

# Norfolk Vanguard Offshore Wind Farm

# Appendix 17.2

## Stage 1 Geoarchaeological Review

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*Photo: Kentish Flats Offshore Wind Farm*



# Environmental Impact Assessment Environmental Statement

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For and on behalf of Norfolk Vanguard Limited

Approved by: Ruari Lean, Rebecca Sherwood

Signed:



Date: 8<sup>th</sup> June 2018



# Vanguard Offshore Wind Farm

## Stage 1 Geoarchaeological Review



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April 2017



# **Vanguard Offshore Wind Farm**

## **Stage 1 Geoarchaeological Review**

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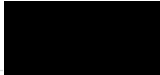

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# Vanguard Offshore Wind Farm

## Stage 1 Geoarchaeological Review

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# Vanguard Offshore Wind Farm

## Stage 1 Geoarchaeological Review

### 1 INTRODUCTION

#### 1.1 Project background

- 1.1.1 Royal HaskoningDHV have requested that Wessex Archaeology (WA) undertake a geoarchaeological review of geotechnical logs and samples in support of the proposed Norfolk Vanguard East and Norfolk Vanguard West Offshore Wind Farm (**Figure 1**).
- 1.1.2 The location of the proposed wind farm and cable route (**Figure 1**) are of particular archaeological interest regarding early prehistoric archaeology being framed by the flooding of the area prior to c.7000 BP (Waddington 2015).
- 1.1.3 An initial review of preliminary vibrocore logs (Fugro 2016a) of 65 vibrocore locations identified sequences of bedded, laminated, fine-grained and organic sediments of probable Pleistocene and Holocene origin and of potential archaeological and palaeoenvironmental interest. This initial review was undertaken in September 2016
- 1.1.4 On the basis of the initial review of the preliminary logs (Fugro 2016a) the vibrocores were assigned low, medium, high and very high priority status. Those of high priority were put aside for further Stage 2 geoarchaeological work. Those identified as low priority were geotechnically logged and sampled with archaeological advice given to the geotechnical engineers on recognising and putting aside sediments of archaeological geoarchaeological significance. The geotechnical logging and sampling of the medium priority locations were monitored at Fugro House, Wallingford by a geoarchaeologist during October 2016.
- 1.1.5 This report summarises the results of the geoarchaeological review of the 65 vibrocores.

#### 1.2 Site location, geology and archaeology

- 1.2.1 The Site is located in the southern North Sea. The provisional offshore cable corridor stretches approximately 80km eastwards from the landfall location (between Bacton and Happisburgh South), joining the two offshore wind farm sites (Norfolk Vanguard East and Norfolk Vanguard West) (**Figure 1**).
- 1.2.2 Quaternary glacial and interglacial sediments (sands, gravels and till) dominate the surficial sediments of the area (Cameron *et al.* 1992). This includes Holocene deposits of sands, silts and gravels with occasional organic-rich layers. Modern marine sediments consisting of unconsolidated shelly sands cap the sequence.
- 1.2.3 The area and sequence of deposits is known to contain an interesting archive of prehistoric archaeological material dating from the earliest known occupation of North Western Europe (Parfitt *et al.* 2010) to the more recent post -Glacial recolonisation of Britain (Waddington 2015).



### 1.3 Scope of report

- 1.3.1 To help frame geoarchaeological investigations of this nature, Wessex Archaeology has developed a five stage approach (see **Table 1**), encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results at the level achieved.

**Table 1: Staged approach to geoarchaeological investigations**

<p>Stage 1: Geoarchaeological review</p>	<p>A review of samples and logs generated by geotechnical contractors. This assessment will establish the presence and location of sediment units with likely archaeological, palaeo-environmental and/or dating potential, as a basis for deciding what Stage 2 archaeological recording is required.</p> <p>The Stage 1 report will state the scale of Stage 2 work proposed. Should no further works be required a brief Stage 1 report outlining the results of the assessment will be prepared.</p>
<p>Stage 2: Geoarchaeological description &amp; interpretation</p>	<p>Each sample containing sediment units identified as having archaeological, palaeo-environmental or dating potential will be cleaned, recorded, and the sediments described geoarchaeologically following Hodgson (1997). Preliminary interpretations will be made, those units of particular archaeological/palaeo-environmental interest will be highlighted, and an outline deposit model will be constructed/ added to if appropriate. The Stage 2 report will set out the nature and scope of any Stage 3 work which may be required to further characterise and interpret the sediment units in order to identify areas of potential archaeological or palaeoenvironmental significance.</p> <p>If during Stage 2 the potential is shown to be limited to well-defined areas which could be addressed by specific targeted sampling, a programme of investigation combining limited Stage 3/4 works may be proposed. This work would output to a final client report or straight to publication, depending on the requirements of the client and curator.</p>
<p>Stage 3: Sub-sampling and palaeoenvironmental assessment</p>	<p>Sub-sampling and assessment of any units of archaeological and/or palaeo-environmental interest. Sub-samples for the assessment of microfossil environmental indicators (including pollen, diatoms, plant macrofossils, molluscs, ostracods and/or foraminifera) will be taken. As far as possible the subsamples will be taken in such a manner that the remaining core is retained intact should further sub-sampling be required.</p> <p>The subsamples will be assessed, with the relevant ecofacts being identified to at least main Taxon, with quality of preservation and approximate quantification). This enables the value of the palaeo-environmental material surviving within the samples to be identified.</p> <p>Should radiocarbon dating have been specified at this stage by the Stage 2 report, then suitable material will be extracted from appropriate subsamples and submitted. If not, then 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, and summarise the archaeological implications of the combined results. The potential of the material will be summarised, and recommendations will be made as to whether any Stage 4 work is warranted. If Stage 4 work is recommended, then the specifics will be laid out.</p>





Stage 4: Analysis and Dating	<p>Full analysis of environmental indicators (including pollen, diatoms, plant macrofossils, molluscs, ostracods and/or foraminifera) from subsamples specified in the Stage 3 report.</p> <p>Typically, Stage 4 will be supported by radiocarbon dating of suitable sub-samples. Should Stage 3 assessment indicate that there is no further analytical work required on the microfossil assemblages, consideration will still be given for a programme of radiocarbon analyses to provide a chronological framework for the deposits encountered unless no suitable samples could be procured. The Stage 4 report will provide an account of the palaeo-environment(s) at each relevant sample location within a chronological framework (absolute or relative) and an outline of the archaeological implications of the analysis.</p>
Final Reporting	<p>If the archaeological results are sufficiently significant, a final report will be compiled for submission to a suitable journal, to be agreed with the client and curator. This publication report will cover all aspects of the palaeo-topography and prehistory of the area affected by the development, incorporating the results of each stage.</p> <p>If the archaeological results are not significant then the relevant Stage Report(s) will constitute the final documents for the investigation.</p>

- 1.3.2 This report follows the approach outlined in **Table 1** above, and summarises the results of the Stage 1 Geoarchaeological review.
- 1.3.3 The work has been undertaken in accordance with discussion with Royal HaskoningDHV and Historic England. The review has been undertaken with reference to the COWRIE (Collaborative Offshore Wind Research into the Environment) guidance document (Gribble and Leather 2011) and the English Heritage guidelines on geoarchaeology (English Heritage 2015) and environmental archaeology (English Heritage 2011).



## **2 AIMS AND OBJECTIVES**

### **2.1 Aims**

2.1.1 The aims of the geoarchaeological works are to increase our knowledge and understanding of the evolution of the landscape within the offshore project area and to enhance current understanding of potential associated with prehistoric human occupation.

### **2.2 Objectives**

2.2.1 The objectives for the Stage 1 work were as follows:

- Review geotechnical logs to identify sediments of potential archaeological interest;
- Monitor geotechnical sampling to ensure safeguarding of archaeologically sensitive deposits and
- Report on the results and make recommendations for any further work (i.e. Stage 2).



### 3 METHOD

#### 3.1 Initial review of preliminary Vibrocore logs

3.1.1 Each of the 65 preliminary vibrocore logs (Fugro 2016) were reviewed by a geoarchaeologist in order to understand their potential utility for further work and to safeguard the samples. Those identified of high (**VC079, VC089, VC095, VC101, VC116, VC117**) and very high (vibrocores **VC074, VC076** and **VC085**) priority were put aside for Stage 2 work.

#### 3.2 Monitoring of geotechnical logging and sampling

3.2.1 The samples identified as medium priority (**VC070, VC071, VC072, VC081, VC084, VC086, VC092, VC094, VC097, VC0103, VC104, VC105, VC106, VC117, VC118, VC119, VC120** and **VC122**) were opened under archaeological supervision (at Fugro House, Wallingford) to ensure adequate samples were retained for further archaeological work.

3.2.2 The remaining (low priority) samples were opened in the laboratory by Fugro and described by a suitably experienced geotechnical engineer who had been briefed to retain material of potential archaeological significance. A final geotechnical report was produced (Fugro 2016b) and reviewed to ensure no further archaeologically significant sequences were missed.



## 4 RESULTS

### 4.1 Introduction

4.1.1 The results of the Stage 1 review are primarily the identification of sediments from 22 vibrocore locations that require further Stage 2 work. The following vibrocores contained Pleistocene and Holocene sediments of potential interest for further Stage 2 work: **VC070, VC074, VC075, VC076, VC079, VC080, VC081, VC084, VC085, VC086, VC089, VC092, VC095, VC097, VC101, VC103, VC104, VC107, VC116, VC117, VC118** and **VC119**. The location of these vibrocores are shown on **Figure 1**.

4.1.2 The types of sediments encountered in the southern North Sea are notoriously complex (Cameron *et al.* 1992) and at this early stage it is not possible to confidently assign specific dates or environments to the sediments. There are however three main groups of sediments that have been noted which are summarised below:

### 4.2 Pleistocene sediments

4.2.1 Many of the vibrocore samples included interbedded sand and clay deposits which were interpreted as Pleistocene sediments. Whilst further work needs to be undertaken, some of the sediments observed are noted to be similar to the so called Brown Bank formation which is of Early Devensian, Middle Palaeolithic date. As these sediments were frequent and widespread only a selection of vibrocores containing these sediments were retained for Stage 2 work.

### 4.3 Holocene Sediments

4.3.1 A range of sediments were interpreted as Holocene alluvial and terrestrial sediments (alluvium and peat). Of particular interest were peat deposits recorded within vibrocores **VC075** and **VC080** which may relate to Post glacial and Holocene (Upper Palaeolithic and Mesolithic) land surfaces in the area.

### 4.4 Recent Sediments

4.4.1 More recent sands and gravels interpreted as recent/Holocene shallow marine sediments were recorded within many of the vibrocores.



## 5 CONCLUSION AND RECOMMENDATIONS

- 5.1.1 Based on the results, it is recommended that a programme of Stage 2 recording be carried out on sediments from the following locations: **VC070, VC074, VC075, VC076, VC079, VC080, VC081, VC084, VC085, VC086, VC089, VC092, VC095, VC097, VC101, VC103, VC104, VC107, VC116, VC117, VC118** and **VC119**.
- 5.1.2 The Stage 2 recording and interpretation of the sediments within the vibrocores should be correlated with the known geological sequences in the area and an outline deposit model created. This should also be cross referenced with the interpretation of the sub bottom geophysical data. It is also noted that there are CPT (Cone Penetrometer Test) data within the geotechnical report (Fugro 2016b) which records sediments at a greater depth than penetrated by the vibrocores. This data should also be integrated into the deposit model.
- 5.1.3 The aim of this work will be to understand which deposits are of archaeological significance and if warranted to identify those deposits which have potential for Stage 3 work.
- 5.1.4 It is also recommended that should further geotechnical sampling be undertaken in the area (e.g. boreholes or vibrocores) archaeological input into the survey locations/sampling strategy should be taken into account.

## 6 REFERENCES

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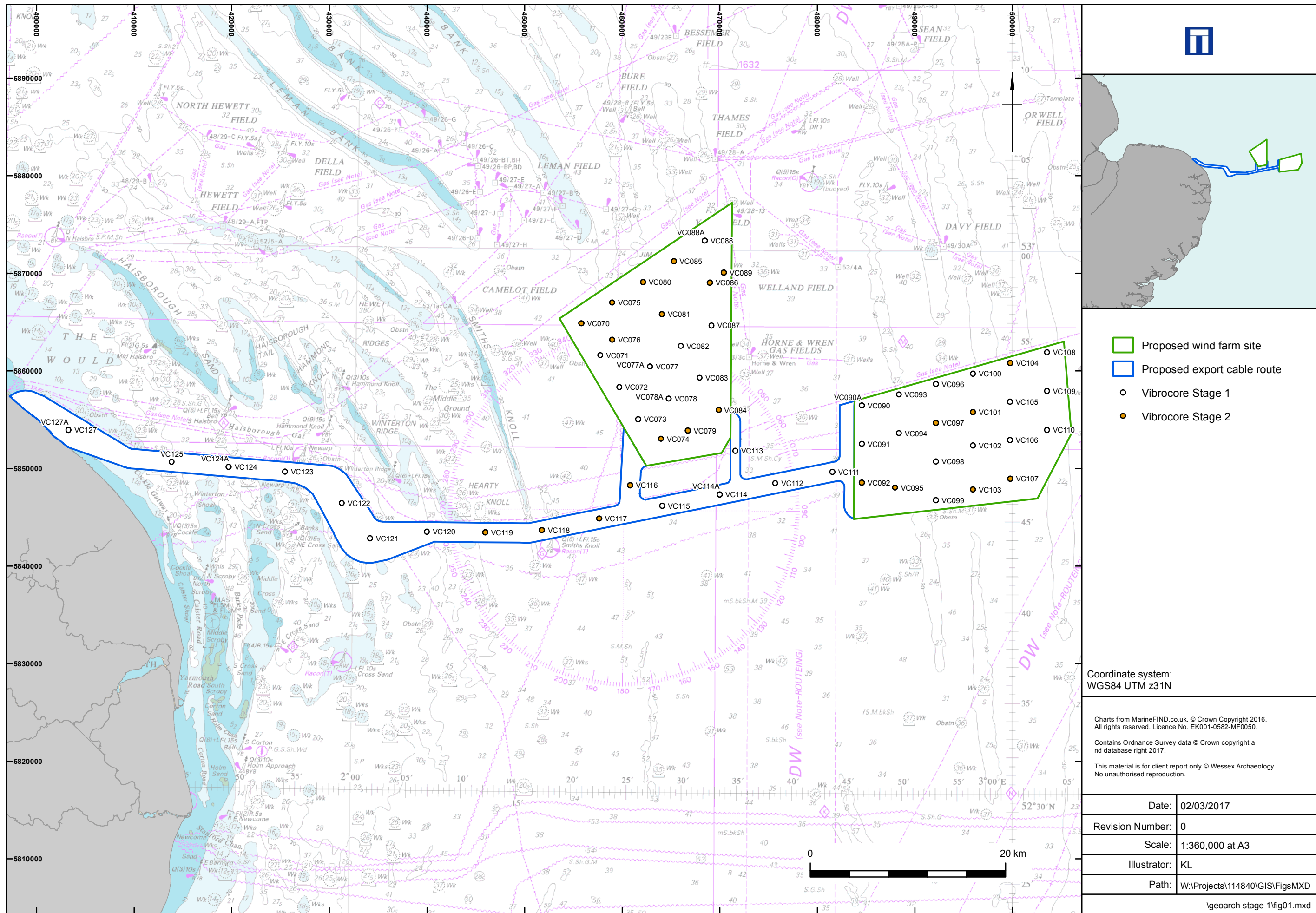


## APPENDIX 1: VIBROCORE LOCATIONS

Vibrocore	Easting	Northing
VC070	455852.02	5864848.67
VC071	457789.19	5861575.84
VC072	459733.79	5858302.82
VC073	461674.93	5855022.22
VC074	464000.93	5853014.97
VC075	458998.4	5866965.64
VC076	458994.6	5863171.76
VC077	462872.09	5860409.98
VC077A	462867.36	5860404.44
VC078	464804.48	5857128.93
VC078A	464812.36	5857124.55
VC079	466749.74	5853859.05
VC080	462164.33	5869081.71
VC081	464097.07	5865794.96
VC082	466032.19	5862517.31
VC083	467975.53	5859246.24
VC084	469907.58	5855974.15
VC085	465321.16	5871195.82
VC086	469004.42	5869009.34
VC087	469187.56	5864639.97
VC088	468497.89	5873319.26
VC088A	468489.64	5873314.62
VC089	470432.18	5870045.67
VC090	484582.32	5856435.21
VC090A	484582.83	5856431.87
VC091	484596.62	5852488.59
VC092	484593.66	5848529.7
VC093	488380.99	5857538.86
VC094	488388.62	5853581.62
VC095	488002	5848006.36
VC096	492186.04	5858609.77
VC097	492179.5	5854650.76
VC098	492182.19	5850698.63
VC099	492173.18	5846736.21
VC100	495981.53	5859701.53
VC101	495986.68	5855742.43
VC102	495978.07	5852347.64
VC103	495974.87	5847831.42
VC104	499790.16	5860796.19



<b>VC105</b>	499780.37	5856829.93
<b>VC106</b>	499778.66	5852882.88
<b>VC107</b>	499791.68	5848922.33
<b>VC108</b>	503591.73	5861869.14
<b>VC109</b>	503581.19	5857917.44
<b>VC110</b>	503586.2	5853928.56
<b>VC111</b>	481575.54	5849630.3
<b>VC112</b>	475728.27	5848468.03
<b>VC113</b>	471614.74	5851798.5
<b>VC114</b>	470006.38	5847308.61
<b>VC114A</b>	470002.94	5847307.73
<b>VC115</b>	464129.73	5846136.85
<b>VC116</b>	460846.75	5848268.39
<b>VC117</b>	457661.62	5844832.89
<b>VC118</b>	451797.78	5843651.75
<b>VC119</b>	445996.79	5843425.39
<b>VC120</b>	440003.37	5843497.5
<b>VC121</b>	434188.36	5842817.52
<b>VC122</b>	431292.89	5846416.81
<b>VC123</b>	425477.96	5849668.35
<b>VC124</b>	419700.02	5850154.5
<b>VC124A</b>	419694.49	5850149.81
<b>VC125</b>	413871.25	5850652.41
<b>VC127</b>	403284.69	5853926.04
<b>VC127A</b>	403274.62	5853926.12



- Proposed wind farm site
- Proposed export cable route
- Vibrocore Stage 1
- Vibrocore Stage 2

Coordinate system:  
WGS84 UTM z31N

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Vibrocore locations

Figure 1



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