

# **East Anglia ONE North Offshore Windfarm**

## **Site Characterisation Report (Offshore Cable Corridor)**

Applicant: East Anglia ONE North Limited

Document Reference: 8.16

SPR Reference: EA1N-DWF-ENV-REP-IBR-000398 Rev 01

Pursuant to APFP Regulation: 5(2)(q)

Date: October 2019

Revision: Version 1

Author: Royal HaskoningDHV

| <b>Prepared by:</b> | <b>Checked by:</b> | <b>Approved by:</b> |
|---------------------|--------------------|---------------------|
|                     |                    |                     |

| Revision Summary |            |                |            |              |
|------------------|------------|----------------|------------|--------------|
| Rev              | Date       | Prepared by    | Checked by | Approved by  |
| 01               | 08/10/2019 | Paolo Pizzolla | Ian MacKay | Helen Walker |

| Description of Revisions |      |         |                      |
|--------------------------|------|---------|----------------------|
| Rev                      | Page | Section | Description          |
| 01                       | n/a  | n/a     | Final for Submission |

# Table of Contents

|          |  |           |
|----------|--|-----------|
| <b>1</b> | <b>Introduction</b>  | <b>1</b>  |
| 1.1      | Background   | 1         |
| 1.2      | Purpose of this Document   | 1         |
| <b>2</b> | <b>The Need for Disposal of Material</b>                             | <b>5</b>  |
| 2.1      | Cable Installation   | 5         |
| 2.2      | Mitigation and Best Practice   | 9         |
| <b>3</b> | <b>Type of Material to be Disposed</b>                               | <b>9</b>  |
| 3.1      | Sea Bed Sediment Type  | 9         |
| 3.2      | Sediment Contamination Analysis of the Offshore Development Area     | 9         |
| <b>4</b> | <b>Quantity of Material to be Disposed</b>                           | <b>18</b> |
| 4.1      | Sea Bed Preparation  | 18        |
| 4.2      | Programme  | 19        |
| 4.3      | Daily Disposal Amounts   | 19        |
| <b>5</b> | <b>Alternatives Considered</b>                                       | <b>19</b> |
| 5.1      | Use of Material for Ballast  | 19        |
| 5.2      | Other Disposal Sites   | 20        |
| <b>6</b> | <b>Potential Impacts of Disposal</b>                                 | <b>20</b> |
| 6.1      | Potential Impacts of Sediment Disposal on Physical Characteristics   | 24        |
| 6.2      | Potential Impacts of Sediment Disposal on Water and Sediment Quality | 31        |
| 6.3      | Potential Impacts of Sediment Disposal on Benthic Ecology            | 32        |
| <b>7</b> | <b>Summary</b>   | <b>35</b> |
| <b>8</b> | <b>References</b>  | <b>37</b> |
|          | <b>Appendix 1</b>  | <b>39</b> |

The appendix associated with the Site Characterisation Report (Offshore Cable Corridor) for the proposed East Anglia ONE North project is listed in the below table.

| Appendix number | Title  |
|-----------------|--|
| Appendix 1      | Coordinates Delineating the Proposed Disposal Site |

The figures in the Site Characterisation Report (Offshore Cable Corridor) for the proposed East Anglia ONE North project are listed in the table below.

| Figure number | Title   |
|---------------|---|
| Figure 1      | Disposal Site Locations   |
| Figure 2      | Sediment Distribution   |
| Figure 3      | Location of Sediment Contamination Sample Sites                     |
| Figure 4      | Marine Geology, Oceanography and Physical Processes Receptor Groups |

## Glossary of Acronyms

|                |  |
|----------------|--|
| DCO            | Development Consent Order                    |
| EIA            | Environmental Impact Assessment              |
| ES             | Environmental Statement                      |
| GBS            | Gravity Base Structure                       |
| LAT            | Lowest Astronomical Tide                     |
| m              | Metre  |
| m <sup>3</sup> | Metre Cubed                                  |
| MarSEA         | Marine Evidence based Sensitivity Assessment |
| MMO            | Marine Management Organisation               |
| PAH            | Polycyclic Aromatic Hydrocarbon              |
| PCB            | Polychlorinated Biphenyl                     |
| PEL            | Probable Effect Levels                       |
| SPR            | ScottishPower Renewables                     |
| SQG            | Sediment Quality Guidelines                  |
| SSC            | Suspended Sediment Concentration             |
| TEL            | Threshold Effect Levels                      |
| ZEA            | Zone Environmental Appraisal                 |

## Glossary of Terminology

|   |  |
|---|--|
| Applicant                                       | East Anglia ONE North Limited.   |
| Construction operation and maintenance platform | A fixed offshore structure required for construction, operation, and maintenance personnel and activities.   |
| Development area                                | The area comprising the Indicative Onshore Development Area and the Offshore Development Area.   |
| East Anglia ONE North project                   | The proposed project consisting of up to 67 wind turbines, up to four offshore electrical platforms, up to one offshore construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.        |
| East Anglia ONE North windfarm site             | The offshore area within which wind turbines and offshore platforms will be located.   |
| European site                                   | Sites designated for nature conservation under the Habitats Directive and Birds Directive, as defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017 and regulation 18 of the Conservation of Offshore Marine Habitats and Species Regulations 2017. These include candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation and Special Protection Areas. |
| Evidence Plan Process                           | A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and the information required to support HRA.  |
| Horizontal directional drilling (HDD)           | A method of cable installation where the cable is drilled beneath a feature without the need for trenching.  |
| Inter-array cables                              | Offshore cables which link the wind turbines to each other and the offshore electrical platforms, these cables will include fibre optic cables.  |
| Landfall  | The area (from Mean Low Water Springs) where the offshore export cables would make contact with land, and connect to the onshore cables.   |
| Natura 2000 site                                | A site forming part of the network of sites made up of Special Areas of Conservation and Special Protection Areas designated respectively under the Habitats Directive and Birds Directive.  |
| Offshore cable corridor                         | This is the area which will contain the offshore export cable between offshore electrical platforms and landfall jointing bay.   |
| Offshore development area                       | The East Anglia ONE North windfarm site and offshore cable corridor (up to Mean High Water Springs).   |
| Offshore electrical infrastructure              | This includes transmission assets required to export generated electricity to shore. This includes inter-array cables from the wind turbines to the offshore electrical platforms, offshore electrical platforms, platform link cables and export cables from the offshore electrical platforms to the landfall.   |
| Offshore electrical platform                    | A fixed structure located within the windfarm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.  |
| Offshore export cables                          | The cables which would bring electricity from the offshore electrical platforms to the landfall.   |
| Offshore infrastructure                         | All of the offshore infrastructure including wind turbines, platforms, and cables.   |
| Offshore platform                               | A collective term for the offshore operation and maintenance platform and the offshore electrical platforms.   |
| Scour protection                                | Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.  |

# 1 Introduction

## 1.1 Background

1. East Anglia ONE North Limited ('the Applicant') (which is a wholly owned subsidiary of ScottishPower Renewables (SPR) UK Limited) is seeking a Development Consent Order (DCO) for the proposed East Anglia ONE North project consisting of an offshore windfarm and an associated offshore cable corridor to the landfall location just north of Thorpeness.
2. The offshore components of the proposed East Anglia ONE North project would comprise:
  - Up to 67 wind turbines;
  - Up to four offshore electrical platforms;
  - Up to one offshore construction, operation and maintenance platform;
  - One meteorological mast;
  - Up to 20 buoys (LiDAR, wave or guard buoys);
  - Inter-array cables (a maximum of 200km combined length); platform link cables between offshore electrical platforms (each up to 15km in length with an overall maximum length of 75km);
  - Fibre optic cables may also be installed; however, these would be bundled with, or secured to the outside of the inter-array, platform link or export cables; and
  - Up to two export cables (up to 76km in length each).
3. A full project description is available as part of the Environmental Statement (ES) in **Chapter 6 Project Description**.

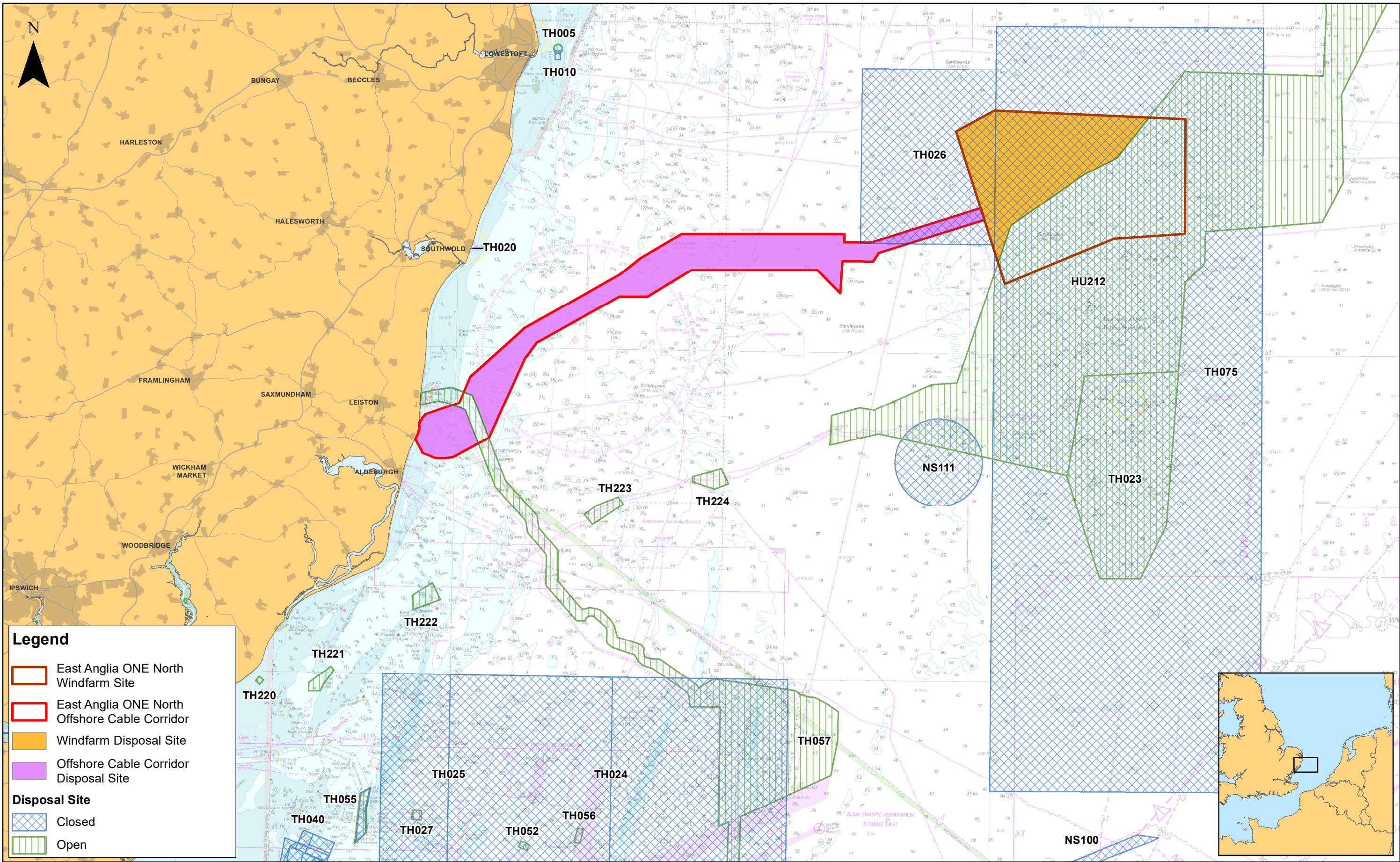
## 1.2 Purpose of this Document



4. The Applicant is applying to designate the following areas for the disposal of material extracted during the construction period (e.g. drilling and / or sea bed preparation (dredging)). The proposed disposal areas are:
  - The East Anglia ONE North windfarm site; and
  - The offshore cable corridor.
5. This document has been produced to enable the Applicant to designate the East Anglia ONE North offshore cable corridor as a licenced disposal site. It provides the necessary information to characterise the disposal requirements in the offshore cable corridor. It should be noted that, given the East Anglia ONE North

and East Anglia TWO projects may potentially share an offshore cable corridor, the Applicant has requested for the northern offshore cable corridor route option of East Anglia TWO (see **Figure 1**) to be a shared disposal site (where they overlap) with the proposed East Anglia ONE North offshore cable corridor disposal site, should the northern offshore cable corridor route option for East Anglia TWO be selected post-consent. Full details of the disposal requirements in the East Anglia TWO offshore cable corridor are provided in that project's Site Characterisation Report however given the similarity in the worst case export cable lengths required for the two projects, the sediment disposal assumptions in the offshore cable corridor are identical for both projects.

6. For information on the disposal requirements in the East Anglia ONE North windfarm site see the Site Characterisation Report (Windfarm Site) (Document Reference 8.15). The locations of the proposed East Anglia ONE North disposal sites are shown in **Figure 1** (and the coordinates to delineate the offshore cable corridor disposal site are provided in **Appendix 1**). The offshore cable corridor disposal site consists of the entire East Anglia ONE North offshore cable corridor minus areas which overlap with open disposal sites (the open and closed disposal sites are also shown on **Figure 1**).
7. The purpose of this document is to provide the information required to enable disposal site designation. Accordingly, this document sets out:
  - The need for disposal of material;
  - Alternatives considered;
  - The location of the disposal sites;
  - The types of material to be disposed of;
  - The quantity of the material to be disposed; and
  - Potential impacts of disposal.





|   |     |            |    |               |           |           |   |   |            |                         |   |
|---|-----|------------|----|---------------|-----------|-----------|---|---|------------|-------------------------|---|
|  |     |            |    |               |           | 1:300,000 |    | <b>East Anglia ONE North</b><br><br>Disposal Site Locations | Drg No     | EA1N-DEV-DRG-IBR-000997 |   |
|   | 2   | 02/09/2019 | AB | Second Issue. | Prepared: | AB        |   |   | Scale @ A3 | Rev                     | 2 |
|   | 1   | 02/08/2019 | AB | First Issue.  | Checked:  | PM        | <small>Source: © Cefas, 2018. © The Crown Estate, 2019. Contains OS data © Crown copyright and database right, 2019. © British Crown and OceanWise, 2019. All rights reserved. License No. EMS-EK001-548150. Not to be used for navigation.<br/>This map has been produced to the latest known information at the time of issue, and has been produced for your information only.<br/>Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map.<br/>To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise) in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.</small> |   | Date       | 02/09/19                |   |
|   | Rev | Date       | By | Comment       | Approved: | PP        | Figure  |   | 1          |                         |   |



**This page is intentionally blank**

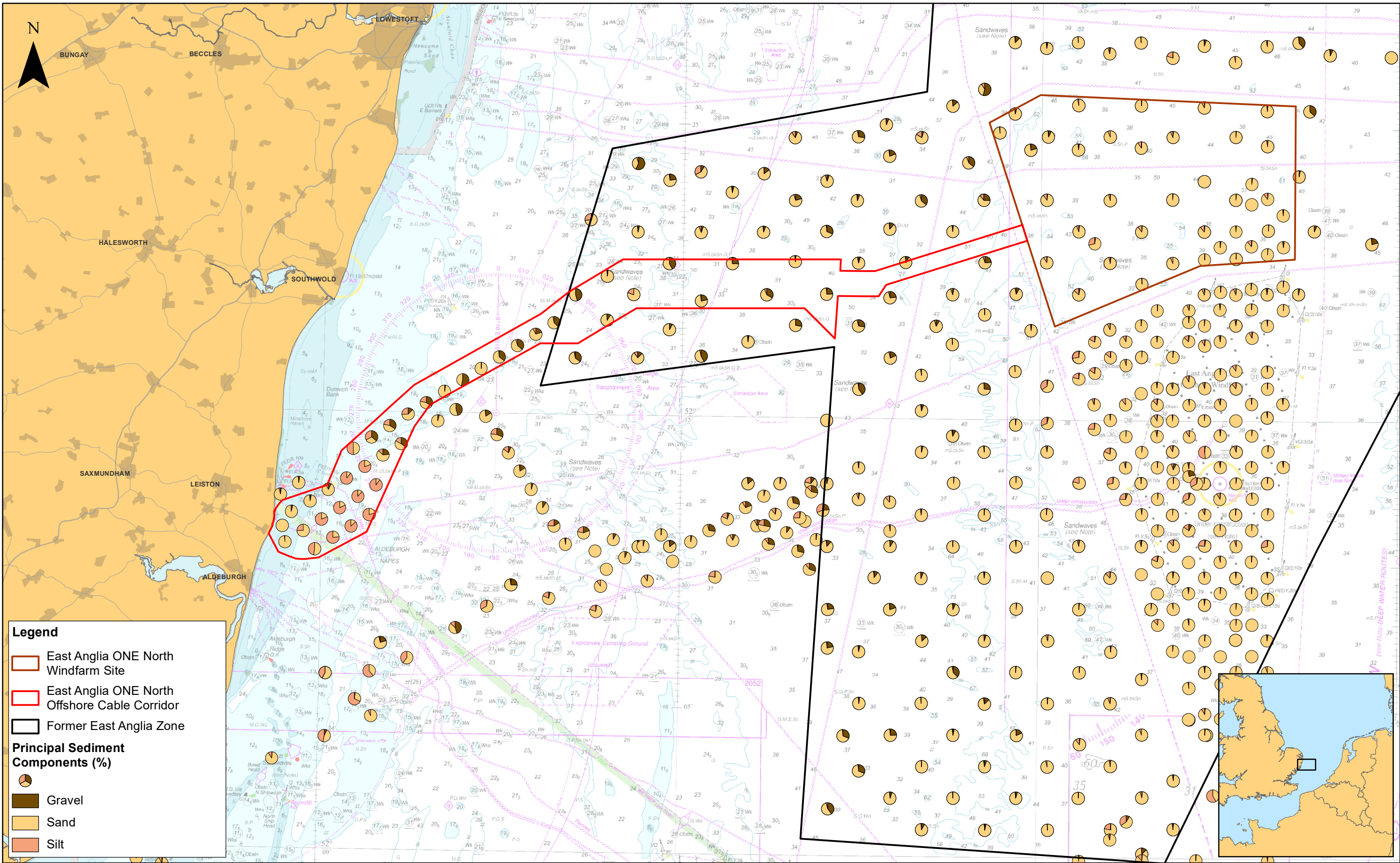
## 2 The Need for Disposal of Material

8. The installation of export cables may result in the disposal of sediment where sand wave levelling or dredging / trenching (for example through the use of a backhoe dredger, see **Chapter 6 Project Description** of the ES) is required to facilitate the installation of export cables.
9. All spoil material would be disposed of in a disposal area adjacent to each location from where it was derived, where it would be dispersed by natural processes as described in the ES, **Chapter 7 Marine Geology, Oceanography and Physical Processes**.

### 2.1 Cable Installation

10. Sand wave levelling (pre-sweeping) to a stable reference sea bed level may be undertaken in areas with large ripples and sand waves to reduce the potential that cables become unburied over the life of the project.
11. The sediment throughout the offshore cable corridor is primarily gravelly sand (see **Figure 2**) and therefore it is expected that the majority of export cables will be buried using a cable plough. This means that for the majority of the export cable route, no excavation and subsequent disposal of sediment would be required.
12. Anticipated sediment volumes for the excavation of sand waves and for dredging are provided in **section 4.1**.


**This page is intentionally blank.**



|     |            |    |              |           |    |
|-----|------------|----|--------------|-----------|----|
|     |            |    |              |           |    |
| 1   | 01/10/2019 | FC | First Issue. | Checked:  | PM |
| Rev | Date       | By | Comment      | Approved: | PP |

1:225,000

Scale @ A3

A horizontal scale bar with a black and white alternating pattern. It is marked with the numbers 0, 2.5, 5, and 10. The unit 'Km' is written at the right end of the bar.

0 2.5 5 10 Km

Source: © M&S Ltd, 2011 & 2018. © Bibby Offshore, 2018. © FUGRO, 2014. © The Crown Estate, 2019. Contains OS data © Crown copyright and database right, 2019. © British Crown and Oceanwise, 2019. All rights reserved. License No. EMS-EX001-548150. Not to be used for navigation.

This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map. To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.

|                       |                         |             |  |
|-----------------------|-------------------------|-------------|--|
| East Anglia ONE North |                         |             |  |
| Sediment Distribution |                         |             |  |
| Drg No                | EA1N-DEV-DRG-IBR-001067 |             |  |
| Rev                   | 1                       | Datum:      |  |
| Date                  | 01/10/19                | WGS 1984    |  |
| Figure                | 2                       | Projection: |  |
|                       |                         | Zone 31N    |  |

**This page is intentionally blank**

## 2.2 Mitigation and Best Practice

13. The Applicant has committed to a number of areas of mitigation and best practice in order to minimise the potential impacts of the proposed East Anglia ONE North project. The following examples of embedded mitigation are of relevance to sediment disposal:
- Routing to avoid sand waves, where possible.

# 3 Type of Material to be Disposed

## 3.1 Sea Bed Sediment Type

14. Grab samples collected within the offshore cable corridor as part of the project-specific benthic survey (see **Appendix 9.2** of the ES) show the majority of the sediments to be slightly gravelly sand (using the Folk scale). The section of the cable corridor furthest offshore and closest to the East Anglia ONE North windfarm site is composed of seabed sediments primarily slightly gravelly sand and gravelly muddy sand. The central section of the offshore cable corridor has the highest percentage of fines in samples collected (reaching over 90%), with sediment mainly falling within the sandy mud classification. Closest to landfall, sediment size is highly variable, ranging from sandy mud to sandy gravel in the samples that were taken. One sample was found to contain 53% gravel while another was calculated at less than 1% gravel.

## 3.2 Sediment Contamination Analysis of the Offshore Development Area

15. The locations of the East Anglia ONE North and East Anglia TWO site specific sediment contamination sample sites are shown in **Figure 3** and contaminant data for heavy and trace metals are summarised in **Table 2**. Contaminant sample numbers C01, C02, C03, C07, C08, C13, C16 and C19 were taken within the East Anglia ONE North offshore cable corridor and are therefore of particular relevance to this report. However, reference to samples taken in the East Anglia ONE North windfarm site (sample numbers C14, C15 and C17) and East Anglia TWO windfarm site and southern cable corridor route option (sample numbers C04, C05, C06, C09, C10, C11, C12 and C18) is provided for context.
16. Cefas Action Levels are commonly used to provide an indication of contaminant levels within sediments. Whilst these levels were specifically developed to assess dredged material, they are an accepted way of assessing the risks to the environment from other marine activities as part of the EIA process. The Marine Management Organisation (MMO) (using the Cefas Action levels) states that, in general, contaminant levels below Action Level 1 are not considered to be of concern. Material with persistent contaminant levels above Cefas Action Level 2

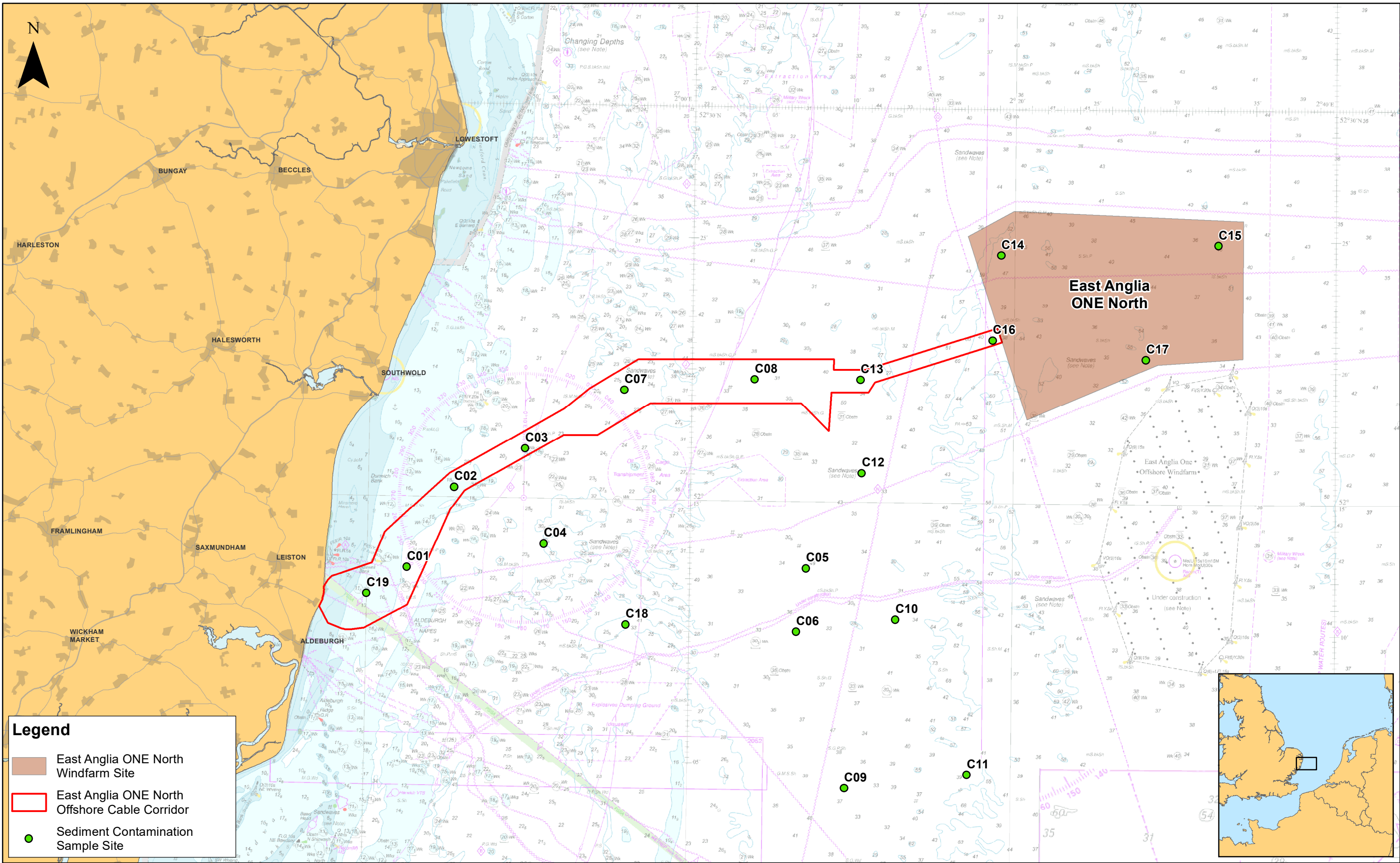


are generally considered to pose an unacceptable risk to the marine environment (and therefore material is unlikely to be considered suitable for disposal to sea). For material with persistent contaminant levels between Action Levels 1 and 2, further consideration of additional evidence is required before the risk can be identified. Cefas Action Levels are summarised in the ES, **Chapter 8 Water and Sediment Quality**.

17. If contaminant levels in the material under consideration persistently exceed Cefas Action Levels, additional assessment is required. This can be undertaken by applying the more stringent Canadian sediment quality guidelines (SQG) (CCME 2002) which also consist of two sets of concentrations: Threshold Effect Levels (TEL) and Probable Effect Levels (PEL). The Canadian SQGs also include PELs for individual polycyclic aromatic hydrocarbons (PAHs) which do not have Cefas Action Level 2 concentrations. Canadian SQGs are summarised in the ES, **Chapter 8 Water and Sediment Quality**



**This page is intentionally blank.**



|     |            |    |              |           |    |
|-----|------------|----|--------------|-----------|----|
|     |            |    |              |           |    |
| 1   | 01/10/2019 | FC | First Issue. | Prepared: | FC |
| Rev | Date       | By | Comment      | Checked:  | RZ |
|     |            |    |              | Approved: | PP |

1:250,000  
Scale @ A3

Source: © Blyth Offshore, 2019. © The Crown Estate, 2019. Contains OS data © Crown copyright and database right, 2019. © British Crown and OceanWise, 2019. All rights reserved. License No. EMS-EK001-548150. Not to be used for navigation.

This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map.

To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise) in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.

## East Anglia ONE North

### Location of Sediment Contamination Sample Sites

|        |                         |                      |  |
|--------|-------------------------|----------------------|--|
| Drg No | EA1N-DEV-DRG-IBR-001068 |                      |  |
| Rev    | 1                       | Datum: WGS 1984      |  |
| Date   | 01/10/19                | Projection: Zone 31N |  |
| Figure | 3                       |                      |  |

This page is intentionally blank.

18. The difference between these values and the Cefas Action Levels is that ecotoxicological information has been used from field and laboratory testing. Therefore, the TEL and PEL concentrations represent concentrations where adverse effects may or may not occur. The lower level (TEL) represents a concentration below which adverse biological effects are expected to occur only rarely (in some sensitive species for example). The higher level (PEL), defines a concentration above which adverse effects may be expected in a wider range of organisms.
19. Levels of aluminium, iron, barium and tin were also measured however as there are no associated Cefas Action Levels or Canadian SQG values, they are not discussed further.
20. Sediment contaminant analysis was also undertaken for polychlorinated biphenyls (PCBs), PAHs and organotins. The combined PCBs<sup>1</sup> gave a value below 0.001mg/kg. Individual PAH concentrations were all below 0.00008mg/kg and combined 2-6 ring PAH were below 0.00128mg/kg. Concentrations of organotins were highest at site C01 (see **Appendix 9.3** of the ES) where they were 0.01mg/kg. None of these results exceeded Cefas Action Level 1 or Canadian TEL levels.
21. A number of samples (11) exceed Cefas Action Level 1 for concentrations of arsenic. The majority of samples that exceeded Cefas Action Levels 1 do so only marginally, remaining well below Action Level 2. All samples exceeded the TEL for concentrations of arsenic with three samples (C05, C07 and C16) also marginally exceeding the PEL.
22. The elevated levels of arsenic which were recorded are typical of the region; inshore these are associated with a history of arsenic waste disposal and offshore these are associated with estuarine and geological inputs and sea bed rock weathering (Royal Haskoning 2011). Given that there were no exceedances of Action Level 2 and levels are typical for the region, further assessment (i.e. comparison with additional sediment quality guidelines or other methods) is not deemed necessary.
23. One sample (C01) marginally exceeded Cefas Action Level 1 for cadmium, copper, nickel and zinc (**Table 2**). Sample C01 also exceeded the TEL for cadmium, copper, lead and zinc. The exceedances did not approach the higher Action Level 2 or the PEL. Considering the predominantly sandy nature of the sea bed sediments, which significantly reduces the potential for any contaminants to accumulate and for sediments to be resuspended into the water column and

---

<sup>1</sup> Based on the "ICES 7 PCBs". Seven of the 209 existing PCBs are analysed in monitoring because they are found in relatively high concentrations in technical mixtures and cover the range of toxicological properties of the PCB group

transported over long distances (see **section 6.2.2**), these are not deemed to be of concern.

24. From the information and data presented above it can be concluded that the baseline sediment quality in the offshore development area is generally good and site specific information in relation to concentrations of contaminants in sediments does not record significantly elevated levels.

## East Anglia ONE North Offshore Windfarm

### Site Characterisation Report (Offshore Cable Corridor)

**Table 1 East Anglia ONE North and East Anglia TWO Site Specific Sediment Contamination Analysis Results Compared to Cefas Action Levels (mg/kg) (see **Figure 3** and **Appendix 9.3** of the ES)**

| Sample station | Arsenic | Cadmium | Chromium | Copper | Lead  | Mercury | Nickel | Vanadium | Zinc   | Total Hydrocarbon Content |
|----------------|---------|---------|----------|--------|-------|---------|--------|----------|--------|---------------------------|
| C01            | 12.6*   | 0.8*    | 33.8     | 52.2*  | 45.5* | 0.09    | 22.8   | 45.4     | 132.3* | 53.5                      |
| C02            | 34.2*   | 0.26    | 17.1     | 10.1   | 7.7   | 0.03    | 13.6   | 38.1     | 23.7   | 26.2                      |
| C03            | 31.7*   | 0.07    | 9.7      | 7      | 7.7   | 0.03    | 6.6    | 35.5     | 24     | 36.6                      |
| C04            | 29*     | 0.05    | 7.4      | 5.3    | 5.8   | 0.03    | 6.2    | 31.2     | 19.8   | 33.4                      |
| C05            | 43.9**  | 0.08    | 13.9     | 6.5    | 8.1   | 0.02    | 8.2    | 52.3     | 24.8   | 35.1                      |
| C06            | 28.2*   | 0.05    | 20.5     | 10.2   | 5.2   | 0.02    | 14.2   | 28.4     | 13.7   | 35.8                      |
| C07            | 42.4**  | 0.08    | 6.9      | 5.6    | 7.5   | 0.05    | 8.4    | 41       | 21.6   | 33.9                      |
| C08            | 16.4*   | <0.04   | 6        | 5.5    | 4.7   | 0.03    | 4.2    | 21.4     | 14.2   | 32.0                      |
| C09            | 8.9*    | <0.04   | 4.2      | 3.8    | 2.8   | 0.03    | 3.5    | 10.1     | 8.1    | 32.3                      |
| C10            | 24*     | 0.07    | 5.5      | 3.4    | 4.5   | 0.02    | 5.8    | 25.5     | 11.9   | 31.8                      |
| C11            | 7.5*    | <0.04   | 4        | 5.1    | 2.4   | 0.02    | 3.3    | 8.5      | 7.1    | 32.5                      |
| C12            | 28.1    | <0.04   | 8.2      | 6.2    | 6.1   | 0.03    | 6.5    | 32.3     | 18.3   | 34.3                      |
| C13            | 20.3    | 0.05    | 7.6      | 6.2    | 5.4   | 0.03    | 4.6    | 21.3     | 14.9   | 34.9                      |
| C14            | 34.9    | 0.05    | 4.4      | 5      | 5.2   | 0.06    | 5.3    | 29.9     | 15.4   | 32.6                      |
| C15            | 9.7*    | <0.04   | 6.5      | 4.4    | 2.9   | 0.02    | 3.9    | 13.6     | 10.6   | 24.5                      |

## East Anglia ONE North Offshore Windfarm Site Characterisation Report (Offshore Cable Corridor)

| Sample station | Arsenic | Cadmium | Chromium | Copper | Lead | Mercury | Nickel | Vanadium | Zinc | Total Hydrocarbon Content |
|----------------|---------|---------|----------|--------|------|---------|--------|----------|------|---------------------------|
| c 16           | 65.6**  | 0.07    | 7.5      | 4.9    | 5.4  | 0.02    | 10.2   | 49       | 22.6 | 28.2                      |
| c 17           | 16.6*   | <0.04   | 4.5      | 3.6    | 2.9  | 0.02    | 3.8    | 15.7     | 9.6  | 26.9                      |
| c 18           | 14.1*   | 0.06    | 10       | 6.9    | 6.3  | 0.04    | 5.2    | 26.6     | 20.1 | 30.6                      |
| c 19           | 20.8*   | 0.1     | 14.4     | 7.8    | 15.7 | 0.05    | 10.7   | 34       | 41.3 | 28.5                      |

Yellow highlight above Cefas Action Level 1; \*Above Canadian SQC TEL; \*\*Above Canadian SQC PEL;

Orange cells indicate sample locations in the East Anglia ONE North offshore cable corridor.

Unhighlighted cells indicate sample locations in the East Anglia ONE North or East Anglia TWO windfarm sites or East Anglia TWO southern cable corridor route option which were gathered in the same survey and which have been included for context.



## 4 Quantity of Material to be Disposed

25. Material to be disposed of may arise from sand wave levelling and dredging for export cable installation.

### 4.1 Sea Bed Preparation

#### 4.1.1 Export Cables

26. Up to 1,000,000m<sup>3</sup> of sediment may be excavated as a result of sand wave levelling for up to 152km of export cables. It is acknowledged that a portion of the export cable(s) will be within the East Anglia ONE North windfarm site and therefore 10% (100,000m<sup>3</sup>) of this volume has been attributed the windfarm site disposal volume (see Site Characterisation Report (windfarm site) (Document reference 8.15)) which is considered conservative. Up to 900,000m<sup>3</sup> could therefore be deposited within the offshore cable corridor disposal site. Any required sand wave levelling is anticipated to be in discrete areas and not along the full length of the offshore cable corridor, and would be deposited back within the offshore cable corridor at locations which avoid sensitive features. These locations would be determined post consent in consultation with Natural England and the MMO.
27. Furthermore, there may be a requirement for dredging in the offshore cable corridor. This could be at any point along the length of the offshore cable corridor and it is anticipated that up to **68,800m<sup>3</sup>** of sediment could be excavated as a result of dredging activity.
28. This results in a total of up to **968,800m<sup>3</sup>** of sediment potentially being disposed of within the offshore cable corridor.

#### 4.1.2 Total volumes

29. These volumes are summarised in **Table 2**.

**Table 2 Total Worst Case Surface Sediment Disturbance**

| Infrastructure / Activity        | Worst Case Scenario type  | Worst case volume (m <sup>3</sup> ) |
|----------------------------------|---|-------------------------------------|
| Export cable sand wave levelling | Based on a maximum of 152km combined length. Levelling of a corridor up to 60m wide, with an average depth of 2.5m                                      | 900,000                             |
| Dredging                         | Based on experience from EA1, but noting an anticipation for harder ground, it is assumed that up to 5% (4km) of each cable corridor could require a v- | 68,800                              |



| Infrastructure / Activity | Worst Case Scenario type                           | Worst case volume (m <sup>3</sup> ) |
|---------------------------|--|-------------------------------------|
|                           | shaped trench cross section: 8.6m wide by 4m deep. |                                     |
| <b>Total</b>              |  | <b>968,800</b>                      |

## 4.2 Programme

30. It is anticipated that the offshore construction works would be completed in approximately 27 months. The time periods of specific offshore activities would vary and would be encompassed within this 27 month period.

## 4.3 Daily Disposal Amounts

31. The worst case assumes that up to **968,800m<sup>3</sup>** of near-surface sediment would be removed by means of dredging throughout the entire construction period within the offshore cable corridor. Dredged sediment would be returned to the water column at its surface layer as overflow from a dredger vessel.
32. In the East Anglia ONE modelling studies, consecutive daily releases of 22,500m<sup>3</sup> of sediment (mostly medium-grained sand, but also with small proportions of gravel, other sand fractions and muds) were simulated at the water surface at 15 wind turbine locations. This sediment release represents a suitable analogue for the type and magnitude of effect that would be anticipated from the proposed East Anglia ONE North project. Therefore, 22,500m<sup>3</sup> of sediment release per day is considered as the worst case daily sediment disposal volume for the proposed East Anglia ONE North project.

# 5 Alternatives Considered

## 5.1 Use of Material for Ballast

33. Where extensive excavation works are required, such as for sand wave levelling or sea bed preparation for foundation installation, it is possible that material could be retained and used for infill works or ballast material, if geotechnically suitable for purpose. Ballast material is heavy material which is used to enhance stability of foundations and is likely to be composed of locally dredged sand.
34. The Applicant is considering the use of several different foundation types. Sand dredged locally during the sea bed preparation could be used as ballast material for GBS foundations during the foundation preparation works if geotechnically suitable for purpose. This reuse of sand would be preferable to sourcing ballast

material from elsewhere in accordance with the waste hierarchy. The remainder would be disposed of as described in **section 4** above.

35. The use of excavated material as ballast would depend on a suitable foundation type being used and the results of detailed post-consent geotechnical investigations. However, for the purposes of the EIA, and as a worst case for this report, it has been assumed that all drilled and dredged material would be disposed of on site, rather than being used as ballast material.

## 5.2 Other Disposal Sites

36. The suitability and capacity of nearby existing disposal sites (**Figure 1**) has been considered.
37. The largest open disposal sites in the vicinity of the offshore cable corridor are associated with the East Anglia ONE offshore windfarm (TH222, TH223, TH224, TH023), East Anglia THREE offshore windfarm (HU212) and the Galloper offshore windfarm (TH057). The marine licence conditions for these disposal sites state that they are only to be used for disposal of material derived from their associated windfarm, therefore these sites are not available to the proposed East Anglia ONE North project. However, as noted in the Site Characterisation Report (Windfarm Site), the Applicant wishes to dispose within the area of the HU212 disposal site which overlaps with the East Anglia ONE North windfarm site, subject to disposal volume capacity being available.

# 6 Potential Impacts of Disposal

38. The impact of disposal of material within the offshore cable corridor has been incorporated into impacts assessed within the East Anglia ONE North Environmental Impact Assessment (EIA) and presented within the ES (SPR 2019); specifically, within **Chapter 7 Marine Geology, Oceanography and Physical Processes**, **Chapter 8 Marine Water and Sediment Quality** and **Chapter 10 Benthic Ecology**. It should be noted however that the impacts presented within the ES assess the impacts of the proposed East Anglia ONE North project as a whole and so the specific parts of the assessment that consider disposal of sediment have been drawn out and are presented below.
39. **Chapter 5 EIA Methodology** of the ES presents an overarching method for enabling assessments of the potential impacts arising from the proposed East Anglia ONE North project on the receptors under consideration. Such assessments incorporate a combination of the sensitivity of the receptor, its value (if applicable) and the magnitude of the change to determine a significance of impact. This method has been followed for the assessment of marine geology,

oceanography and physical processes receptors; marine water and sediment quality receptors and benthic ecology receptors.

40. The sensitivity of a receptor is dependent upon its:

- **Tolerance:** the extent to which the receptor is adversely affected by an effect;
- **Adaptability:** the ability of the receptor to avoid adverse impacts that would otherwise arise from a particular effect; and
- **Recoverability:** a measure of a receptor's ability to return to a state at, or close to, that which existed before the effect caused a change.

41. Definitions of sensitivity of receptor are summarised in **Table 3**.

**Table 3 Definition of Different Sensitivity Levels for a Generic Receptor**

| Sensitivity | Definition   |
|-------------|--|
| High        | <p>Individual receptor has very limited or no capacity to avoid, adapt to, accommodate or recover from the anticipated impact.</p> <p><u>Tolerance:</u> Receptor has very limited tolerance of effect</p> <p><u>Adaptability:</u> Receptor unable to adapt to effect</p> <p><u>Recoverability:</u> Receptor unable to recover resulting in permanent or long-term (greater than ten years) change</p>  |
| Medium      | <p>Individual receptor has limited capacity to avoid, adapt to, accommodate or recover from the anticipated impact.</p> <p><u>Tolerance:</u> Receptor has limited tolerance of effect</p> <p><u>Adaptability:</u> Receptor has limited ability to adapt to effect</p> <p><u>Recoverability:</u> Receptor able to recover to an acceptable status over the medium term (5-10 years)</p>                 |
| Low         | <p>Individual receptor has some tolerance to accommodate, adapt or recover from the anticipated impact.</p> <p><u>Tolerance:</u> Receptor has some tolerance of effect</p> <p><u>Adaptability:</u> Receptor has some ability to adapt to effect</p> <p><u>Recoverability:</u> Receptor able to recover to an acceptable status over the short term (1-5 years)</p>                                     |
| Negligible  | <p>Individual receptor is generally tolerant to and can accommodate or recover from the anticipated impact.</p> <p><u>Tolerance:</u> Receptor generally tolerant of effect</p> <p><u>Adaptability:</u> Receptor can completely adapt to effect with no detectable changes</p> <p><u>Recoverability:</u> Receptor able to recover to an acceptable status near instantaneously (less than one year)</p> |

42. A value component may also be considered when assessing a receptor. This ascribes whether the receptor is rare, protected or threatened.
43. The magnitude of an effect is dependent upon its:
- Scale (i.e. size, extent or intensity);
  - Duration;
  - Frequency of occurrence; and
  - Reversibility (i.e. the capability of the environment to return to a condition equivalent to the baseline after the effect ceases).
44. Definitions of magnitude of effect levels are summarised in **Table 4**.

**Table 4 Definitions of the Magnitude of Effect Levels for a Morphological Receptor**

| Value      | Definition   |
|------------|--|
| High       | Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness  |
| Medium     | Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness   |
| Low        | Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness  |
| Negligible | Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness |

45. Following the identification of receptor sensitivity and magnitude of the effect, it is possible to determine the significance of the impact using an impact matrix (**Table 5**). Impacts may be deemed as being either positive (beneficial) or negative (adverse).

**Table 5 Impact Significance Matrix**

|             |            | Negative Magnitude |            |            |            | Beneficial Magnitude |            |            |          |
|-------------|------------|--------------------|------------|------------|------------|----------------------|------------|------------|----------|
|             |            | High               | Medium     | Low        | Negligible | Negligible           | Low        | Medium     | High     |
| Sensitivity | High       | Major              | Major      | Moderate   | Minor      | Minor                | Moderate   | Major      | Major    |
|             | Medium     | Major              | Moderate   | Minor      | Minor      | Minor                | Minor      | Moderate   | Major    |
|             | Low        | Moderate           | Minor      | Minor      | Negligible | Negligible           | Minor      | Minor      | Moderate |
|             | Negligible | Minor              | Negligible | Negligible | Negligible | Negligible           | Negligible | Negligible | Minor    |

46. Impact significance is described using the definitions in **Table 6**.

**Table 6 Impact Significance Definitions**

| Value      | Definition   |
|------------|--|
| Major      | Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation |
| Moderate   | Intermediate change in receptor condition, which are likely to be important considerations at a local level  |
| Minor      | Small change in receptor condition, which may be raised as a local issue but which is unlikely to be important in the decision-making process  |
| Negligible | No discernible change in receptor condition  |
| No change  | No impact, therefore no change in receptor condition   |

47. Within **Chapter 7 Marine Geology, Oceanography and Physical Processes** of the ES, impacts on the physical characteristics of the site have been assessed. The impacts which contain relevant information for this assessment are as follows:

- Changes in Suspended Sediment Concentrations During Export Cable Installation (**section 6.1.2.1**); and
- Changes in Sea Bed Level due to Export Cable Installation (**section 6.1.3.1**).

48. **Chapter 8 Marine Water and Sediment Quality** of the ES incorporates the potential effects of disposal on water and sediment quality. This assessment directly builds upon the assessment in **Chapter 7 Marine Geology, Oceanography and Physical Processes**. The impacts which contain relevant information for this assessment are as follows:

- Deterioration in Offshore Water Quality due to Increased Suspended Sediment Concentration (SSC) (**section 6.2.1**); and

- Deterioration in Water Quality due to Re-suspension of Sediment Bound Contaminants (**section 6.2.2**).
49. **Chapter 9 Benthic Ecology** of the ES incorporates the potential effects of disposal on the biological characteristics of the project. This assessment also builds upon the assessment in ES **Chapter 7 Marine Geology, Oceanography and Physical Processes**. The impacts which contain relevant information for this assessment are as follows:
- Increased SSC and Associated Potential Smothering of Benthic Receptors (**section 6.3.1**); and
  - Remobilisation of Contaminated Sediments (**section 6.3.2**).

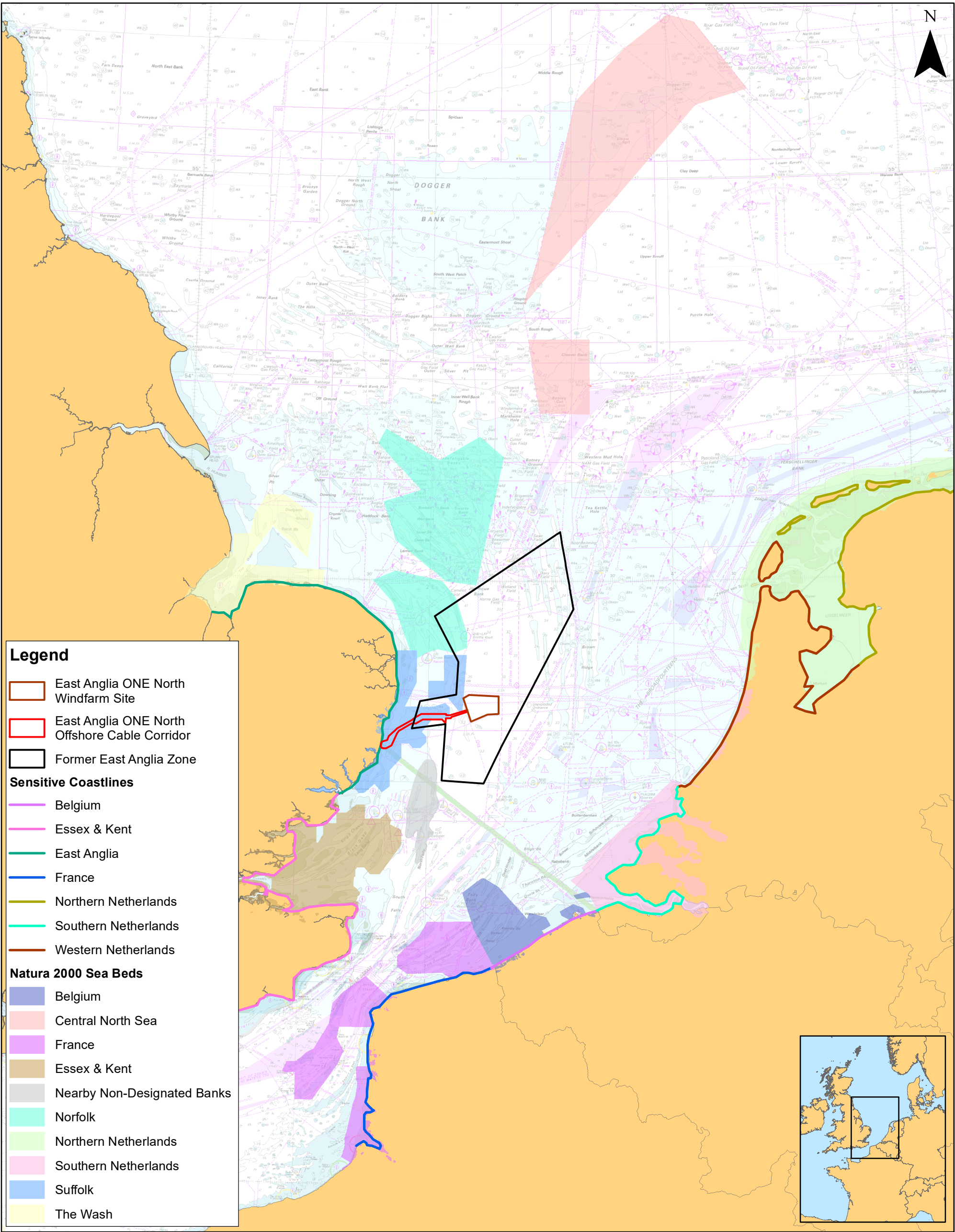
## 6.1 Potential Impacts of Sediment Disposal on Physical Characteristics


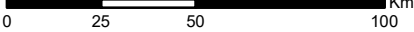
50. The assessment provided in ES **Chapter 7 Marine Geology, Oceanography and Physical Processes** is supported by an evidence-base obtained from research into the physical impacts of marine aggregate dredging on sediment plumes and sea bed deposits (Whiteside *et al.* 1995; John *et al.* 2000; Hiscock and Bell 2004; Newell *et al.* 2004; Tillin *et al.* 2011; Cooper and Brew 2013).
51. Modelling simulations undertaken for East Anglia ONE using the Delft3D plume model (ABPmer 2012) confirm the above assessments of suspended sediment concentrations and sea bed deposits arising from disturbance of surface and shallow near-surface sediments.

### 6.1.1 Identified Receptors for the Physical Processes Assessment

52. The East Anglia Zone Environmental Appraisal (ZEA) identified 17 receptor groups in total. The location of these is shown in **Figure 4**.





|   |          |    |              |  |    |   |          |                         |   |
|---|----------|----|--------------|--|----|---|----------|-------------------------|---|
|  |          |    |              | <p>Source: © ABPMer, 2015. © The Crown Estate, 2019. Contains OS data © Crown copyright. All rights reserved. 2019. © British Crown and OceanWise, 2019. All rights reserved. License No. EMS-EK001-548150. Not to be used for navigation.</p> <p>This map has been produced to the latest known information at the time of issue, and has been produced for your information only.</p> <p>Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map.</p> <p>To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.</p> |    | <h1>East Anglia ONE North</h1> <h2>Receptor Groups for Marine Geology, Oceanography and Physical Processes</h2> |          |                         |   |
|   |          |    |              | Prepared:  | FC | Scale @ A3: 1:2,000,000    |          |                         |   |
| 1   | 01/10/19 | FC | First Issue. | Checked:   | DB | Figure  | Date     | Dwg No.                 | Datum: WGS 1984<br>Projection: Zone 31N |
| Rev   | Date     | By | Comment      | Approved:  | PP | 4   | 01/10/19 | EA1N-DEV-DRG-IBR-001069 |   |

This page is intentionally blank.



53. Seven receptor groups covered sensitive coasts in both eastern England (two receptor groups, 'East Anglia' and 'Essex & Kent') and across northern mainland Europe (five receptor groups, including 'France', 'Belgium', 'Southern Netherlands', 'Western Netherlands' and 'Northern Netherlands').
54. Nine further receptor groups were identified to cover the designated Natura 2000 sites in eastern England (five receptor groups, 'The Wash', 'Central North Sea', 'Norfolk', 'Kent & Essex' and 'Suffolk') and wider Europe (four receptor groups, 'France', 'Belgium', 'Southern Netherlands' and 'Northern Netherlands'). It should be noted that the Natura 2000 sites often comprise groupings of multiple distinct (and designated) features, such as sand banks, sand dunes, and sand and shingle beaches.
55. One further receptor group covered nearby 'non-designated sand banks' in the Outer Thames Estuary, including Inner Gabbard, Outer Gabbard, The Galloper, North Falls and one un-named bank.
56. The Suffolk Natura 2000 site receptor group has been identified as having the potential to be affected from proposed sediment disposal activities in the offshore cable corridor and is considered as such in the following sections.

#### 6.1.2 Changes in Suspended Sediment Concentrations

57. Baseline suspended sediment concentrations within the former East Anglia Zone are typically between 1mg/l and 35mg/l, with a clear pattern of enhancement in values due to wave-stirring of sediment from the sea bed during storm conditions. During such conditions, values can reach greater than 80mg/l offshore, with up to 170mg/l recorded at the coast.

##### 6.1.2.1 Changes in Suspended Sediment Concentrations due to Export Cable Installation

58. The assessment of changes in suspended sediment concentrations during export cable installation have been considered separately from those for the inter-array and platform link cables (see Site Characterisation Report (Windfarm Site) Document Reference 8.15) because parts of the offshore cable corridor are in shallower water and closer to the identified morphological receptor groups (see **section 6.1.1**).
59. Subject to the final project design, present estimates are that up to two cables would be installed, each with a maximum length of 76km, providing a total maximum length of 152km of export cable. As for other cables, there is potential to disturb the seabed down to a sediment thickness of up to 5m through sea bed levelling. The volume of sediment affected due to sand wave excavation is estimated to be up to 900,000m<sup>3</sup> (**section 4.1**), removed by means of dredging and returned to the water column at its surface layer as overflow from a dredger

vessel. The sediment released at any one time would depend on the capacity of the dredger.

60. This assessment is based on the overall sediment release volumes being low and confined to areas along the alignment of the offshore cable corridor where sand waves that require levelling are present.
61. It is likely that the concentrations would be enhanced by the greatest amount in the shallowest sections of the offshore cable corridor, but in these locations the background concentrations are also greater than in deeper waters.
62. Modelling simulations undertaken for East Anglia ONE (ABPmer 2012b) confirm the expert-based assessment and provided the following quantification of magnitude of change:
- Sand-sized sediment (which represents most of the disturbed sediment) would settle out of suspension within less than 1km from the point of installation within the offshore cable corridor and persist in the water column for less than a few tens of minutes.
  - Mud-sized material (which represents only a very small proportion of the disturbed sediment) would be advected a greater distance and persist in the water column for hours to days.
  - In water depths greater than 20m LAT, peak suspended sediment concentrations would be typically less than 100mg/l, except in the immediate vicinity (a few tens of metres) of the release location.
  - In shallow water depths nearer to the coast (less than 5m LAT) the potential for dispersion is more limited and therefore suspended sediment concentrations are likely to be greater, approaching 400mg/l at their peak. However, these plumes would be localised to within less than 1km of the location of installation and would persist for no longer than a few hours.
  - After 180 hours following cessation of installation activities any plume would have been fully dispersed.
63. There are similarities in water depth, sediment types and metocean conditions between the offshore cable corridor for East Anglia ONE and for the proposed East Anglia ONE North project making the earlier modelling studies a suitable analogue for the present assessments.

#### 6.1.2.2 Assessment of Effect Magnitude and / or Impact Significance

64. The likely magnitudes of effect of worst case changes in suspended sediment concentrations due to export cable installation are summarised in **Table 7**.

**Table 7 Magnitude of Effect on Suspended Sediment Concentrations Under the Worst Case Scenarios**

| Location                         | Scale      | Duration   | Frequency  | Reversibility | Magnitude of Effect |
|----------------------------------|------------|------------|------------|---------------|---------------------|
| <b>Export Cable Installation</b> |            |            |            |               |                     |
| Near-field* (nearshore)          | High       | Negligible | Negligible | Negligible    | Medium              |
| Near-field* (offshore)           | Low        | Negligible | Negligible | Negligible    | Low                 |
| Far-field                        | Negligible | Negligible | Negligible | Negligible    | Negligible          |

\*The near-field effects are confined to a small area of sea bed (likely to be of the order of several hundred metres up to a kilometre from the offshore cable corridor) and would not cover the whole East Anglia ONE North windfarm site or offshore cable corridor.

65. The effects on suspended sediment concentrations due to export cable installation are considered highly unlikely to have the potential to impact directly upon the identified receptor groups for marine geology, oceanography and physical processes due to separation distances, except for parts of the Suffolk Natura 2000 site receptor group across which part of the offshore cable corridor crosses. Effects will be spread along the offshore cable corridor with the slow progression of the cable installation.
66. Given these aspects, the sensitivity and value of the Suffolk Natura 2000 site receptor group are presented in **Table 8**.

**Table 8 Sensitivity and Value Assessment for the Suffolk Natura 2000 Site Receptor Group**

| Receptor                   | Tolerance  | Adaptability | Recoverability | Value | Sensitivity |
|----------------------------|------------|--------------|----------------|-------|-------------|
| 'Suffolk Natura 2000' site | Negligible | Negligible   | Negligible     | High  | Negligible  |

67. The overall impact of export cable installation activities under a worst case scenario on suspended sediment concentrations for the identified morphological receptor groups is considered to be no impact, except for the 'Suffolk Natura 2000' site receptor group which is assessed to have an impact of **minor adverse** to **negligible** significance.
68. The effects of suspended sediment concentrations due to export cable installation do have the potential to impact upon other receptors, discussed in **sections 6.2** and **6.3**.

### 6.1.3 Changes in Sea Bed Level due to Export Cable Installation

#### 6.1.3.1 Changes in Sea Bed Level due to Export Cable Installation

69. Up to 900,000m<sup>3</sup> of sediment may be released as a result of sand wave levelling of up to 152km of export cables (**section 4.1**). With the exception of any potential sand waves occurring on the section of the export cable route that is inside the East Anglia ONE North windfarm site, sediment would be disposed of within the offshore cable corridor itself with no net loss of sand from the area other than potentially very fine sands which could be dispersed more widely. It is likely that some of this sand would be redistributed over time by tidal currents, back over the levelled area as re-formed sand waves. Given the relatively low volumes of sand likely to be affected, the overall effect of changes to the seabed would be minimal.

#### 6.1.3.2 Assessment of Effect Magnitude and / or Impact Significance

70. The likely magnitudes of effect of worst case changes in sea bed level due to foundation installation, inter-array cable and platform link cable installation are summarised in **Table 9**.

**Table 9 Magnitude of Effects on Sea Bed Level Changes Under the Worst Case Scenarios**

| Location                         | Scale      | Duration   | Frequency  | Reversibility | Magnitude of Effect |
|----------------------------------|------------|------------|------------|---------------|---------------------|
| <b>Export Cable Installation</b> |            |            |            |               |                     |
| Near-field*                      | Low        | Negligible | Negligible | Negligible    | Low                 |
| Far-field                        | Negligible | Negligible | Negligible | Negligible    | Negligible          |

\*The near-field effects are confined to a small area of sea bed (likely to be of the order of several hundred metres up to a kilometre from the offshore cable corridor), and would not cover the whole offshore cable corridor.

71. These effects on sea bed level are considered highly unlikely to have the potential to impact directly upon the identified receptor groups for marine geology, oceanography and physical processes due to separation distances, except for parts of the 'Suffolk Natura 2000' site receptor group across which part of the offshore cable corridor crosses.

72. Given these aspects, the sensitivity and value of the 'Suffolk Natura 2000' receptor site are presented in **Table 10**.

**Table 10 Sensitivity and Value Assessment for the 'Suffolk Natura 2000' Site Receptor Group**

| Receptor                   | Tolerance  | Adaptability | Recoverability | Value | Sensitivity |
|----------------------------|------------|--------------|----------------|-------|-------------|
| 'Suffolk Natura 2000' site | Negligible | Negligible   | Negligible     | High  | Negligible  |

73. The overall impact of export cable installation activities under a worst case scenario on bed level changes for the identified morphological receptor groups (see **Chapter 7 Marine Geology, Oceanography and Physical Processes**) is considered to be no impact, except for the 'Suffolk Natura 2000' site receptor group which is assessed to have an impact of **negligible** significance.
74. The effects of sea bed level changes due to export cable installation do have the potential to impact upon other receptors, discussed in **sections 6.2** and **6.3**.

#### 6.1.4 Cumulative Impacts

75. Due to the negligible magnitude of effects at the far-field scale it is considered that there is no potential for cumulative impacts with other projects or activities.

#### 6.1.5 Summary of Impacts of Sediment Disposal on Physical Characteristics

76. With the exception of the 'Suffolk Natura 2000' site receptor group across which part of the offshore cable corridor crosses, the conclusion of all relevant impacts on physical characteristics was that there would be no impact. The overall impact of export cable installation activities on suspended sediment concentrations and bed level changes, under a worst case scenario, is assessed as being of **minor adverse** to **negligible** significance. Therefore, it is unlikely that there would be any discernible effect on the physical characteristics of the proposed East Anglia ONE North offshore cable corridor disposal site, should it be designated.

### 6.2 Potential Impacts of Sediment Disposal on Water and Sediment Quality

#### 6.2.1 Deterioration in Offshore Water Quality due to Increased SSC

77. As summarised in **section 6.1.2.1**, disturbance to sea bed sediments and potential generation of plumes from installation of the offshore export cable (including sand wave levelling) would be limited in temporal and spatial extent due to the temporary nature of the activity and the dominance of sand sized material along the offshore export cable route. Therefore, the magnitude of impact would be low. Designated Bathing Waters are not located within the 1km area identified as being the most at risk of experiencing elevated levels (the nearest being over 30km away) and are therefore considered to be of low sensitivity. Since the sensitivity of the receptor and the magnitude of the impact are considered to be low, an overall **minor adverse** impact is predicted.

#### 6.2.2 Deterioration in water quality due to re-suspension of sediment bound contaminants

78. The disposal of dredged material at the sea surface has the potential to release sediment-bound contaminants, such as heavy metals and hydrocarbons into the water column. The data in **Table 1** illustrates that levels of contaminants within the East Anglia ONE North windfarm site and offshore cable corridor are very low.

79. There were eight exceedances of Cefas Action Level 1 for arsenic within the offshore cable corridor (out of 11 samples) with two samples in the offshore cable corridor (C05 and C07 (see **Table 1**)) also marginally exceeding the PEL. Exceedances were marginal for arsenic and likely due to high concentrations of naturally occurring arsenic (**section 3.2**). Sample site C01 also recorded levels of cadmium, copper, lead, nickel and zinc above Cefas Action Level 1. None of the increases bring the concentrations close to Cefas Action Level 2 (**Table 1**), therefore the potential magnitude of effect is considered to be negligible.
80. Considering the negligible magnitude of effect, low receptor sensitivity (as discussed in **section 6.2.1**) and the localised nature of the impact (see above impacts on increased SSCs), the re-suspension of contaminated sediment from construction activities is considered to have a **negligible** impact on water quality.

### 6.2.3 Cumulative impacts

81. Due to the negligible magnitude of effects at the far-field scale it is considered that there is no potential for cumulative impacts with other projects or activities.

### 6.2.4 Summary of Impacts of Sediment Disposal on Water and Sediment Quality

82. The conclusion of all relevant impacts on water and sediment quality was that there is considered to be a **minor adverse** impact on water quality due to increased SSC and a **negligible** impact on water quality as a result of the potential to release sediment-bound contaminants.

## 6.3 Potential Impacts of Sediment Disposal on Benthic Ecology

### 6.3.1 Increased Suspended Sediment Concentrations and Associated Potential Smothering of Benthic Receptors

83. The majority of receptors in the East Anglia ONE North windfarm site are not sensitive to increased suspended sediments and smothering. *S. spinulosa* and *S. bombyx* use sediment to build tubes and can therefore thrive in environments with increased suspended sediments. This type of impact could occur within a few metres of the disposal locations where heavy smothering (>5cm) would be expected, representing a low impact magnitude. The worst case scenario is therefore an impact of **minor adverse** significance.

#### 6.3.1.1 Increased Suspended Sediment Concentrations and Associated Potential Smothering of Benthic Receptors in the Offshore Cable Corridor

84. As described in **section 6.1**, sand wave levelling / pre-sweeping activities associated with the export cable would result in the removal and disposal of sediment which would result in a temporary increase in suspended sediment concentrations. This increase has the potential to affect benthic ecology receptors through blockage to the sensitive filter feeding apparatus of certain species and / or smothering of sessile species upon deposition of the sediment.



85. As described in **section 6.1**, most of the sediment released during construction would be coarse material. As a result, this would fall as a highly turbid dynamic plume upon its discharge, reaching the sea bed within minutes or tens of minutes. The resulting mound would be likely to be tens of centimetres to a few metres high local to the release point. Sand-sized sediment would settle to the sea bed within approximately 1km along the axis of tidal flow from the location at which it was released.
86. The sensitivity of receptors in the offshore cable corridor to increases in suspended sediments and smothering are shown below in **Table 11**.

**Table 11 Sensitivities to Increased Suspended Sediment and Smothering by Deposited Sediment** (source: Tyler-Walters et al 2018; Gibb et al 2014; Tyler-Walters, Lear and Allen 2004; Tillin et al. 2015; Jackson and Hiscock 2008; Budd and Hughes 2005)

2019, Jackson and Hiscock 2006, Budd and Hargnes 2003)

| Receptor   | Tolerance / Resistance  | Recoverability / Resilience | Overall Sensitivity |
|--|-------------------------|-----------------------------|---------------------|
| Light smothering – up to 5cm of fine materials             |                         |                             |                     |
| Circalittoral coarse sediment biotopes                     | Medium                  | High                        | Low                 |
| <i>S. spinulosa</i>  | High                    | Immediate                   | Not sensitive       |
| <i>S. bombyx</i>   | High                    | High                        | Low                 |
| <i>N. hombergii</i> (proxy species for <i>N. cirrosa</i> ) | Tolerant                | N/A                         | Not sensitive       |
| Heavy Smothering – up to 30cm of fine materials            |                         |                             |                     |
| Circalittoral coarse sediment biotopes                     | Not available           |                             |                     |
| <i>S. spinulosa</i>  | Not available (Medium*) |                             |                     |
| <i>S. bombyx</i>   | Not available           |                             |                     |
| <i>N. hombergii</i> (proxy species for <i>N. cirrosa</i> ) | Not available           |                             |                     |
| Increased suspended sediment concentrations                |                         |                             |                     |
| Circalittoral coarse sediment biotopes                     | High                    | High                        | Not sensitive       |
| <i>S. spinulosa</i>  | High                    | Immediate                   | Not sensitive       |
| <i>S. bombyx</i>   | Tolerant                | N/A                         | Not sensitive       |
| <i>N. hombergii</i> (proxy species for <i>N. cirrosa</i> ) | Tolerant                | N/A                         | Not sensitive       |

87. Any increases in suspended sediment concentration in the offshore cable corridor arising from the disturbance of near surface sediments would be less than those arising during foundation installation activities (see Site Characterisation Report (Windfarm Site) Document Reference 8.15). As described in **section 6.1**, peak suspended sediment concentrations would be typically less than 100mg/l in

deeper offshore parts of the cable route (>20m LAT), except in the immediate vicinity of the release location. In the shallow near shore area (<5m LAT) SSCs are likely to be greater, approaching 400mg/l at their peak. However, these plumes would be localised to within less than 1km of the location of installation and would persist for no longer than a few hours

88. Although a relatively large quantity of material could be released, this would be spread throughout the entire offshore cable corridor area, which constitutes a maximum area of 133km<sup>2</sup>. The disturbance of near surface sediments would be less than those arising during foundation installation activities therefore any potential smothering impact on benthic receptors is deemed to have a low impact magnitude. When considering the low sensitivity of receptors this would result in an overall impact of **minor adverse** significance.

### 6.3.2 Remobilisation of Contaminated Sediments

89. As described in **section 6.2.2**, sediment disturbance could lead to the mobilisation of contaminants which may be lying dormant within sediment and which could be harmful to the benthos. Given the low level of contaminants present in the sediments within the development area (**section 3.2**), changes in water and sediment quality due to re-suspension of contaminants during construction have been assessed as negligible.
90. Marine Evidence based Sensitivity Assessment (MarSEA) (MarLIN 2017) shows that, where contaminant levels are within environmental protection standards, marine species and habitats are not sensitive to changes that remain within these standards. As a result of the absence of significant existing contamination and the application of mitigation to avoid release of contaminants, there would be **negligible** impact with regard to benthic ecology receptors.

### 6.3.3 Cumulative Impacts

91. East Anglia ONE North and East Anglia TWO may potentially share an offshore cable corridor and so there is potential for cumulative impacts between the two projects. Furthermore, there is an aggregate extraction area approximately 3km west of the East Anglia ONE North offshore cable corridor. There is therefore potential for cumulative impacts associated with suspended sediments and deposition if there is any temporal overlap in offshore construction activities between the two projects. However, the programmes to install the offshore export cables for the proposed East Anglia ONE North and East Anglia TWO projects are highly unlikely to be aligned and so there is limited potential for cumulative impacts.
92. Small theoretical bed level changes are estimated as a result of cumulative impacts of East Anglia ONE North cable installation and dredging at nearby aggregate sites. However, any changes would be small in scale, temporary and



temporally distinct depending on whether aggregate dredging and construction of the proposed East Anglia ONE North and East Anglia TWO projects were carried out at the same time. The sensitivity of benthic receptors to this level of change would be as described in **section 6.3.1** (low to negligible). Therefore, an overall impact of **minor adverse** significance would result.

#### 6.3.4 Summary of Impacts of Sediment Disposal on Benthic Ecology

93. As the conclusion of all relevant impacts on benthic ecology was that they would range from no impact to minor adverse significance it is likely that, should the proposed East Anglia ONE North offshore cable corridor disposal site be designated, impacts would occur to benthic species, however these would be no greater than of **minor adverse** significance.

## 7 Summary

94. As part of the DCO application for the proposed East Anglia ONE North project, the Applicant is applying to designate the offshore cable corridor (see **Figure 1**) as a single disposal site. Furthermore, the Applicant has proposed that, should the northern offshore cable corridor route option for East Anglia TWO be selected in the project design phase then this disposal site would overlap with the proposed East Anglia ONE North offshore cable corridor disposal site. This would allow the Applicant to dispose of material extracted during construction for associated export cable installation works for both the East Anglia ONE North and East Anglia TWO projects in the same licenced disposal area. If the southern cable corridor route option is selected for the East Anglia TWO project then each project would have a separate licenced disposal site for their respective offshore cable corridors.
95. Two alternative disposal options have been considered for the disposal of drilled and dredged material:
- Use of the material for ballast for certain foundation types; and
  - Use of other existing disposal sites.
96. The majority of the sediments in the offshore cable corridor are gravelly sand. The central section of the offshore cable corridor has the highest percentage of fines (reaching over 90%), with sediment mainly falling within the sandy mud classification. Closest to landfall, sediment size is highly variable, ranging from sandy mud to sandy gravel.
97. Sea bed levelling of any large sand waves that may be present along the export cable route prior to cable installation has the potential to disturb near-surface sediments, as does export cable installation. However, disturbance from sand

wave levelling would be in discreet areas along the length of the cable route with the actual export cable installation being episodic and disturbance confined to near the sea bed. Therefore, this represents limited potential for adverse effects on water quality and sea bed levels.

98. It is likely that the suspended sediment concentrations would be increased by the greatest amount in the shallowest sections of the offshore cable corridor (<5m LAT), approaching 400mg/l at their peak. Background suspended sediment concentrations are also greater in shallow waters. It is likely that some of the deposited material would be redistributed over time by tidal currents, back over the levelled area as re-formed sand waves.
99. The disposal of dredged material has the potential to release sediment-bound contaminants, such as heavy metals and hydrocarbons into the water column. However, levels of contaminants within the offshore cable corridor are generally very low. Elevated levels of arsenic, which are typical of the region, have been recorded at some locations but they are not at concentrations considered to pose an unacceptable risk to the marine environment. Similarly, elevated concentrations of some contaminants at one sample location on the nearshore section of the export cable route (C01) were not sufficiently high to pose an unacceptable risk to the marine environment or to have adverse effects on marine organisms.
100. Results of the benthic ecology assessment show that the majority of receptors in the offshore cable corridor are not sensitive to increased suspended sediments and smothering. Adverse impacts could occur within a few metres of the disposal locations where heavy smothering would be expected, but overall the worst case impact from the proposed designation of the East Anglia ONE North offshore cable corridor disposal site would be of minor significance.

## 8 References

ABPmer (ABP Marine Environmental Research Ltd). (2012). East Anglia Offshore Wind Project ONE Windfarm: Marine geology, oceanography and physical processes environmental baseline. Report R3945. May 2012.

Budd, G.C. & Hughes, J.R. 2005. *Nephtys hombergii* A catworm. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 03-08-2018]. Available from: <https://www.marlin.ac.uk/species/detail/1710>

Canadian Council of Ministers of the Environment (CCME) (2002). Canadian sediment quality guidelines for the protection of aquatic life: Summary tables. Update. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Cooper, N.J. and Brew, D.S. (2013). Impacts on the physical environment. In: R.C. Newell and T.A. Woodcock (Eds.). *Aggregate dredging and the marine environment: an overview of recent research and current industry practice*. The Crown Estate.

EAOL (East Anglia ONE Ltd) (2012). East Anglia ONE Offshore Windfarm Environmental Statement. November 2012.  
Hiscock, D.R. and Bell, S. (2004). Physical impacts of aggregate dredging on sea bed resources in coastal deposits. *Journal of Coastal Research*, 20 (10), 101-114

Jackson, A. & Hiscock, K. (2008). *Sabellaria spinulosa* Ross worm. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from: <http://www.marlin.ac.uk/species/detail/1133>

John, S.A., Challinor, S.L., Simpson, M., Burt, T.N. and Spearman, J. (2000). *Scoping the assessment of sediment plumes from dredging*. CIRIA Publication.

MarLIN (2017). Marine Evidence based Sensitivity Assessment (MarESA). Available at: [http://www.marlin.ac.uk/species/sensitivity\\_rationale](http://www.marlin.ac.uk/species/sensitivity_rationale)

Newell, R.C., Seiderer, L.J., Robinson, J.E., Simpson, N.M., Pearce, B and Reeds, K.A. (2004). *Impacts of overboard screening on sea bed and associated benthic biology community structure in relation to marine aggregate extraction*. Technical Report to the Office of the Deputy Prime Minister and Minerals Industry Research Organisation. Project No. SAMP 1.022, Marine Ecological Surveys Ltd, St. Ives, Cornwall.

Royal Haskoning (2011). Galloper Wind Farm Project, Environmental Statement Chapter 10: Marine Water and Sediment Quality.

ScottishPower Renewables (2019) East Anglia TWO Offshore Windfarm  
Environmental Statement. Volume 1.

Tillin, H.M. & Marshall, C.M., (2015). *Sabellaria spinulosa* on stable circalittoral mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Available from:  
[http://www.marlin.ac.uk/habitats/detail/377/sabellaria spinulosa on stable circalittoral mixed sediment](http://www.marlin.ac.uk/habitats/detail/377/sabellaria_spinulosa_on_stable_circalittoral_mixed_sediment)

Tillin, H.M., Houghton, A.J., Saunders, J.E. Drabble, R. and Hull, S.C. (2011). Direct and indirect impacts of aggregate dredging. *Science Monograph Series No. 1*. MEPF 10/P144

Tyler-Walters, H., Lear, D. & Allen J.H. 2004. Identifying offshore biotope complexes and their sensitivities. Report to Centre for Environmental, Fisheries, and Aquaculture Sciences from the Marine Life Information Network (MarLIN). Plymouth: Marine Biological Association of the UK. [Sub contract reference A1148]

Whiteside, P.G.D., Ooms, K. and Postma, G.M. (1995). Generation and decay of sediment plumes from sand dredging overflow. *Proceedings of the 14<sup>th</sup> World Dredging Congress*. Amsterdam, The Netherlands. World Dredging Association, 877 – 892.

# Appendix 1

1. This appendix provides coordinates to delineate the disposal sites for the proposed East Anglia ONE North project. **Table A 1** has coordinates delineating the proposed offshore cable corridor disposal site.

**Table A 1 Coordinates Delineating the Offshore Cable Corridor Disposal Site for the Proposed East Anglia ONE North Project**

| Point | Latitude (Degree, minutes, seconds) | Longitude (Degrees, minutes, seconds) |
|-------|-------------------------------------|---------------------------------------|
| 1     | 01 37 24.5343                       | 52 11 31.2096                         |
| 2     | 01 37 24.5048                       | 52 11 33.4212                         |
| 3     | 01 37 50.2463                       | 52 11 53.6630                         |
| 4     | 01 40 17.5842                       | 52 12 26.1063                         |
| 5     | 01 41 4.0136                        | 52 13 37.1942                         |
| 6     | 01 45 3.4416                        | 52 15 54.9431                         |
| 7     | 01 52 5.2756                        | 52 18 25.1927                         |
| 8     | 01 56 37.3269                       | 52 20 19.4961                         |
| 9     | 02 8 48.4289                        | 52 20 25.4004                         |
| 10    | 02 8 47.4610                        | 52 20 2.1962                          |
| 11    | 02 10 44.0704                       | 52 20 2.2391                          |
| 12    | 02 18 57.3513                       | 52 21 40.2396                         |
| 13    | 02 19 14.7835                       | 52 21 7.9755                          |
| 14    | 02 11 21.9802                       | 52 19 34.0598                         |
| 15    | 02 10 57.4908                       | 52 19 10.4589                         |
| 16    | 02 8 40.0188                        | 52 19 10.4095                         |
| 17    | 02 8 31.8301                        | 52 17 42.6133                         |
| 18    | 02 6 49.3187                        | 52 18 44.2625                         |
| 19    | 01 57 24.8484                       | 52 18 39.6496                         |
| 20    | 01 54 9.9694                        | 52 17 25.8581                         |
| 21    | 01 52 3.3739                        | 52 17 24.6630                         |
| 22    | 01 45 57.6061                       | 52 15 14.3727                         |

| Point | Latitude (Degree, minutes, seconds) | Longitude (Degrees, minutes, seconds) |
|-------|-------------------------------------|---------------------------------------|
| 23    | 01 45 6.0501                        | 52 14 29.5099                         |
| 24    | 01 42 32.4603                       | 52 10 51.3650                         |
| 25    | 01 39 52.4425                       | 52 9 56.7130                          |
| 26    | 01 37 38.5965                       | 52 10 6.7018                          |
| 27    | 01 37 4.5507                        | 52 10 44.4665                         |
| 28    | 01 37 17.7500                       | 52 11 1.5038                          |
| 29    | 01 37 15.8334                       | 52 11 2.3784                          |
| 30    | 01 37 21.4166                       | 52 11 30.6776                         |