



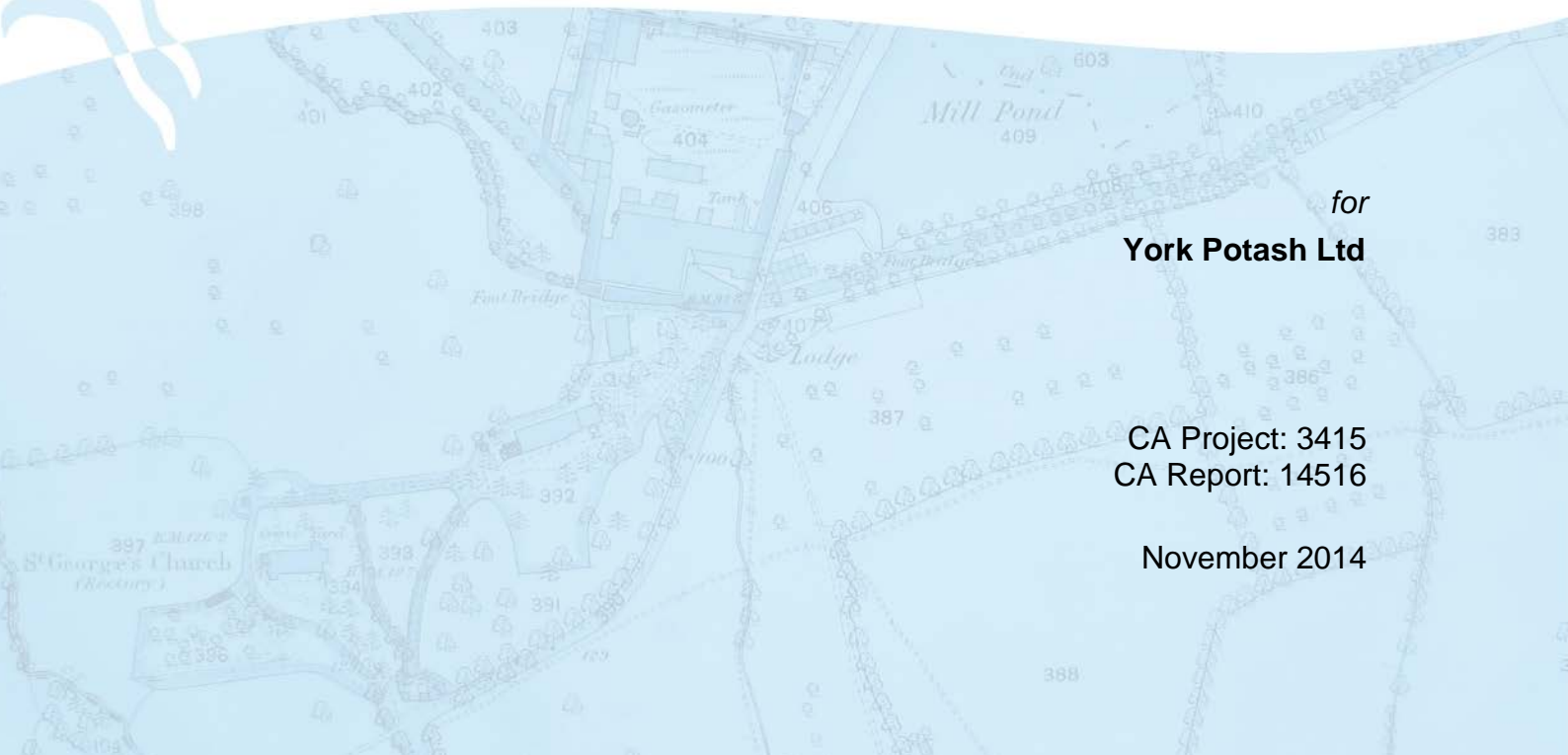
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**Section 15 Appendix 15.3
Stage 1 Geoarchaeological
Assessment**

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York Potash Harbour Facility, River Tees Yorkshire

Geoarchaeological Stage 1 Vibrocore and Borehole Assessment



for
York Potash Ltd

CA Project: 3415
CA Report: 14516

November 2014

York Potash Harbour Facility,
River Tees,
Yorkshire

Geoarchaeological Stage 1 Vibrocore and
Borehole Assessment

CA Project: 3415
CA Report: 14516

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CONTENTS

1.	INTRODUCTION.....	6
	<i>Project background</i>	<i>6</i>
	<i>Geology.....</i>	<i>6</i>
2.	SUMMARY OF ARCHAEOLOGICAL POTENTIAL	6
3.	METHODOLOGY.....	8
	<i>Vibrocores.....</i>	<i>8</i>
	<i>Boreholes.....</i>	<i>9</i>
4.	RESULTS	9
	<i>Overview of the Sedimentary Sequence.....</i>	<i>9</i>
	<i>UNIT 1 extremely weak Mudstone.....</i>	<i>10</i>
	<i>UNIT 2 sandy/ silty/ gravelly Clay (possible mid-Holocene sediments).....</i>	<i>10</i>
	<i>UNIT 3 gravelly Sand and slightly silty and clayey Sand (marine sediments)</i>	<i>10</i>
	<i>UNIT 4 gravelly sandy Clay (estuarine alluvium/ polluted fluvial sediments).....</i>	<i>11</i>
	<i>UNIT 5 silty, sandy gravel with cobbles (20th century reclamation).....</i>	<i>11</i>
	<i>Summary of sediments from the proposed Material Handling Facility.....</i>	<i>11</i>
5.	DISCUSSION.....	12
6.	RECOMMENDATIONS.....	14
7.	REFERENCES.....	15

LIST OF ILLUSTRATIONS

- Figure. 1 2014 vibrocore and borehole locations within the proposed Harbour Facility
- Figure. 2 2014 borehole locations within the proposed Materials Handling Facility
- Figure. 3 Extract from the 1895 Ordnance Survey map showing vibrocore and borehole locations



SUMMARY

Project Name: York Potash Harbour Facility,
Location: River Tees, Middlesbrough
NGR: 454962, 525030

In October 2014 Cotswold Archaeology was commissioned by York Potash Ltd. to carry out an archaeological Stage 1 vibrocore and borehole assessment of eight vibrocore and five borehole logs recovered from the area of the proposed Harbour Facility.

The following five sedimentary units were interpreted from the logs:

- Unit 1 Weathered Bedrock
- Unit 2 Estuarine alluvium and peat (possible mid-Holocene sediments)
- Unit 3 Marine sediments/ Estuarine alluvium
- Unit 4 Estuarine alluvium/ polluted fluvial sediments
- Unit 5 Made ground (20th century)

Of these units it is considered possible that Unit 2 may have the potential to contain *in situ* prehistoric archaeological material associated with mid-Holocene seasonal use of the estuary/ marshland.

Unit 2 was not present within any of the vibrocore logs due to their limited depth of penetration. No retained boreholes samples include material from Unit 2 that would be suitable for further analysis. Due to the infrequent and slight nature of the peat deposit within Unit 2 it cannot be guaranteed that further borehole survey would encounter these deposits again. No further work is therefore recommended.



1. INTRODUCTION

Project background

- 1.1 Cotswold Archaeology was commissioned by York Potash Ltd. (YPL) to undertake a geoarchaeological Stage 1 assessment of vibrocore and borehole logs as part of the archaeological works for the York Potash Harbour Facility Environmental Impact Assessment.
- 1.2 YPL proposes to develop a Harbour Facility on Teesside for the export of polyhalite bulk fertilizer. The proposed Harbour Facility would comprise a marine terminal at Bran Sands on the Tees Estuary to provide facilities to export the product, storage facilities and a conveyor system to transfer the product to the marine terminal from a materials handling facility to be located at Wilton.
- 1.3 The Stage 1 assessment of vibrocore and borehole logs obtained from York Potash Harbour Facility (Figure 1) has been undertaken in response to English Heritage's letter of 18 December 2013 regarding the Application by York Potash Ltd for an order granting development consent for the proposed York Potash Harbour Facilities'. The letter stated that '*...all new vibrocore and borehole logs produced, as a result of the proposed works, to be examined by a qualified Geo-archaeologist to ascertain the presence/absence of peat or other organic raw materials.*'

Geology

- 1.4 The solid geology of the site comprises mudstone of the Mercia Mudstone Group, which was formed in the Triassic Period. The superficial deposits recorded across the site comprise Quaternary tidal flat deposits formed of sand, silt and clay. These deposits were formed in shoreline environments (British Geological Society (BSG) November 2014).

2. SUMMARY OF ARCHAEOLOGICAL POTENTIAL

- 2.1 An archaeological and historical background of the study area is provided in the cultural heritage Desk-Based Assessment (AOC 2005) and the Royal Haskoning DHV Desk-Based Appraisal/ Technical note (RHDHV 2014) and is not repeated here. It is, however, worthy of note that previous studies highlight extensive reclamation within the Tees Estuary and that no prehistoric remains have been

recorded from the immediate vicinity of the site. The AOC desk-based assessment (2005) acknowledges that there is the potential for prehistoric land surfaces (indicated by surviving peat deposits) to be preserved beneath later sediments.

- 2.2 Intertidal peat beds dating to the mid-Holocene (later Mesolithic) are well known north of the Tees Estuary near Hartlepool and Seaton Carew. These deposits indicate fluctuating sea levels since the last glacial period (12,000 years ago) (Waughman 2005). The peat beds south of the Tees at Redcar are less well known as they are generally covered by sand and infrequently revealed. When revealed they can span c. 2 hectares on the beach and occasionally extend north and southwards. They were exposed in July 2013, and evidence of coppicing and one tree stump with possible stone axe marks was recorded, before the peat was once again covered by sand (Carter 2013). The peat surface was observed to be firm and compressed, and dense grey clay (marine or glacial till/ lacustrine) was occasionally evident in pools at the edge margins of the peat, underlying the peat beds (Carter 2013).
- 2.3 Sea level fluctuations in Hartlepool Bay during the mid to late Holocene resulted in a complex changing environment, vegetation cover, and faunal presence in a landscape. The landscape was always reasonably close to the sea throughout the Late Mesolithic, and at points it was submerged (during periods of marine transgression). Analysis of sediments, pollen and diatoms indicate woodland/forest, fenland, and saltmarsh conditions at various stages (marine regression), interspersed with marine transgressions (Carter 2013). The peat beds within the Tees Estuary attest to woodland/ forest development during a period of marine regression in the mid-Holocene.
- 2.4 The channel of the Tees was subject to straightening during the 19th century, and large areas of the intertidal zone around the channel were reclaimed. When the channel was straightened it was narrowed in places from 300m, to between 100m and 200m. Narrowing of the channel was achieved by the dumping of ironworks and ship ballasts along the river bank (<http://www.teescoast.co.uk/history/>).
- 2.5 Historic mapping and aerial photography suggest that the area of the site was not reclaimed until the mid-20th century (AOC 2005). Prior to this, it would have been located within the intertidal zone, within an area consisting of marshland and sand adjacent to the channel (Figure 3). Historic mapping indicates that this would have been the case since at least 1856 (not illustrated). By the 1970s 90% of the intertidal

mudflats and sandbanks had been reclaimed. At the same time the River Tees Estuary was described as the most polluted in the UK and it was agreed to stop reclamation and resolve the pollution problems (<http://www.teescoast.co.uk/history/>).

- 2.6 Historic mapping indicates that in the late 19th century the river bank within the site was located further to the west, this can be seen on the 1895 Ordnance Survey (OS) map (Figure 3). This suggests that when the area was reclaimed in the 20th century the channel was dredged; widening and straightening the channel and building up the river bank.

3. METHODOLOGY

- 3.1 A total of eight vibrocore logs and five borehole logs and accompanying geotechnical data and photographs have been assessed as part of this Stage 1 assessment (Fugro 2014 and Dunelm 2014a) (Figure 1). These logs were collected as part of geotechnical investigations of the proposed Harbour Facility area.
- 3.2 The proposed Material Handling Facility is located to the east of the proposed Harbour Facility, 15 borehole logs were recorded from within this area in 2014 (Dunelm 2014b) (Figure 2). These have been reviewed as part of the assessment in order to provide context for the Stage 1 assessment of the vibrocore and borehole logs from the proposed Harbour Facility area.
- 3.3 Borehole logs previously recorded within the vicinity of the proposed development were also reviewed. These included publically available boreholes from the British Geological Survey website (BGS November 2014), and boreholes taken from the proposed Materials Handling Facility in 2002 (WSP 2002).

Vibrocores

- 3.4 The eight vibrocore logs and accompanying photographs and geotechnical data (Fugro 2014) were assessed by a qualified geoarchaeologist. The locations of the vibrocores are shown on Figure 1 and in Table 1 below. Vibrocore penetration varied between 1.1m and a maximum of 6.0m.



Table 1: Vibrocore locations

Vibrocore ID	Easting	Northing
VC01A	454598	524826
VC02A	454737	525000
VC03A	454862	524849
VC04	454832	524969
VC05A	454814	525102
VC06	454814	525237
VC07	454826	525327
VC08A	454829	525427

Boreholes

- 3.5 Five Borehole logs and accompanying photographs and geotechnical data (Dunelma 2014a) were also assessed. Their locations are shown on Figure 1 and in Table 2 below.

Table 1: Borehole locations

Borehole ID	Easting	Northing
BHP2	454964	524966
BHP3	454964	525106
BH4PA	454961	525193
BHP5B	454958	525260
BHP6	454946	525358

4. RESULTS

- 4.1 For each log an interpretation of the sedimentary sequence was carried out and a unitary system generated in order to group the sediments. Five major units (Units 1 to 5) were recognised and these are described below.
- 4.2 The sedimentary sequence observed within the boreholes obtained from proposed Materials Handling Facility in 2014 did not correspond with those observed within the boreholes from proposed Harbour Facility. A summary of the sedimentary sequence observed within the boreholes obtained from proposed Materials Handling Facility in 2014 is provided at the end of this section.

Overview of the Sedimentary Sequence

- 4.3 The following table summarises the sedimentary sequence.

Sedimentary Unit	Interpretation
Unit 5	Made ground (20th century)
Unit 4	Estuarine alluvium/ polluted fluvial sediments
Unit 3	Marine sediments/ Estuarine alluvium
Unit 2	Estuarine alluvium and peats (possible mid-Holocene sediments)
Unit 1	Weathered Bedrock

UNIT 1 extremely weak Mudstone

- 4.3 This basal unit was encountered in all of the boreholes and was encountered from a depth of 14.25m (in **BHP2**), although it was generally present from c. 20m (**BHP3, BHP4A, BHP5B** and **BHP6**).
- 4.4 This unit was not recorded within any of the vibrocores, due to their limited depth of penetration (i.e. no deeper than 6m). This unit is interpreted as weathered bedrock, part of the Mercia Mudstone Group.

UNIT 2 sandy/ silty/ gravelly Clay (possible mid-Holocene sediments)

- 4.5 This unit was recorded in all but one of the boreholes (**BHP3, BHP4A, BHP5B** and **BHP6**). This unit was present from 16.7m, so once again it was not present within the vibrocores due to their limited depth of penetration. This sediment was generally about 2m in extent, although it was up to 5.2m thick in **BHP5B**.
- 4.6 This sediment was identified at a similar depth within several of the online BGS borehole logs viewed within the area of the site (BGS November 2014).
- 4.7 The unit consisted of a firm sandy/ gravelly/ silty Clay, with some layers containing thinly laminated layers of sand. This unit is interpreted as possible mid-Holocene estuarine alluvium.
- 4.8 Coal was recorded within this sediment within one of the borehole (**BHP3**), between 16.7 and 18.2m.
- 4.9 Pseudofibrous peat lenses/ pockets and fragments of wood and organic material within a clay context were recorded within one of the boreholes (**BHP6**), between 20.8 and 21.8m. This deposit overlies a stiff thinly laminated sandy Clay, and was overlain by a sandy gravelly clay with fragments of wood, all of which are attributed to Unit 2. The development of peat within a clay context indicates temporary marshland/ terrestrial conditions within the estuarine environment.

UNIT 3 gravelly Sand and slightly silty and clayey Sand (marine sediments)

- 4.10 This unit was recorded within all of the vibrocore and borehole logs and consists of a clayey Sand and gravelly Sand containing fragments of shell.

- 4.11 Within the boreholes this unit was up to 12m thick and mainly consisted of gravelly Sand. A silty Sand was recorded within **BHP2** and **BHP6**. Within the vibrocores this unit was the basal unit, up to 1m thick, and mainly consisted of a slightly clayey Sand. It is possible that this unit would have been a similar thickness within the vibrocores, but the limited depth of penetration of the vibrocores meant that it was not possible to determine this. The unit was often shelly and is interpreted as seabed sediment.
- 4.12 Two of the vibrocores (**VC03A** and **VC08A**) within this unit also had a thin layer of Clay (up to 0.08m thick) stratified between the Sand, and one had a layer of Clay below the Sand (2.2m thick) (**VC06**). These sediments are interpreted as estuarine sediments within the marine sediment.

UNIT 4 gravelly sandy Clay (estuarine alluvium/ polluted fluvial sediments)

- 4.13 This unit was recorded within all of the vibrocores and boreholes.
- 4.14 Within the vibrocores this unit formed the top of the sequence and was generally 1 to 2m thick. However, within **VC07** it was 4.87m thick, extending the whole depth of the vibrocore with a strong smell of hydrocarbon (Furgo 2014). This unit is interpreted as modern polluted fluvial sediment.
- 4.15 Within the boreholes this unit was generally 0.5m thick, although it was recorded up to 2.2m thick within **BHP5B**. This unit is interpreted as estuarine sediments, and it was overlain by what appears to be made ground (reclaimed land). A layer of Sand overlays the Clay within **BHP3**, this is also interpreted as an estuarine sediment, potentially a sand bank.

UNIT 5 silty, sandy gravel with cobbles (20th century reclamation)

- 4.16 This unit consists of silty, sandy gravel, silty gravel, and a sandy gravel with cobbles, and was up to 9.3m thick. This unit only occurs within the boreholes at the top of the sequence. This unit had inclusions of slag, concrete and brick and is interpreted as 20th century reclaimed land.

Summary of sediments from the proposed Material Handling Facility

- 4.17 There are no organic or peat deposit present within any of these boreholes. Unit 1, Mudstone (weathered bedrock) is present within most of the boreholes from a depth of 3.55 to 11.5m below ground level.

- 4.18 A clay sediment overlays Unit 1. This sediment frequently contains coal and occasionally concrete, along with orders of petrol and chemicals (Dunelm 2014b). Laminated sand is recorded within the clay sediment within **BH507** and **BH152** (Figure 2).
- 4.19 'Made Ground' containing brick and concrete is present at the top of the sequence in most of the boreholes.
- 4.20 The nature of sediments overlying the weathered bedrock (Unit 1) indicates that they have been largely altered/ removed within this area. The limited depth of the bedrock within these boreholes compared to the proposed Harbour Facility area also suggests alteration of the overlaying deposits. It is possible that some areas have been subject to less alteration, such as the sequences which contain laminated sands (i.e. **BH507** and **BH512**).

5. DISCUSSION

- 5.1 The sequence interpreted from the 2014 vibrocores and boreholes within the proposed Harbour Facility is concurrent with the sequence mapped by the British Geological Survey in the Tees Estuary (BGS November 2014). Unit 1, interpreted as bedrock has been mapped in the area as sedimentary bedrock, part of the Mercia Mudstone Group (BGS November 2014). This unit was not reached within any of the vibrocores due to their limited depth of penetration. The basal records from the vibrocores and Unit 2 and 3 from the boreholes appear to be consistent with the superficial tidal flat deposits recorded within the area.
- 5.2 The sequences interpreted from the 2014 vibrocores and boreholes within the proposed Harbour Facility are not concurrent with those recorded within the Tees Estuary to the north-east of the site at Hartlepool and to the south-east of the site at Redcar. The sequences recorded within these locations include a firm and compressed peat surface with tree stumps (Carter 2013 and Waughman 2005). The compressed peat surface representing a marine regression which allowed a ground surfaces to develop and forests to grow. This deposit has been dated to the mid-Holocene.

- 5.3 Unit 2 within the boreholes consisted of a sandy/ silty/ gravelly Clay, with only one borehole recording a layer containing pockets/ lenses of peat. The thinly laminated layers present within Unit 2, sometimes with bands of sand, suggest that the area was subject to intertidal deposition. Intertidal sediments are characterised by twice-a-day flooding and drainage, with estuarine and/ or marine sediments deposited during episodes of flooding.
- 5.4 It is possible that the sequence identified elsewhere in the Tees Estuary does not exist within the area of the site due to its location within/ beside the river channel. This may have meant that the site remained subject to intertidal inundations, even during the mid-Holocene marine regression. Small pockets/ lenses of peat were recorded within one of the boreholes, indicating that the flow of water within the area would have been restricted enough (due to the marine regression) to allow at least temporary land surfaces to develop.
- 5.5 Unit 2 may not concur with the mid-Holocene deposits recorded elsewhere in the Tees Estuary, but it does have some similar characteristics to these deposits. It is therefore likely that Unit 2 dates to the mid-Holocene, representing a period of marine regression. These deposits are potentially of archaeological interest.
- 5.6 Unit 3 appears to predominantly represent marine sediments, indicating a period of marine transgression. This is followed by estuarine/ fluvial sediments within Unit 4.
- 5.7 Historic mapping demonstrates that the vibrocores and boreholes were located within an area of estuarine conditions during the late 19th century, as seen on the 1895 OS map (Figure 3). During reclamation of the area in the 20th century the river was dredged, and the deposits were used to build up the river bank. The estuarine sediments are recorded from within the boreholes, which are located adjacent to the channel, and would have been sealed by reclaimed land (Unit 5). Unit 5 had inclusions of slag, concrete and brick and is therefore interpreted as 20th century reclaimed land, overlaying estuarine deposits.
- 5.8 The vibrocores are located within the river channel so it is likely that the estuarine deposits were removed/ disturbed when the river was dredged during reclamation of the area. Unit 4 within the vibrocores therefore represents the top of the sequence, and has been interpreted as modern polluted fluvial sediment. This is because this

area has been subject to the fluvial conditions of the river and the strong smell of hydrocarbons from VC07 indicates that it is polluted.

- 5.9 The BGS borehole logs viewed online, from within the River Tees and its banks, extended to a similar depth as the 2014 boreholes and generally correlate with either a laminated clay or organic clay containing vegetation (Unit 2) located above the bedrock (Unit 1), and below a sand deposit (Unit 3). The organic clay (Unit 2) varied from soft to firm, and was generally located from 12m to 18m below ground level. Although one horizon is recorded from c. 5m below ground level. Unit 2 within the five 2014 boreholes was located at a depth from 16.7m to 19.6m below ground level.
- 5.10 No peat was identified within the boreholes taken from the proposed Materials Handling Facility to the east of the site (WSP 2002 and Dunelm 2014b), and the sediment sequence within these boreholes does not appear to correspond to those recorded within proposed Harbour Facility area. Clay was recorded overlaying the weathered bedrock, and below 'made ground' within the majority of the boreholes. The 2002 investigations identified both 'brownfield' and 'greenfield' areas. The sediments overlaying the weathered bedrock appear to have been disturbed within the majority of the 2014 boreholes.

6. RECOMMENDATIONS

- 6.1 The depths of deposits taken by the vibrocores are of little archaeological interest. No further recording work is therefore required from these vibrocore cores. One of the boreholes, **BHP6**, contained peat deposits of potential archaeological interest, within Unit 2. Coal was identified from Unit 2 within **BHP3**.
- 6.2 Consultation was carried out between the 4th and 10th of November 2014 with Jacqui Huntley, English Heritage's Science Advisor, North East, and Dr Rob Young, Inspector of Ancient Monument, North East. Dr Young recommended that pollen analysis and radiocarbon dating could potentially be carried out on the peat deposits within Unit 2 (specifically those within **BHP6**) in order to determine whether any further work would be required. This analysis could potentially allow the deposits to be compared with the mid-Holocene deposits that are recorded elsewhere on the coast and in the Tees Estuary.

- 6.3 There are, however, no surviving samples obtained from Unit 2 suitable for further analysis. Dunelm Geotechnical and Environmental Ltd. provided a list of samples retained from the boreholes. These samples are predominantly 'disturbed' bagged samples with occasional undisturbed core sections. It is highly likely that the 'disturbed' samples have been subject to contamination so they are not suitable for radiocarbon dating or pollen analysis. None of the undisturbed core sections remain from Unit 2 in **BHP3** and **BHP6**. Radiocarbon dating and pollen analysis of **BHP6** is therefore not possible.
- 6.4 Due to the infrequent and slight nature of the peat deposit it cannot be guaranteed that further borehole survey would encounter these deposits again. No further work is therefore recommended.

7. REFERENCES

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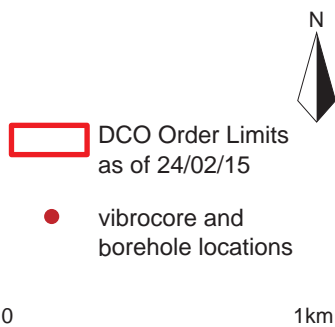
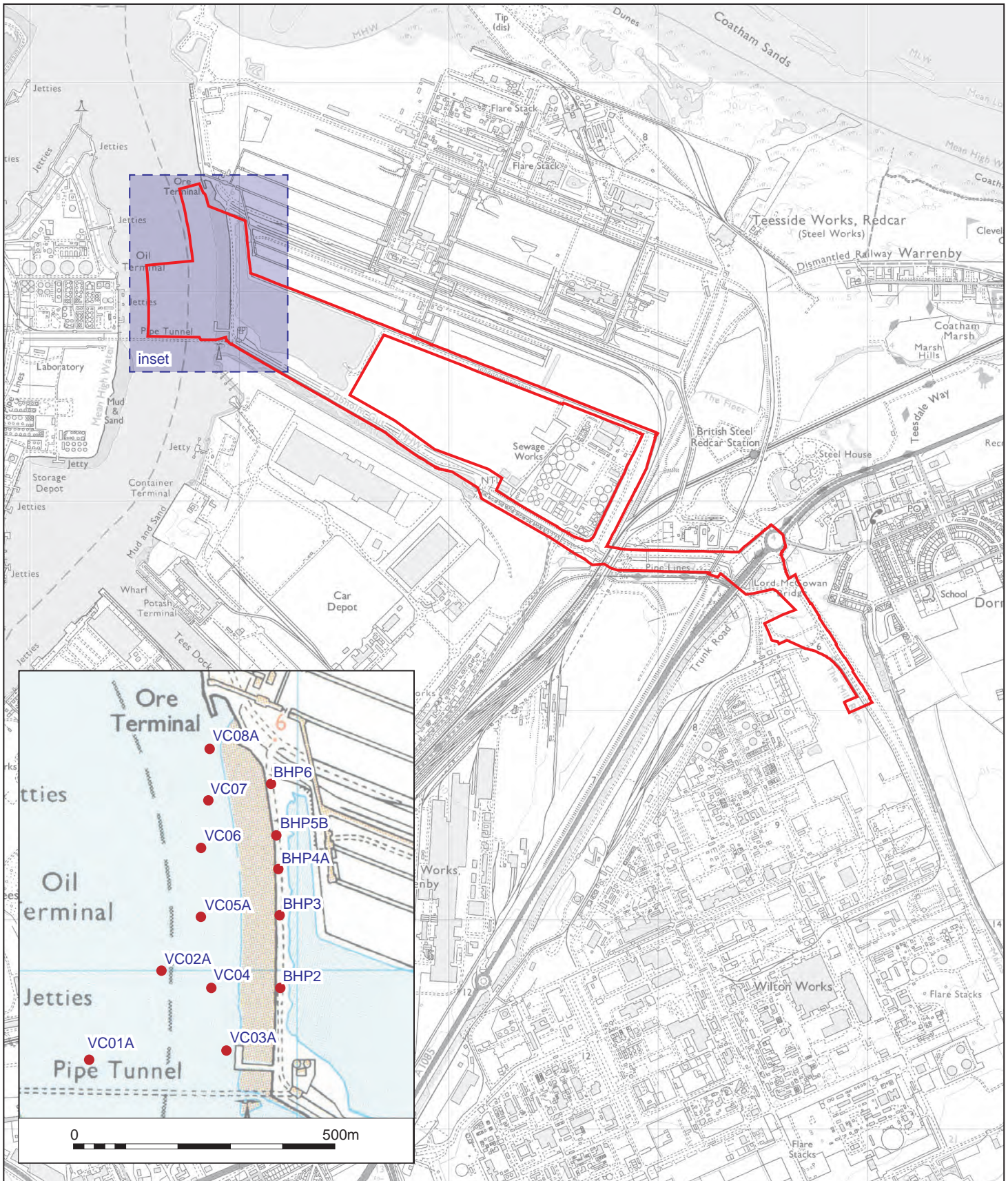
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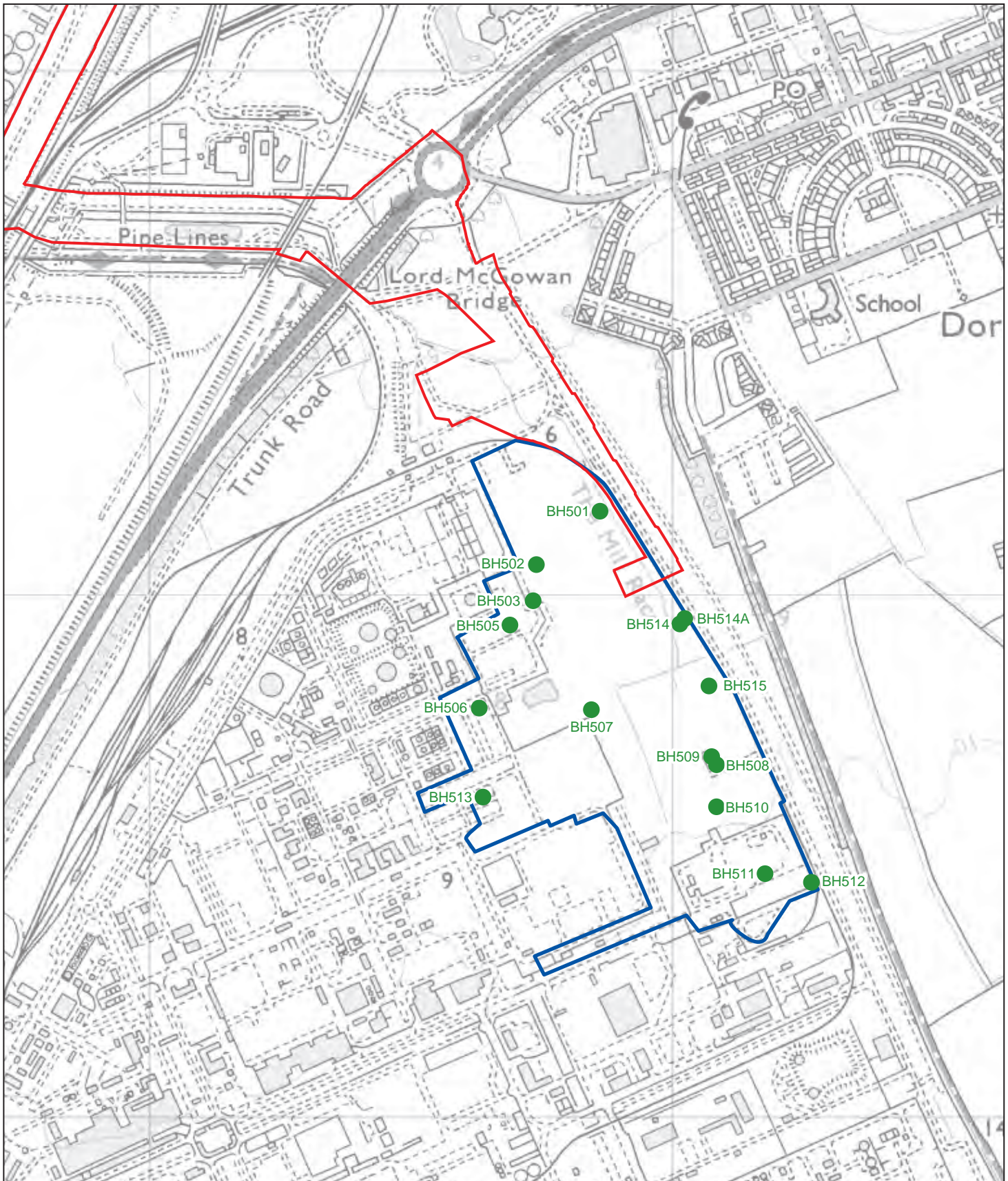
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PROJECT TITLE
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FIGURE TITLE
 2014 vibrocore and borehole locations within the proposed Harbour Facility


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 Materials Handling Facility

 vibrocore and borehole locations



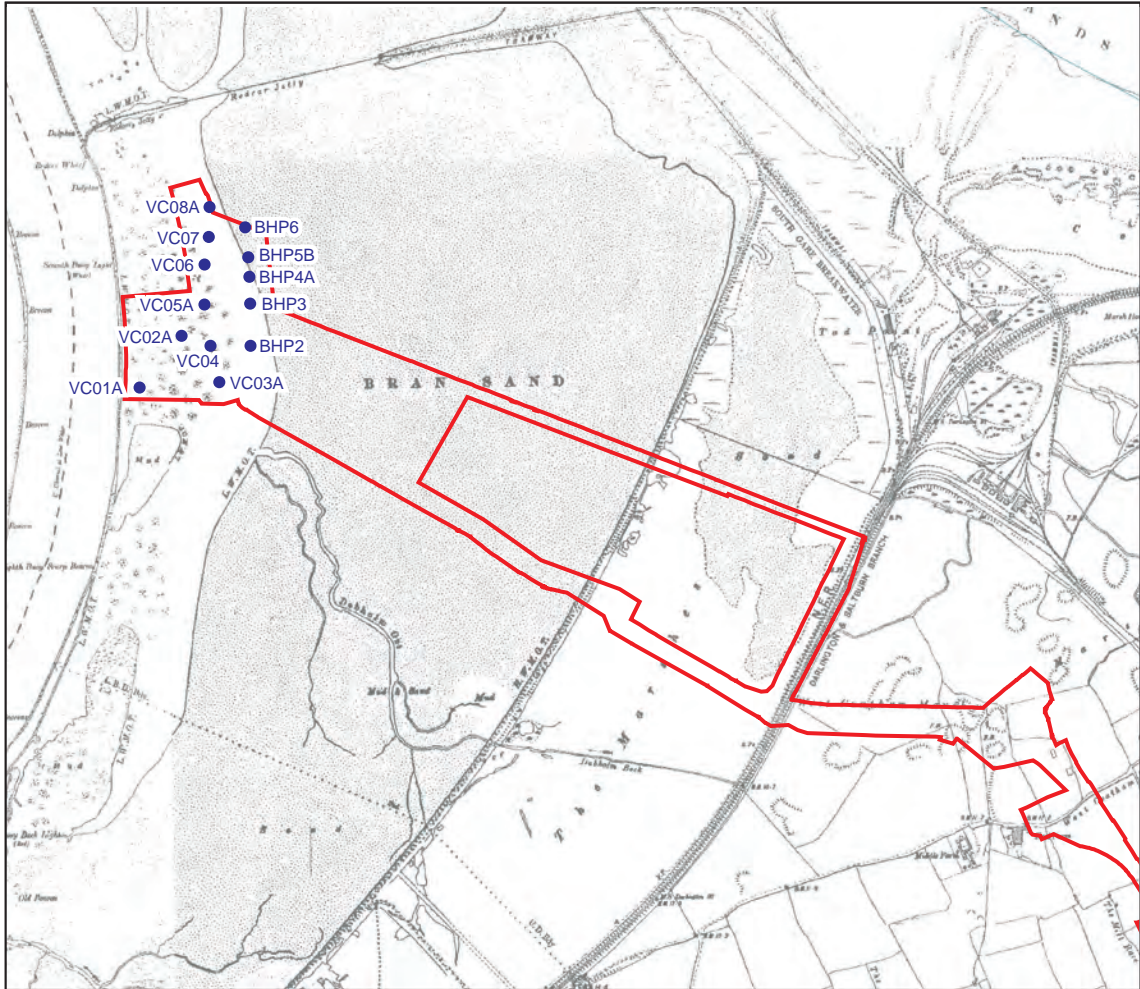
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FIGURE TITLE

2014 borehole locations within the proposed Materials Handling Facility



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 vibrocore and borehole locations



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FIGURE TITLE

Extract from the 1895 Ordnance Survey map showing vibrocore and borehole locations



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