	96594	Vibrocore
DT-137	464274	96465	Vibrocore
DT-141	464432	96238	Vibrocore

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7 APPENDIX I – LOCATIONS OF ALL GEOTECHNICAL SAMPLES ACQUIRED BY FUGRO SEACORE LIMITED (FUGRO).

All Boreholes (Fugro 2012): specific geotechnical logs described during site visit listed in appendix II.

Borehole No.	Easting (BNG)	Northing (BNG)	Water Depth (mCD)	Core Length (m)
LCP-01	462814	99539	-8.06	15.00
LCP-02	462884	99303	-9.91	15.00
LCP-03	463880	98094	-16.39	32.00
LCP-04	462831	98293	-1.60	32.29
LCP-05	462764	99250	-9.34	15.00
LCP-06	461903	102004	-7.80	32.85
LCP-07	463363	97630	-2.50	32.45
LCP-08	463632	96835	-4.67	32.00
LCP-09	462812	98971	-3.99	15.00
LCP-10	462854	98735	-1.88	15.50
LCP-11	462967	98530	-3.25	15.00
LCP-12	463236	98086	-5.54	15.00
LCP-13	463422	98523	-10.74	15.00
LCP-14	463559	97673	-8.90	15.45
LCP-15	463999	96856	-4.93	15.45
LCP-16	462979	98598	-2.94	15.00
LCP-17	462876	98821	-2.99	15.00
LCP-18	462888	98651	-1.47	15.00
LCP-19	462809	98887	-2.35	15.00
LCP-20	464064	96629	-5.62	15.50
LCP-21	464085	96414	-6.53	15.45
LCP-22	462725	99346	-7.30	28.00
LCP-23	464451	96306	-10.03	15.65
LCP-24	462636	100604	-11.16	10.55
LCP-25	463950	97099	-6.41	15.15
LCP-26	462666	101150	-13.42	10.45
LCP-27	462649	99509	-8.96	15.00

Selected Vibrocores (Coastline 2011)

Core No.	Easting (BNG)	Northing (BNG)	Water Depth (mCD)	Core Length (m)
DT-018	462532	101027	-10.90	1.16
DT-029	462463	100559	-10.98	1.96
DT-119	464021	97065	-7.80	4.50
DT-141	464432	96238	-10.60	2.25

8 APPENDIX II – GEOTECHNICAL SAMPLE DESCRIBED DURING SITE VISIT

Boreholes.

Sample No.	Sample Type	Depth From (mBSB)	Depth To (mBSB)	Colour	Description	Comments
LCP01 (D6)	Tub	4.45	4.50	2.5Y 4/2 (Dark Greyish Brown)	Soft CLAY with occasional gravel and degraded wood/organic material (poss. Reeds?). Some darker areas of mottling and iron staining.	Disturbed sample, occasional very small patches of white mould on surface.
LCP01 (D8)	Tub	5.50	5.95	10YR 4/2 (Dark Greyish Brown)	Soft, sandy CLAY with poss. Occasional small pieces of degraded organics. Mottled colour, with a lot of iron staining.	Disturbed sample, surfaces are discoloured, possibly due to partial drying out, oxidation and/or mould.
LCP02 (D7)	Tub	5.00	5.45	5Y 3/1 (Very Dark Grey)	Soft CLAY, with some layers of sandy CLAY containing numerous shell fragments. Some degraded pieces of wood identified, along with organic streaking and a slight organic odour.	Disturbed sample, occasional very small patches of white mould on surface.
LCP06 (D2)	Tub	1.50	1.95	2.5Y 4/3 (Olive Brown)	Very soft CLAY with poss. Occasional very small pieces of slightly degraded wood. High moisture content, very homogeneous sample. Possible modern sediment?	Disturbed sample, occasional very small patches of white mould on surface.

Sample No.	Sample Type	Depth From (mBSB)	Depth To (mBSB)	Colour	Description	Comments
LCP15 (D5)	Tub	3.00	3.45	2.5Y 4/4 (Olive Brown)	Very soft slightly sandy to sandy CLAY with occasional whole shells. Numerous, very small black speckles, poss. Iron minerals.	Disturbed sample.
LCP21 (D9)	Tub	6.00	6.45	2.5Y 4/4 (Olive Brown)	Very soft silty CLAY with numerous, very small organic (possibly root) traces. Some root material present, but very badly degraded/oxidised. Occasional other degraded organic material (poss. Reeds?) also present. Some organic speckling/streaking.	Disturbed sample, occasional very small patches of white mould on surface.

Vibrocores: Note that where sediment is listed as missing this is typically because samples were previously taken for geotechnical testing prior to description of geotechnical logs by Wessex Archaeology.

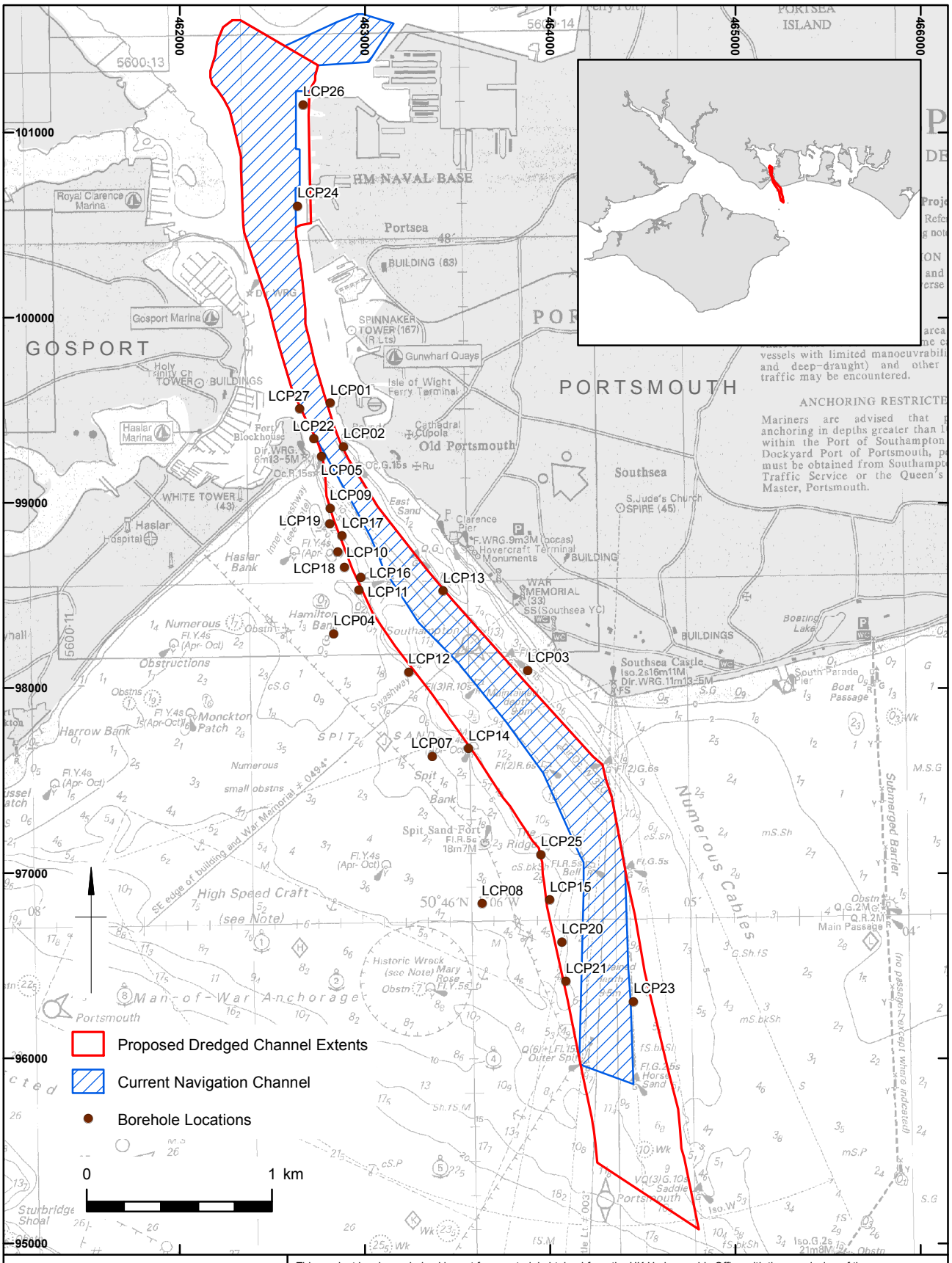
Sample No.	Sample Type	Depth From (mBSB)	Depth To (mBSB)	Colour	Description	Comments
DT034	Liner (Vibrocore)	0.00	0.40	MISSING		Generally decent samples (two separate 1m sections). Possibly partially dried out, particularly the sand, but this is unclear. Some sections missing, presumably sampled.
		0.40	0.93	10YR 4/4 (Dark Yellowish Brown)	Very gravelly, very sandy CLAY with very high shell content, both intact and large fragments. Sediment is mostly shell, and so is difficult to categorise.	

Sample No.	Sample Type	Depth From (mBSB)	Depth To (mBSB)	Colour	Description	Comments
		0.93	1.00	5Y 7/2 (Light Grey)	Very clean, well sorted, homogeneous, very fine, possibly slightly silty SAND. No inclusions or internal structure, occasional slight iron staining. Very abrupt boundary with overlying unit.	
		1.00	1.60	5Y 7/2 (Light Grey)	Very homogeneous fine silty sand with occasional iron staining.	
		1.60	1.80	MISSING		
DT123	Liner (Vibrocore)	2.70	2.90	MISSING		Sample seems very dried out, cracked and hard, although some moisture has been retained - maybe more towards centre of sample. Missing section presumably sampled.
		2.90	3.23	5Y 4/2 (Olive Grey)	Medium clayey SAND with occasional gravel and shells/shell fragments. Coarser layer with increased gravel and shell at 3.08m - 3.19m.	
		3.23	3.70	5Y 4/2 (Olive Grey)	Soft, sandy CLAY with occasional shell fragments and gravel. Occasional pockets of medium clayey SAND. Shelly layer at 3.28m - 3.32m.	
		3.70	4.70	NOT RECORDED		

Sample No.	Sample Type	Depth From (mBSB)	Depth To (mBSB)	Colour	Description	Comments
		4.70	5.35	2.5Y 4/2 (Dark Greyish Brown)	Silty CLAY, quite hard but probably due to drying out and sample is likely to have been softer originally. Frequent thin, lighter sand partings and very occasional shell fragments. One very badly degraded possible root hole/burrow.	
DT026	Liner (Vibrocore)	0.00	0.10	MISSING		Sample seems slightly dried out but not bad, a lot of moisture still retained. Very occasional very small patches of white mould on surface. Large 'example' samples taken from 0.6m - 0.7m and 0.8m - 0.9m.
		0.10	0.20	10YR 4/1 (Dark Grey)	Coarse clayey, gravelly, very shelly SAND, grading to sandy shelly CLAY downwards.	
		0.20	0.60	10YR 4/1 (Dark Grey)	Very soft silty CLAY with numerous, well degraded organic remains, poss. Wood and or/roots. Numerous black, possibly organic speckles/streaks.	
		0.60	0.70	MISSING		
		0.70	1.00	10YR 4/1 (Dark Grey)	Soft silty CLAY with some well degraded organic remains, poss. Wood and or/roots. Some black, possibly organic speckles/streaks.'	

Sample No.	Sample Type	Depth From (mBSB)	Depth To (mBSB)	Colour	Description	Comments
DT 018	Liner (Vibrocore)	0.00	0.35	MISSING		Sample appears slightly dried out, but generally good quality. Small section missing, presumably sampled for testing. Small sample taken at 1.7m.
		0.35	0.40	2.5Y 3/2 (Very Dark Greyish Brown)	Soft, silty, highly organic CLAY with degraded plant remains and organic streaks. Organic odour.	
		0.40	0.57	5Y 4/1 (Dark Grey)	Soft, silty CLAY with some degraded plant remains and organic streaks. Colour darkens towards base.	
		0.57	0.72	2.5Y 3/2 (Very Dark Greyish Brown)	Soft, silty, very organic CLAY with pockets of possible peat and wood. Numerous degraded plant remains and occasional gravel. Poss. Buried soil?	
		0.72	1.06	5Y 4/1 (Dark Grey)	Soft, silty CLAY with some degraded plant remains and organic streaks. Occasional gravel.	
		1.06	1.43	10YR 4/4 (Dark Yellowish Brown)	Hard sandy CLAY with numerous roots and wood fragments at top. Amount of roots decreases downwards. Gravelly layer at 2.26m - 2.31m.	Sample very dried out and mouldy in some places, especially towards the top. Section missing, presumably sampled for testing.

Sample No.	Sample Type	Depth From (mBSB)	Depth To (mBSB)	Colour	Description	Comments
		1.43	1.55	2.5Y 4/4 (Olive Brown)	Hard, silty CLAY, no real inclusions. Top 0.05m darker, more organic, with occasional rounded gravel. Slight organic odour.	
		1.55	1.76	Reddy-Brown	Very coarse, sandy, clayey gravel with cobbles. Gravel and cobbles well rounded. Poss. Terrace gravel?	
		1.76	2.10	MISSING		
DT136A	Liner (Vibrocore)	4.02	5.02	5Y 4/3 (Olive)	Hard, silty CLAY with occasional degraded pieces of wood.	Sample dried out and cracked, central section (4.47m - 4.67m) very hard, red/brown and possibly oxidised, almost like an iron pan-type crust.



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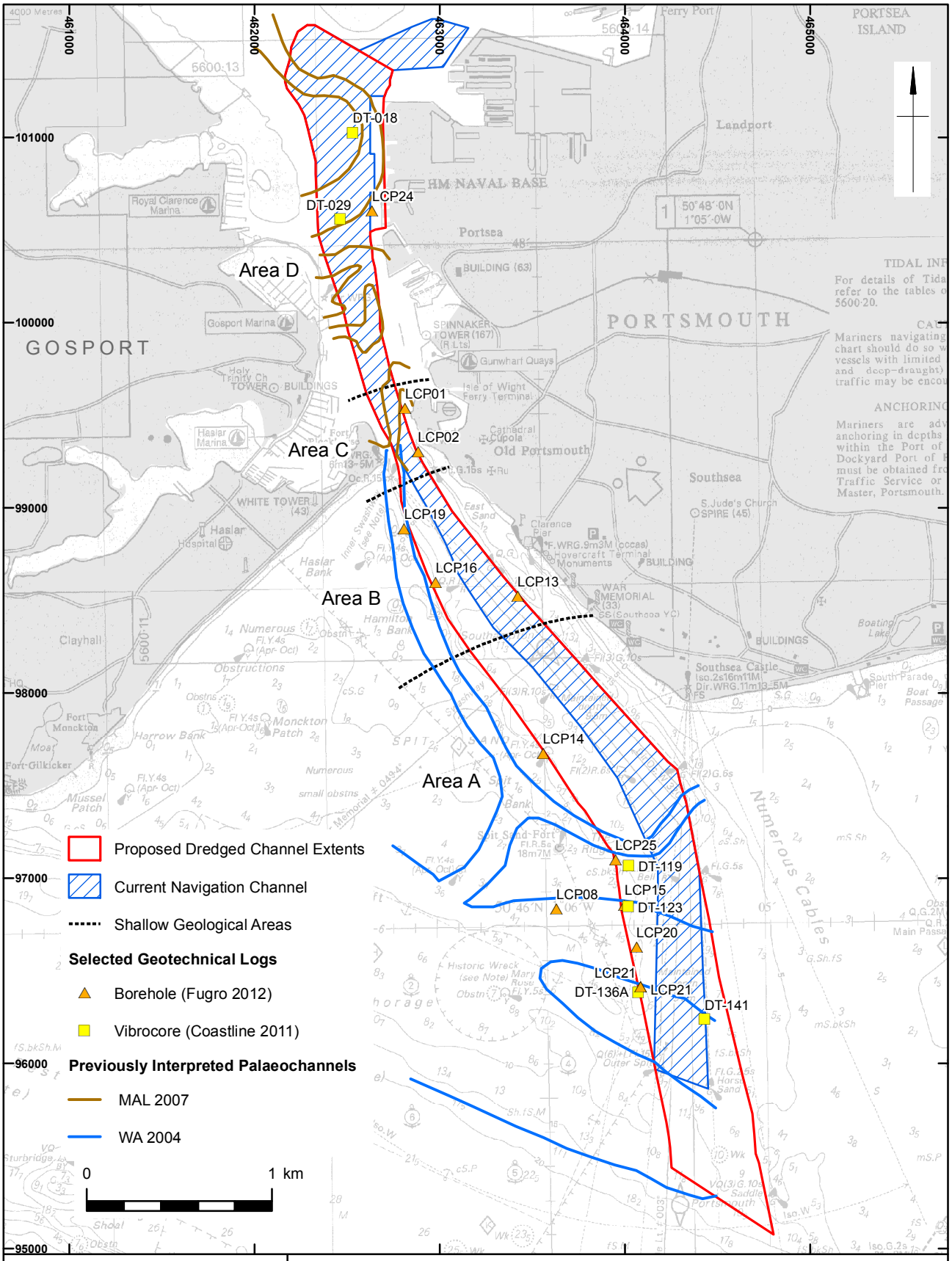
Study Area and Borehole Locations

Figure 1



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Palaeogeographic Interpretation

Figure 2

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