



E.ON Climate and Renewables UK Limited

**Annex I Survey and Benthic Sampling
for the Humber Gateway Offshore
Wind Farm**

Date: August 2012

Project ref: P011-11-0045/EON/ANN1

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Humber Gateway Offshore Wind Farm**

Client Name: E.ON Climate and Renewables UK Limited

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Report Title: Annex I Survey and Benthic Sampling for the Humber Gateway Offshore Wind Farm

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1. Introduction

1.1 The Proposed Development

Humber Wind Ltd has obtained the necessary consents required to construct the Humber Gateway offshore wind farm which is to be located approximately 8 to 13.5km to the east of Easington and Spurn Head and will consist of a maximum of 83 turbines covering an area of 35 km² with a maximum capacity of up to 300MW. The current plans for the development include a series of inter-array undersea cables between the offshore wind turbines and the offshore substation along with two export undersea cables from the offshore substation to shore. The FEPA consent **34011/11/0** was issued in February 2011 and outlines the responsibilities of the developer with respect to environmental monitoring for the project. A Benthic Monitoring Plan (BMP) was issued to the MMO in January 2012 which defined the proposed range of preconstruction surveys to be undertaken in order to fulfil FEPA consent requirements (see Appendix 1).

In accordance with the BMP, this document outlines additional detail with regards to Annex I and benthic monitoring to be undertaken in August and September 2012 as preconstruction survey before commencement of construction in summer 2013.

The survey strategy outlined in this document optimises the most recent geophysical survey undertaken in winter 2012 and current thinking with regards to the array cable routing. This document is therefore intended to be supplementary information to the BMP.

1.2 The Benthic Monitoring Programme

The BMP issued by the developer in January 2012 addressed a number of clauses/conditions within the FEPA Licence (34011/1/0) which relate to pre-construction benthic (seabed) habitats monitoring (Appendix 1) and included provisions for the following monitoring regimes:

- The range of environmental monitoring (in relation to benthic and seabed habitats) proposed for the project;
- The specifications of the proposed monitoring in terms of approach and equipment;
- The provisional schedule for the proposed monitoring;
- The proposed analysis and reporting requirements to present the findings of these surveys.

The BMP included requirements for the proposed pre-construction monitoring due to be undertaken in 2012 in relation to bathymetric surveys (FEPA condition 9.40), survey of Annex I habitats including *Sabellaria* reef and Stony Reef (FEPA condition 9.33) and benthic survey (FEPA 34011/11/0 Annex 1 section 2). The BMP outlines the nature of the proposed surveys to be undertaken including methodologies, survey design and outputs and also survey timings. The BMP received minor comments from the Marine Management Organisation (MMO) and was reissued to the MMO in May 2012 addressing these

comments. In this way, the approach of the BMP has been approved by consultees, including the MMO.

Although the BMP provided the proposed survey rationale and methods for the Annex I and benthic survey components, it also proposed that the final scope for these surveys would be issued following the 2012 winter geophysical surveys in order to ensure that the final survey design was based on the most up to date information. The winter bathymetric (geophysical) survey was undertaken in Q1 2012 and a summary report outlining the findings of this survey will be issued in a separate report together with the results of the summer pre-construction bathymetric survey.

This document therefore addresses the pre-construction Annex I monitoring and benthic survey requirements (based on those in the BMP) following review of the winter 2012 geophysical data and provides a more detailed survey plan in terms of site layout.

As outlined in the BMP, the offshore component of construction is due to take place from 2013 to 2015 with pre-construction monitoring undertaken in 2012 and a summary of the schedule for proposed works and pre-construction surveys given in the BMP is provided in Table 1. Each survey is likely to take approximately eight days duration.

	2012											
	January	February	March	April	May	June	July	August	September	October	November	December
Bathymetric survey												
Annex 1 survey												
Benthic Survey									alternative survey period			



Survey Periods 
Reporting 

Table 1. Proposed project timeline (pre-construction)

1.3 Previous Surveys

Data from a number of surveys undertaken during the development phase of Humber Gateway were used to derive the detailed survey methodology described in this document. A number of these surveys have been referred to within this document as follows:

- 2004 Benthic Characterisation Survey: Benthic survey reported in the Humber Gateway Environmental Statement. This also incorporated some drop down video for Annex I assessment.
- 2011 Geophysical Survey: Multibeam and sidescan undertaken prior to geotechnical works & UXO assessment within 120m boxes around proposed turbine sites and Cone Penetration Testing (CPT) sites along the export route. Undertaken in late spring/summer 2011.
- 2011 Annex I survey: Drop down video survey at turbine and CPT sites undertaken prior to geotechnical investigations undertaken in March 2011.
- 2012 Geophysical Survey: Multibeam and sidescan undertaken across the full development site to fulfil BMP requirements for a winter preconstruction survey. Undertaken in Spring 2012.

- 2012 Export route video survey: Drop down video survey undertaken along the export route for Annex I assessment with regard to export routing options. Ongoing – due for completion August 2012.
- 2012 Annex I groundtruthing survey: Drop down video survey undertaken along the export route and array cables to assess potential Annex I habitat in relation to geophysical data. Undertaken in May 2012.

2. Annex I Survey Assessment

2.1 Reason for survey

The requirement for Annex I habitat survey is outlined in clause 9.33 of the FEPA licence as follows:

*The Licence Holder must carry out a pre-construction survey to determine the location and abundance of Annex 1 habitat in the vicinity of the array and cable route. Should Annex 1 habitat be identified in the area of the proposed array the Licence Holder is required to undertake an assessment of the need to micro-site individual turbine structures, inter array cable or the export cable. If micro siting is required the Licence Holder must inform the Licensing Authority immediately. The results of the survey and assessment shall be submitted to the Licensing Authority and Natural England **within one month of the completion of the survey and no construction is to commence without the written agreement of the Licensing Authority.***

In consideration of FEPA clause 9.33 and the objectives set out above the hypothesis tested here is as follows:

Establishment of the Humber Gateway Offshore Wind farm causes a significant alteration to the extent and status of Annex 1 reef features at the wind farm site.

2.2 Objectives

The Annex I survey and monitoring plan will utilise recent geophysical data from the pre-construction survey within the turbine array and export cable route to identify areas of potential Annex I habitat (*Sabellaria* reef and cobble reef) that will be used to define a series of survey sites. The survey sites have been selected on the basis of where potential Annex I habitat intersects with proposed turbine, array and export cable locations. Where such intersections have been identified, drop down video survey will be deployed (following standard methodologies) to identify Annex I as well as the extent and status of the Annex I features. Hendrick and Foster-Smith (2007), Gubbay (2007) and Irving (2009) will be used as guidance.

Drop down video survey of the export cable route is currently ongoing (using methodologies agreed with Natural England in 2011) and this was undertaken to provide the developer with an earlier assessment of Annex I risk along the export route. This survey will be completed prior to the array cable Annex I surveys outlined here and the resulting information will also supplement the reporting element of array cable surveys.

2.3 Derivation of survey layout

As described in the BMP, the protocol for deriving a survey layout for Annex I habitats follows the process:

1. Geophysical Survey (multibeam and sidescan) - this was carried out during the pre-construction bathymetric survey required under the BMP
2. Analysis & Interpretation of geophysical data
3. Identification of potential Annex I from geophysical survey results and selection of survey sites
4. Provision of detailed survey scope to Licensing Authority
5. Selection of final Annex I survey sites
6. Drop down video survey
7. Analysis & Assessment of Annex I survey results and positive identification of location of any Annex I
8. Consultation with Licensing Authority

The geophysical survey undertaken in Q1 2012 (including the bathymetric winter pre-construction survey required by the FEPA licence and detailed in the BMP) was carried out as described in the BMP and included multibeam (swathe) bathymetry and sidescan sonar across the entire development site and export route. The outputs from this survey were then examined in conjunction with existing video data obtained during previous Annex I survey data undertaken at turbine locations in 2011 (as part of the geotechnical investigations), ongoing Annex I survey along the export cable route and also recent groundtruthing video survey undertaken in May 2012.

This process identified discrete areas of seabed which differed in topography from the adjacent seabed (gravel ridges) and/or those areas with sidescan data suggesting harder/rougher ground which may comprise of cobble/boulder. This information was then reviewed in order to assess likely areas of potential reef and is detailed in this methodology. The results of the 2012 pre-construction geophysical surveys will be summarised in a separate report (available August 2012) but the main features in relation to Annex I habitat are briefly described below.

2.4 Summary of seabed features & potential Annex I distribution

The full summary of the 2012 pre-construction geophysical surveys will be provided in a separate report following completion of the summer bathymetric survey but a brief description of the habitats recorded during the first geophysical survey (spring 2012) is provided here. A map showing the proposed development layout (turbines, export route and array cables) overlaid on multibeam bathymetry results is provided in Figure 1. The broad seabed features derived from sidescan sonar interpretation are provided in Figure 2. Cable array layouts illustrated in these figures are currently under review but represent the most recent plan.

In terms of bathymetry, the majority of the development area lies between 13m and 16m Chart Datum and aside from small scale features (individual boulders, debris, scar lines etc)

the most obvious features are a series of elevated ridges running across the development site and export route usually orientated NNW to SSE. A broader area of slightly elevated seabed is also present running SSE from the north east corner of the site. Other notable variations in bathymetry are the series of ridges at the inshore end of the export route. These features are clearly identified by the sidescan sonar as highlighted in Figure 2 which provides a summary of the assessment of the 2012 geophysical data collected and analysed (excluding small scale features for clarity). Essentially, the ridges evident from the bathymetric data within the turbine site and at intervals along the export route have been classified as gravel ridges (as highlighted in Figure 2) and subsequent assessment using drop down video in May 2012 (and earlier geotechnical surveys in 2011) have identified these as primarily cobble and small boulder. The ridges at the extreme inshore end of the export route are a complex system of elevated/exposed boulder clay ridges – known locally as clay huts. Some video data was collected in this area during the 2012 export route survey and groundtruthing surveys in May 2012 (and also in previous surveys in 2011) and it is proposed that additional drops may also be taken in this area during the pre-construction monitoring survey but this will largely be dictated by tidal conditions as visibility this close inshore is minimal for much of the year. Whilst there is no statutory protection for these features at present (which generally exhibit relatively sparse epifaunal communities) given their unusual topography and elevation the exposed clay habitats in this area will be assessed as appropriate within the pre-construction survey report.

The remainder of the site is largely characterised by extensive areas of (slightly muddy) mixed coarse sediment comprising of pebbles, sandy gravel and shell with varying amounts of cobble which in some areas appears to form a veneer over the underlying boulder clay. This habitat is extensive and covers the majority of the area and is also characterised by scattered larger boulders which were recorded frequently throughout the site. Drop down video undertaken at the turbine locations in March 2011 prior to geotechnical surveys and subsequent groundtruthing survey in May 2012 highlight a degree of patchiness or variability in this habitat with some areas exhibiting increased *Modiolus* shell and others with increased cobble content. Such areas of slightly rougher ground are also evident from the sidescan data and are scattered across the area although are often adjacent to the cobble ridges described earlier or in some areas at the periphery of the site. There has also been identified a slightly more elevated area of potentially more gravelly sediment running from the north east corner of the site, although an assessment of available video from this area did not appear to highlight a particular change in sediment in this region. Other habitats identified include some areas of sand or mixed gravelly sand at the extreme inshore end of the export route.

In terms of Annex I habitats the detailed drop down video survey of turbine locations (including sites 100m to the north, south, east and west) and Cone Penetration Testing (CPT) sites in the vicinity of the export corridor undertaken in March 2011 only recorded Annex I reef (stony reef) at turbine site 60 with one other area recorded 100m east of turbine site 19 and also an area at CPT site 5 just to the north of the current the export route. Assessment of these areas in relation to geophysical survey data indicated that these corresponded to the areas of gravel ridges described above and subsequently a groundtruthing exercise was undertaken in May 2012 at a number of these habitats which indicated that the majority of these ridge features are likely to qualify as Annex I stony reef

with the boundaries of these features corresponding closely to the more elevated areas. Adjacent to these features are often areas of seabed with somewhat higher cobble content but with limited elevation and such habitats were patchily distributed across the development site as indicated by areas of slightly rougher seabed from multibeam and sidescan data. During the assessment and review of the 2011 video survey data with Natural England such habitats were not considered reef and were classified as transitional or borderline habitats, where the 2012 groundtruthing surveys verified this. A map showing the current Annex I classification at the sites surveyed by drop down video during 2011 and the coverage of video groundtruthing sites surveyed in 2012 is provided in Figure 3.

Consequently, it is considered that the main areas of potential Annex I habitat in the survey area will correspond to the cobble ridges in those areas with pronounced elevation. As such, and it is these areas which will be targeted during the proposed Annex I pre-construction survey. For survey purposes, some provisional boundaries for these have been derived using bathymetric contours and available groundtruthing video data and sidescan to allow planning of survey sites. For the purposes of the current survey plan, it is intended to follow the broad methodology to that outlined in the BMP to target areas of potential reef along the cobble ridges in close proximity to the proposed array cables and export route, where the intersections of potential Annex I and array and export cables for drop down video survey are now identified in Section 3 of this document (see Figure 4).

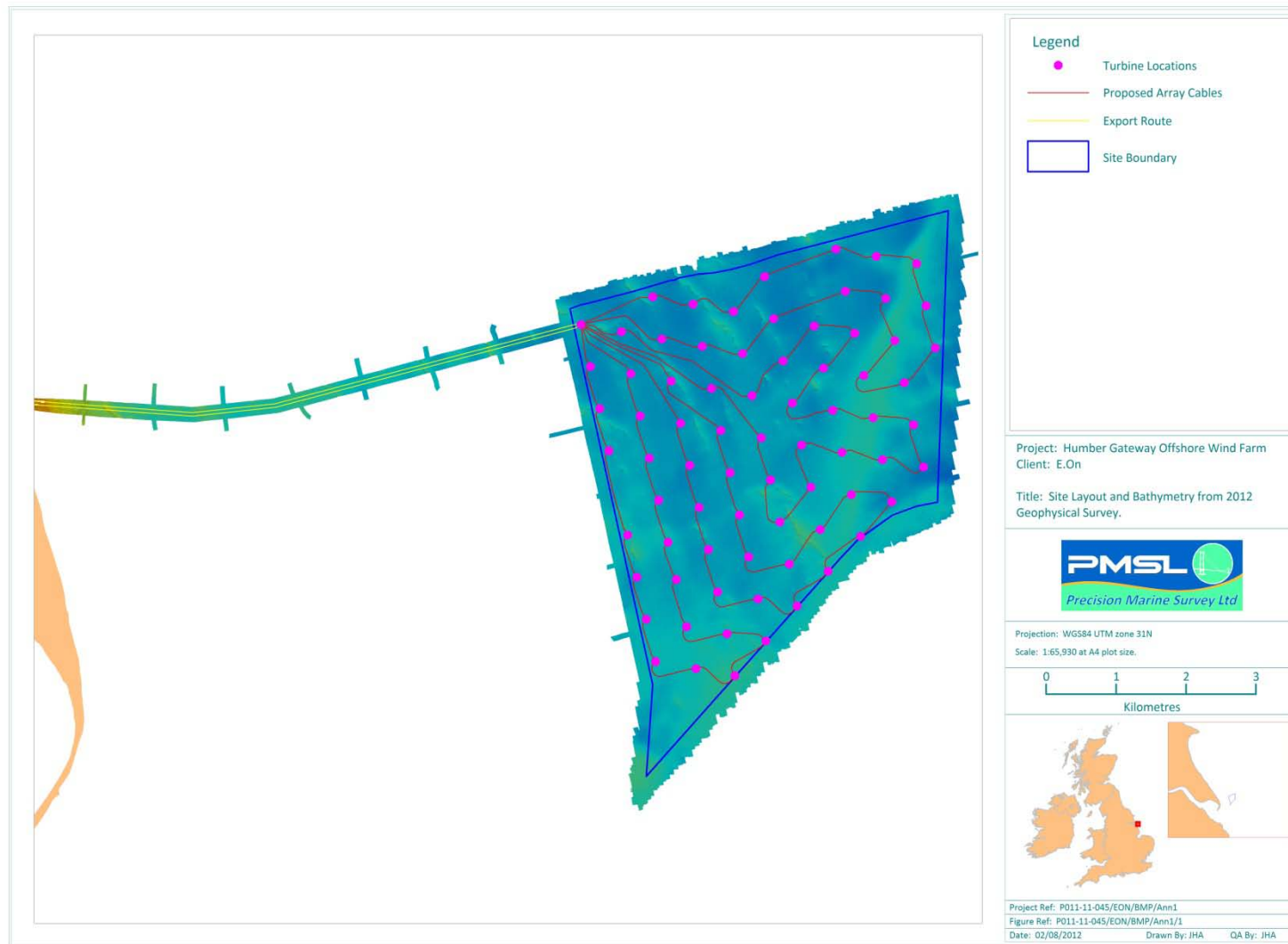


Figure 1. Site layout and bathymetry.

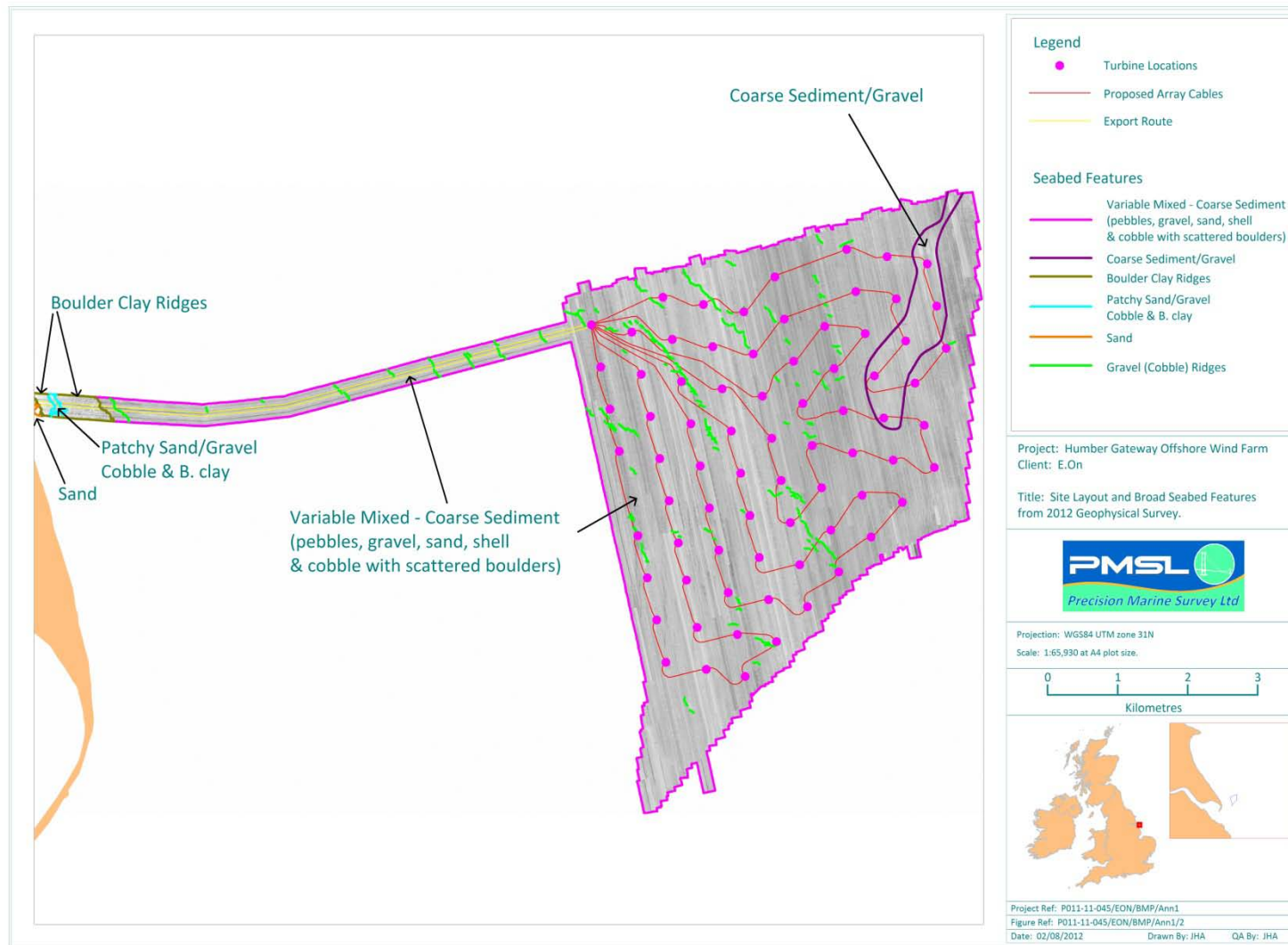


Figure 2. Broad seabed features.

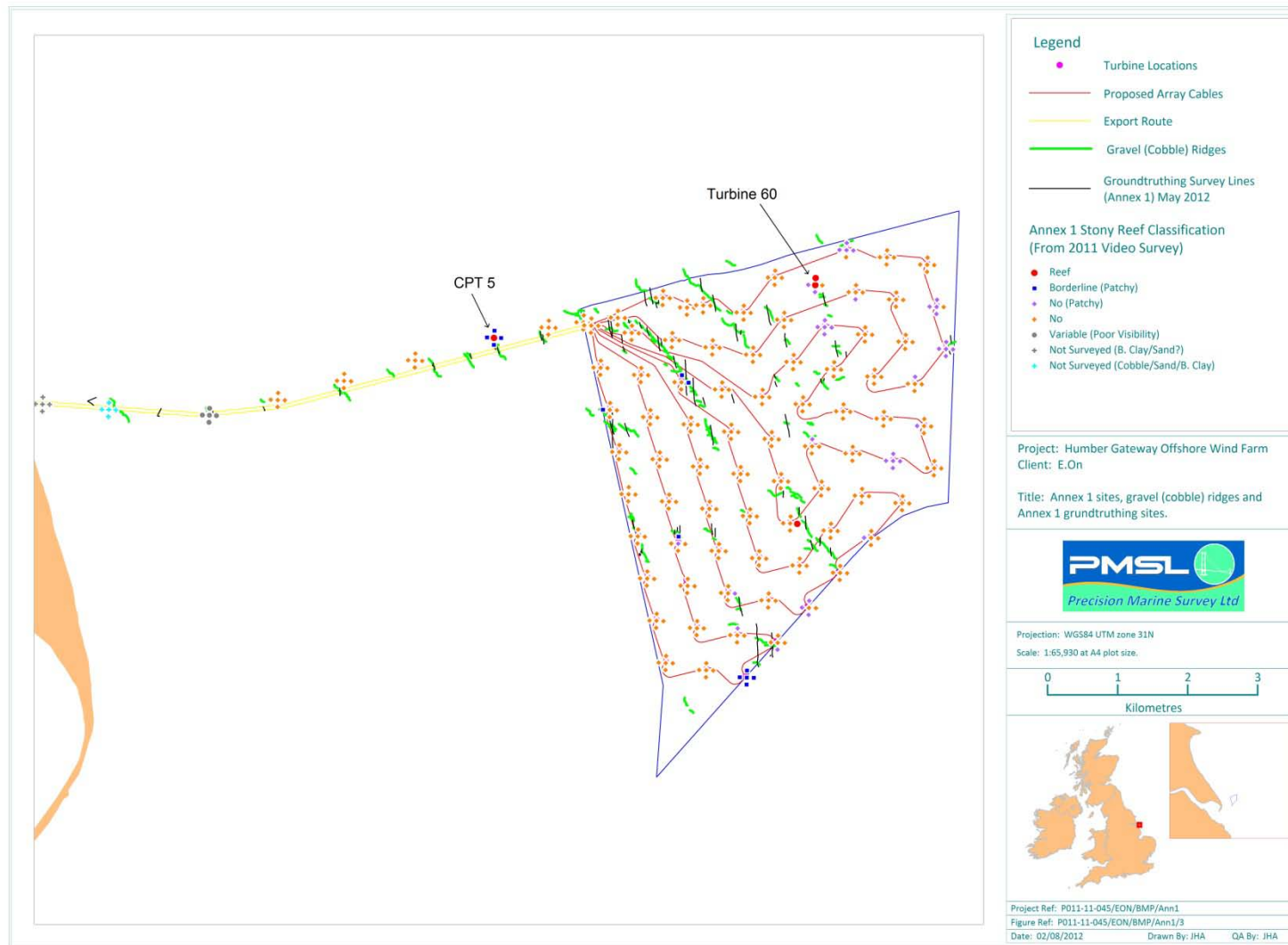


Figure 3. Cobble ridges, previously recorded Annex I habitats and groundtruthing sites.

3. Annex I Survey Method

The survey method to be used for the Annex I survey will follow those provided in the BMP. In summary, the survey will incorporate the use of drop down video to assess seabed features identified during geophysical survey as having potential for Annex I habitats. Drop down methods will follow standard procedures outlined in Goggan *et al* (2007), Limpenny *et al* (2010) and other appropriate guidance e.g. Marine Monitoring Handbook procedural guidance 3.5, MALSF Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (Ware and Kenny, 2011).

The survey will utilise a combined drop down video and digital stills camera (5 megapixels minimum) with appropriate lighting system and strobe flash. The drop down stills/video system should be linked by umbilical to the surface to allow a real-time video feed to the surface and also incorporate a GPS (or site label) overlay. A surface PC will allow monitoring of vessel position overlain on geophysical data (multibeam/sidescan) to allow fine tuning of survey sites and appropriate lengths of drifts. The video system would allow both oblique and vertical viewing as appropriate and allow modifications to camera height/angle to allow optimum images to be obtained. A minimum of 5 digital stills will be taken per site and an appropriate scaling system should also be incorporated into the camera system to allow an assessment of scale for sedimentary/biological features. Video would be recorded digitally and archived on external hard drive/DVD for further analysis. A fresh water lens may also be employed where practicable in areas of high turbidity although in sensitive habitats it is preferred that detailed knowledge of local conditions regarding tides and sediment load be used where possible to allow use of standard camera equipment which is more manoeuvrable.

The Annex I survey will be undertaken during appropriate tides/weather conditions to allow optimum video capture. At each survey station, the immediate survey area will be checked for obstructions e.g. static gear and DGPS or equivalent position systems will be used to move the vessel on to site. The drop down video camera system will undertake short drifts (50-100m) over the survey site (as guided by real time monitoring of the vessel position in relation to features identified in the 2012 geophysical data) with the video frame occasionally allowed to rest on the seabed to allow still photographs to be extracted. The video camera will be kept as close to the seabed as possible to allow for a clear representation of the bed and faunal type to be recorded with periodic drops to the seabed for stills. Sites will be surveyed along the ridge with sufficient drift to capture boundaries of reef features and adjacent habitats and potential array cables intersections.

Methods described in the BMP for Annex I survey utilise the standard cruciform approach with sites surveyed at a centre point and 100m to the north, south, east and west but also allow for modifications to this approach depending on the nature of the reef habitats. Given that the majority of these features appear to be relatively narrow, linear features it is proposed that rather than using an arbitrary 100m cruciform approach (which may miss boundaries or reef features) it would be more practicable to target sites along the ridge at approximately 100m separation but undertake a sufficient drift across these sites (in a north to south drift such that the edge of the feature (and adjacent habitats) can be mapped in one drop rather than using a separate deployments 100m either side. Additional drops to

the east or west may be used as required should reef extend beyond the initial deployment in which case the standard cruciform approach will be applied (guided by assessment of geophysical data during the survey). Given that these features appear to be well defined by bathymetric data the method is to assess those features in the immediate vicinity of the array as per the FEPA licence condition i.e. in areas within 150 - 200m of proposed array cables and export routes. It is not proposed to survey potential Annex I areas outside this.

On the basis of existing information around 20 locations have been identified where the arrays may intersect with potential Annex I habitat with an additional 8 areas along the export route. As such it is anticipated that to provide full coverage of all features within the immediate vicinity of these intersections and other potential Annex I habitat in close proximity (150 to 200m) to the proposed array/export cable routes around 120 to 130 sites would be required at approximately 100m spacing. Given that recent surveys indicates that the majority of potential reef features are narrow linear features running NNW to SSE then as described above it is proposed to undertake single drifts at approximately 100m separation (in the orientation of the potential reef feature) which are of sufficient length enough to establish the edges of the reef from east to west and intersect adjacent array/export cables in the immediate vicinity. Survey coverage will also be supplemented by ongoing video survey of the export cable route (which follows the same methodology as outlined above) and existing groundtruth data collected in May 2012. It is not proposed to undertake additional east and west video drops unless the reef feature is indicated to extend beyond the original 120-130 north to south sites. If the reef extends beyond the ridge system, then a standard cruciform pattern with deployments 100m to the North, South, East and West (or as appropriate) of the identified feature will be used as appropriate to map the extents of the any reef habitats within the 150m buffer zone. If positive identification of Annex I habitat is found outside the initial survey site, then additional drop downs will be undertaken as required to provide extent of Annex I habitat.

In terms of turbine locations the 2011 video survey of these sites indicated that only one turbine location had cobble reef (site 60) and the remainder were not considered to include Annex I reef (although a limited number of other sites exhibited borderline habitats). Consequently, at this stage it is considered that pre-construction drop down survey will not be necessary at the majority of turbine locations although a limited number with potential Annex I in close proximity (e.g. sites 4, 24, 45, 64 and 66) will be re-evaluated with regard to ongoing assessments for micro-routing of array cables.

A map showing an indicative layout of core Annex I survey sites (130 in total) in the vicinity of the proposed array cables and export route is provided in Figure 4.

An assessment of video footage will be made *in-situ* to assess the potential for Annex I habitats which may include *Sabellaria* reef or stony/cobble reef. These assessments will be undertaken using the currently available guidance notes i.e. Gubbay (2007) for potential *Sabellaria* reefs, and Irving (2009) for potential cobble reefs.

3.1 Survey Timing

As per the BMP, the Annex I survey is currently scheduled for neap tides at the end of August 2012 or as weather and sea conditions permit.

3.2 Outputs

The outputs and analysis from the Annex I survey component will include the following:

- Site description (sediment type, topography, key taxa)
- Assessment of reef status at each survey site
- Extent and type of reef (if recorded) for each survey site
- Status/quality of reef
- Construction constraints with regard to Annex I features

Following the drop down video survey an evaluation of Annex I status will be undertaken using current guidance e.g. the scoring systems for *Sabellaria* and Cobble reef (Hendrick and Foster-Smith, 2007; Gubbay, 2007 and Irving, 2009). This information will be used to prepare detailed biotope/Annex I maps using GIS to illustrate the extent of such feature and facilitate micro-siting of turbines, inter-turbine cables and export cable where possible. This output will feed into a micrositing assessment and mitigation report to be submitted to the MMO by December 2012, as required by the FEPA licence. The report will include a description of methods used and a concise summary of the main habitats and characteristic species recorded with representative stills and a description of the extent and characteristics of any areas of Annex I habitat recorded. Mapping of Annex I habitat will incorporate outputs from the pre-construction geophysical survey (multibeam/sidescan) as appropriate to facilitate interpretation of distribution.

Outputs from the Annex I survey will include the following:

Component	Detail
Project summary	
Background information	
Vessel specification (& instrument setup)	
Technical specification	Navigation Video system
Fieldwork summary	
Operations log	
HSE	
	Video records/digital stills
Uncertainties of interpretation (inc. groundtruthing)	
Results	Bathymetry, morphology Annex I features Sediment type/cobble content Site Summary Cobble reef <i>Sabellaria</i> reef Annex 1 Status Interaction with export/array cables

Component	Detail
References	
Charts: A3 or A4 for Annex I habitats (at appropriate scales e.g. 1:20,000/1:40,000)	Survey sites/video transects Reef features Sediment type/cobble content Bathymetry/sidescan mosaic imagery Community/habitats
Photographic Stills	
Example Video	DVD

Reporting timescales will be dependent on survey dates but it is anticipated that this would be within two months of completion of survey (i.e. early December 2012).

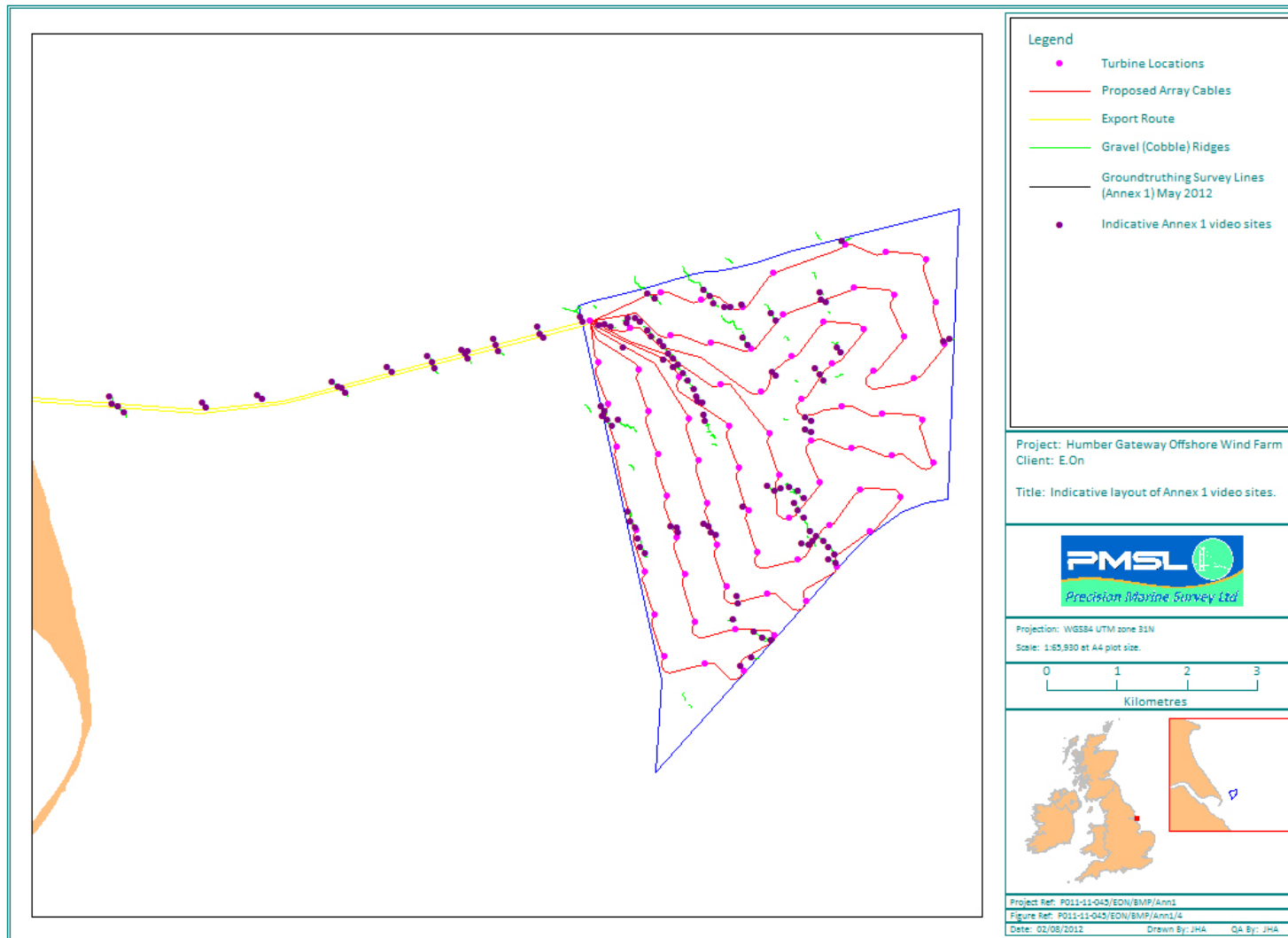


Figure 4. Indicative layout of primary Annex I survey sites.

4. Benthic survey

4.1 Reason for survey

The requirements for benthic monitoring described in the BMP follow conditions outlined in FEPA 34011/11/0 Annex 1 section 2 as follows:

Prior to the commencement of any works the benthic ecology characterisation data must be reanalysed and reinterpreted to the satisfaction of the Licence Authority, in consultation with Cefas and Natural England, in order to provide a robust baseline dataset against which the benthic monitoring data can be measured.

Sample locations for ongoing monitoring must be determined by factors such as precise foundation locations, location of cables. Sample locations must also take full account of factors such as coastal process modelling outputs (for sediment transport/deposition information) and geophysical surveys (to ensure adequate coverage of sea bed habitats).

Sampling should involve a minimum of 3 replicates at each station and the number and location of stations should be determined making use of the data used to characterise the site as part of the Environmental Statement. This monitoring should include a suitable baseline data set and make adequate use of reference sites.

NB. The sediment transport/deposition information and benthic data sets must be closely related.

In consideration of FEPA conditions and the objectives set out above the hypothesis tested here is as follows:

Establishment of the Humber Gateway Offshore Wind farm causes a significant alteration to the status of benthic communities at the wind farm site.

4.2 Objectives

The benthic survey will aim to provide an assessment of the status of benthic communities, biotopes and associated sediment parameters within the development area and adjacent habitats including those potentially subject to construction related disturbance. As per the BMP, this will entail survey by grab sampling and video using the agreed techniques to define benthic communities and sediment parameters in the vicinity of the development and allow a comparison of temporal trends for future (post construction) monitoring.

The following survey components will be undertaken to fulfil this component:

- Benthic sampling using appropriate sampling gear
- Drop down video (this may be incorporated in the Annex I survey as appropriate)
- Sediment sampling and Particle size analysis (PSA)
- Faunal preservation, processing and enumeration
- Faunal Biomass

4.3 Survey Design

The benthic survey design will utilise a stratified random layout in which the benthic sampling stations are sited in each of the main benthic habitats within and adjacent to the development site as described in the BMP review of the 2004 benthic characterisation survey. The numbers of stations within each of the main habitats will take into account the spatial coverage of the main benthic communities and where possible utilise sites previously sampled during the 2004 characterisation survey reported in the Humber Gateway Environmental Statement.

The sites will cover approximately 1 tidal excursion either side of the development area in order to allow assessment of direct and secondary impacts relating to construction related sediment disturbance, suspended sediment movement etc. As outlined in the BMP, the survey design will incorporate a combination of single samples and replicate sampling which allows sampling over a wider range of communities including more discrete variants of the main assemblages.

A survey design was included within the BMP (subject to review of the 2012 geophysical data) with 41 sites identified including: 18 sites with triplicate sampling in the main communities (based on the communities identified from the 2004 characterisation data) inside and outside of the development sites including control sites outside the tidal excursion and 23 sites with single samples which provide additional coverage over the wider area and target more discrete habitats/communities. This resulted in a total of 77 benthic samples.

As described in the BMP, much of the development area comprises of relatively similar (although inherently variable) mixed coarse sediment which varies in terms of cobble and shell content. Such habitats exhibit a natural level of variability relating to the structural complexity of the sediment and prevailing environmental conditions. However, despite small scale patchiness and other variability much of the area within the development site exhibits relatively similar communities (potential Annex I habitats aside). This was described in the BMP, which highlighted three main communities (based on data from the 2004 characterisation survey) along with a number of smaller outlying groups or sub-groups which represent localised variations in species composition and highlights the relatively high natural variability of the area in terms of infauna/epifauna. As such it was considered that many communities were variations on a theme rather than distinct entities and furthermore these habitats are relatively poorly covered within the current UK biotope classification. The summary of seabed features from geophysical data described in Section 3 also identified relatively few major differences in seabed habitats and aside from more elevated cobble reef habitats (covered by Annex I survey) and areas of boulder clay at the extreme inshore end of the export route (not feasible by grab survey) it is considered that the survey design proposed in the BMP covers the main habitats of the area and includes examples of flatter shell, gravel/pebble seabed and also somewhat rougher ground adjacent to cobble ridge habitats.

Following review of the 2012 geophysical data, a few minor adjustments have been made to the benthic survey design in the BMP to allow for variations in export/array cable routing

and features identified from geophysical data. An example of this is the identification of one area of potentially more gravelly sediments running from the north east corner of the site as shown in Figure 2. Whilst existing video data does not indicate any gross changes in sediment in this area, it is considered prudent to include an additional benthic survey site within this area. Some patchy areas of more mobile areas of gravel and/or sand are also present at the periphery of the site to the south east and existing sites in this area have been adjusted slightly to take this into account. It is also considered useful to include a video site within the boulder clay ridge habitat at the inshore end of the export route. An exact position for this has not been identified as this will be dictated by local conditions as this area is extremely turbid for much of the year. The mixed sandy habitats at the extreme inshore end of the export route are small in scale and very close to the intertidal and it is doubtful whether any sampling in this area is feasible and given the nature of the seabed in this area (shallow water and a thin veneer of surficial sediments over compact clay with emergent clay ridges and occasional large boulder) it is not considered practical to sample at this inshore end of the export route although video may be taken as conditions permit.

Consequently, the benthic survey plan now includes 78 samples from 42 sites (18 sites with triplicate sampling and 24 sites with single samples) with additional video sites at the inshore end of the export route (boulder clay ridges and associated habitats). A revised map showing benthic survey layout is provided in Figure 5.

In areas of potential Annex I habitat or areas where grabbing is not possible due to rough ground the cruciform sampling layout (five drops per site) will be followed as described in Section 2.2. Areas of cobble reef will not be sampled by grab although areas of *Sabellaria* reef may be sampled with a single grab to gain quantitative data on *Sabellaria* density (following agreement with Natural England).

There is no requirement in the FEPA licence to undertake any preconstruction epibenthic surveys and this has not been subsequently raised by consultees as a survey requirement following review of the BMP. However, an epibenthic assessment will be undertaken as part of the Annex I and Benthic survey and reporting, where epibenthic species will be identified and assessed from the benthic grab sampling and video and photographic stills. As such, epibenthos will be reported within the Annual Benthic Monitoring report, to be submitted to the MMO in December 2012. No epibenthic trawls are proposed for preconstruction survey, largely due to the seabed being unfavourable to this survey method owing to frequency of large boulders on the seabed.

Methods for benthic sampling will essentially be as specified in the BMP but for completeness these are provided in Appendix 2.

4.4 Survey timing

The current schedule for benthic survey is in early September 2012 as conditions allow. It is intended that the benthic survey follow immediately from the Annex I survey.

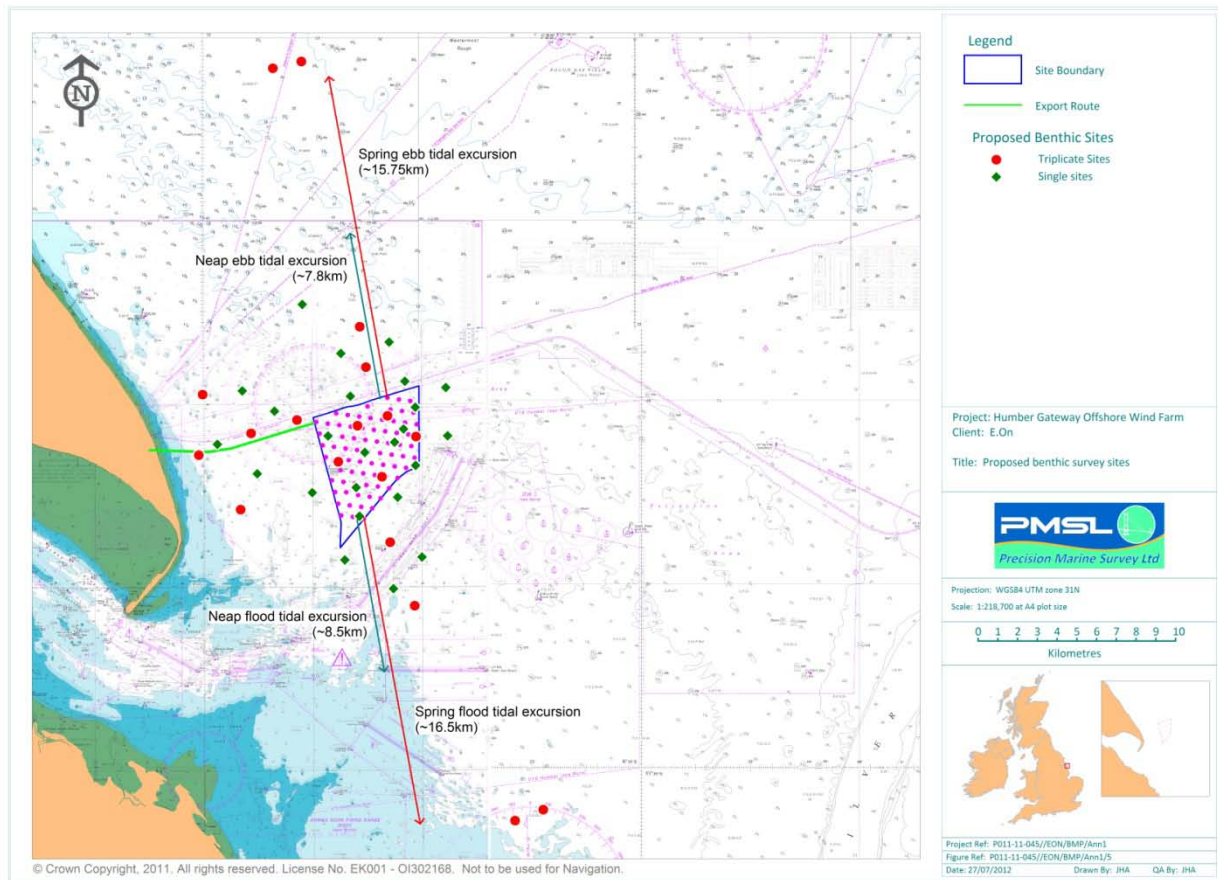


Figure 5. Proposed benthic survey sites.

4.5 Outputs

A technical report will be produced from the survey which will incorporate results of the biological and sedimentary analysis. This report will include details on sampling methodology, site records, laboratory methods and spreadsheets showing invertebrate abundances and biomass. Charts will be provided showing the distribution of sites and relevant biological and sedimentary parameters. Infaunal community structure will be illustrated by summary tables of species composition (by abundance and biomass) and the derivation of primary and derived univariate parameters (e.g. abundance, number of taxa, biomass, Magalef's index of Richness, Pielou's Evenness index, the Shannon-Wiener Diversity index).

Multivariate analysis will also be undertaken using appropriate software (e.g. Primer) following standard methods outlined by Clarke and Warwick (2001) and include classification analysis (hierarchical agglomerative clustering) and ordination (nMDS) using appropriate similarity measures (e.g. Bray Curtis similarity coefficient to assess the similarity of sites based on the faunal composition). The resulting dendrograms and MDS plots will be used in conjunction with other statistical routines such as SIMPROF to define groups of sites

with similar species to assist in the derivation of the main communities in the area. Other univariate and multivariate routines will be used as appropriate such as SIMPER to determine key taxa within each group of sites and the BEST routine to identify relationships between community structure and environmental parameters.

The report shall also draw upon results of the video survey component to assess epifaunal assemblages (and Annex I features) and derive biotope codes for the sampling stations. Biotopes will be assigned to maps using the standard MNCR colours and be provided in a COWRIE GIS data compatible format. The report shall also highlight significant species and habitats (e.g. Annex I reef) within the context of nature conservation and reference made to relevant legislation and the known geographical distribution of such features.

The outputs from the report will include the following:

Component	Detail
Project summary	
Background information	
Vessel specification (& instrument setup)	
Technical specification	Navigation Sampling Equipment Video system
Fieldwork summary	
Operations log	
HSE	
Data description and processing	Grab samples Video records/digital stills PSA data
Uncertainties of interpretation (inc. groundtruthing)	
Results	Benthic community analysis Biotopes Annex I features PSA data Video/Still data
References	
Charts: A3 or A4 (at appropriate scales e.g. 1:20,000/1:40,000)	Site layout (inc. turbine/cable array) PSA data Biotopes/Community data Annex I features
Photographic Stills	
Example Video	DVD

Reporting timescales will be dependent on survey dates but it is anticipated that this would be within two months of completion of survey (i.e. early December 2012).

Appendix 1. Relevant FEPA Licence Conditions for Benthic Monitoring

- Condition 9.28* The Licence Holder must carry out environmental monitoring in accordance with conditions 9.29 to 9.39. Such monitoring shall include pre-construction monitoring for **at least a year prior** to the commencement of construction, to provide a baseline for subsequent monitoring of the effects of the wind farm, construction and post-construction monitoring programme following the completion of the works. Further monitoring requirements may be imposed by the Licensing Authority in the light of the results [see condition 9.55].
- Condition 9.29* The Licence Holder must ensure that a proposal for the specification of the pre-construction (baseline) monitoring (including the turbine array and export cable route) is submitted to the Licensing Authority, for agreement in consultation with Cefas and Natural England, **two months prior to the commencement of the monitoring works.**
- Condition 9.30* The Licence Holder must ensure that the pre-construction (baseline) monitoring report is submitted to the Licensing Authority, for agreement with Cefas and Natural England **two months prior to the commencement of construction works.** Construction should not commence until the Licensing Authority has agreed the baseline monitoring report is fit for purpose in writing.
- Condition 9.31* The Licence Holder shall not commence construction until such time as a programme ("the Monitoring Programme") of sedimentary, benthic and other monitoring, as outlined in Annex 1 and Annex 2 attached to this Schedule, has been agreed in writing by the Licensing Authority. The full specification for the Monitoring Programme will be subject to separate written agreement with the Licensing Authority following consultation with Cefas, and Natural England at least four months prior to the proposed commencement of the construction works. The Monitoring Programme shall include a timetable for construction and post construction monitoring and an annual and interim reporting mechanism. Monitoring must be carried out at the same time each year for comparative purposes.
- Condition 9.32* The Licence Holder shall submit environmental monitoring reports to the Licensing Authority, Cefas and Natural England at the date specified in accordance with the Monitoring Programme and the schedule in accordance with condition 9.1 in order to allow the Licensing Authority to consider if any action may be required to mitigate or correct any adverse environmental effects which may be identified.
- Condition 9.33* The Licence Holder must carry out a pre-construction survey to determine the location and abundance of Annex 1 habitat in the vicinity of the array and cable route. Should Annex 1 habitat be identified in the

area of the proposed array the Licence Holder is required to undertake an assessment of the need to micro-site individual turbine structures, inter array cable or the export cable. If micro siting is required the Licence Holder must inform the Licensing Authority immediately. The results of the survey and assessment shall be submitted to the Licensing Authority and Natural England **within one month of the completion of the survey and no construction is to commence without the written agreement of the Licensing Authority.**

Condition 9.40 The Licence Holder must undertake two (one winter and one summer) high resolution swath-bathymetric surveys per annum (including a pre-construction baseline) of the wind farm intra-array and export cable route to assess the extent of any changes to bedform morphology. Should additional cable protection be required (e.g. rock armour) a separate application must be made for Food and Environment Protection Act/Coast Protection Act consents.

Annex 1 part 2 Prior to the commencement of any works the benthic ecology characterisation data must be reanalysed and reinterpreted to the satisfaction of the Licence Authority, in consultation with Cefas and Natural England, in order to provide a robust baseline dataset against which the benthic monitoring data can be measured.

Sample locations for ongoing monitoring must be determined by factors such as precise foundation locations, location of cables. Sample locations must also take full account of factors such as coastal process modelling outputs (for sediment transport/deposition information) and geophysical surveys (to ensure adequate coverage of sea bed habitats).

Sampling should involve a minimum of 3 replicates at each station and the number and location of stations should be determined making use of the data used to characterise the site as part of the Environmental Statement. This monitoring should include a suitable baseline data set and make adequate use of reference sites.

NB. The sediment transport/deposition information and benthic data sets must be closely related.

Appendix 2. Benthic Survey Methods

Benthic survey will be carried out following standard procedures e.g. Marine Monitoring Handbook procedural guideline 3-9, MALSF Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (Ware and Kenny, 2011) and other standard guidelines (Turnpenny *et al* 2010, DEFRA 2004a, Rees *et al* 1994, Proudfoot *et al* 2003, Cooper & Rees 2002, ICES/OSPAR 2000 & DEFRA 2004b). The survey will utilise a 0.1m² Hamon grab for sampling coarser marine sediments with an inspection of seabed habitats undertaken prior to sampling using an underwater stills/video camera. The stills/video camera will be used to document the presence of any Annex I habitats at the sample sites and may also characterise the benthic habitats in areas of harder ground where grab sampling is not feasible in addition to highlighting any underwater hazards. An assessment of live video footage & stills will be made in-situ to assess the potential for Annex I habitats which may include *Sabellaria* reef or stony/cobble reef following methods outlined in Section 2.2.

Following an assessment of the site by drop down stills camera the Hamon grab will be deployed at the planned survey location and the resulting sample recovered. To ensure adequate material is retained for analysis, sample volumes will be checked prior to the grab sample being accepted with the sediment sample measured by volume. Samples with a volume of less than 5 litres (or those with jaws not fully closed) will be discarded and a repeat sample taken. A minimum of five attempts will be made at each station to collect a valid sample before the station is abandoned or re-located. If samples are persistently less than 5 litres at a given site then expert judgement will be used to assess the adequate minimum representative sample of less than 5 litres. Following a successful grab then photographs of the sample will be taken and notes will be made.

A sample for Particle Size Analysis will also be taken with approximately 500 ml of sediment taken using a plastic scoop and the sediment sub-samples will then be labelled and refrigerated or transported in a cool box prior to PSA undertaken in the laboratory. The PSA sample analysis will also include an assessment of the percentage of the sample that is composed of cobbles. This can also be assessed by volumetric method following CEFAS guidelines or assessed on board the survey vessel. If required (e.g. for predominantly cobbly sediments) a larger PSA sample will be taken from a separate grab sample to allow cobble content to be quantified during PSA.

A full survey log will be maintained throughout the survey detailing time of sampling, DGPS position, number of attempts required, station number, water depth, physical characteristics of the sample, digital image number and presence of any other relevant features. Where the seabed sediments are difficult to adequately sample, a minimum of five attempts will be made to secure the required amount of material from a single grab and samples will **not** be aggregated to collect enough material. If required the stations may be repositioned slightly to obtain adequate and representative samples (e.g. if the original site was located on hard ground or if underwater hazards are in the immediate vicinity) but repositioning should be within 50m of the original position where possible.

Sample processing will be undertaken on a sequential basis utilising a nested sieving technique to reduce the potential for small and delicate invertebrates being damaged by

cobble and gravel. Each acceptable sample is removed from the Hamon grab and placed into a hopper and sieved onboard through a larger sieve (e.g. 5 or 10mm) and then through the appropriate final sieve (1mm sieve) in order to separate large sediment types and reduce damage to invertebrates. The sieved residues will be gently back-washed into sealable containers and borax buffered 4% formo-saline solution is added as a fixative. Each sample will be labelled clearly on the lid and an additional waterproof label placed in the container which will record client and survey name, date, area, station number and grab number.

4.5.1 Laboratory Methodology

All laboratory methodologies will be based on best practice and follow tried and tested method statements within the industry (Marine Monitoring Handbook procedural guideline 3-9; Ware and Kenny, 2011 and Worsfield et al 2010). Laboratory analysis should be undertaken by experienced marine biologists/taxonomists and members of the National Marine Biological and Analytical Quality Control scheme (NMBAQC). A standard sample tracking procedure should be followed throughout the analysis period.

Sorting

The sorting methodology should follow standard procedures as follows:

Each sample should be sieved in freshwater water and then rinsed with running tap water through a nest of 20cm diameter 5mm and 1mm stainless steel sieves with larger sieves used as appropriate to separate cobbles etc. The sieve contents will be backwashed over a white tray (to catch any potential spillage) into pre-labelled 5 litre plastic storage buckets or other suitable containers.

Each sample should then be re-washed through a through a nest of sieves, with the smallest mesh aperture of 1mm, to remove the preservative and partition the sample for ease of sorting. The residue from each sieve will then be gently washed into separate white trays. Water will be added to the trays and the contents agitated. Immediately after agitation, the light fraction is decanted to another tray. This procedure may be repeated up to 3 times, and each tray of light fraction will be examined separately to the heavy fraction.

The trays are marked with the appropriate sample code (relating to the client, date, specific site, sample and replicate no.). All fractions will then be examined as a monolayer under water in white trays, both by eye under a fluorescent bench light and 1.5x illuminated magnifier to remove larger animals with the remaining residue from the light and heavy fractions decanted into petri dishes for further sorting by binocular microscope stereo microscope (6x to 10x magnification). The fauna and residue derived from this process will be retained and stored by group in appropriately labelled containers. Each fraction will then be decanted into separate 100mm petri dishes and examined under a stereoscopic microscope with 20x eyepieces giving a maximum magnification of up to 80x. The fauna derived will be added to the retained containers, preserved and stored ready for identification. Each petri dish should be checked for a final time by another member of staff. In samples with large quantities of sieve residue (gravelly samples) then sorting should follow NMBAQC guidelines.

Taxonomic Identification

Identification should be carried out using binocular zoom microscopes with 10x and 20x eyepieces, giving a maximum magnification of up to 80x. An additional 2x objective may also be used to increase the potential magnification to 160x. Compound microscopes will be used as appropriate for further magnification, up to 800x.

Identification of infaunal samples will be to the lowest possible taxonomic level (i.e. species) and during identification, all individuals will be initially separated into families, with part animals being assigned to families where possible. The macrofaunal animals should be identified to species level using standard taxonomic keys, low and high power stereoscopic microscopes and dissection, when necessary, for identification. Incomplete animals without anterior ends are not recorded as individuals to be included in the quantitative dataset. However, they should be identified where possible and recorded as present. Similarly, colonial sessile epibenthic taxa and meiofauna should be recorded as present and not included within the infaunal quantitative data set.

Each sample residue should be described textually with the residue retained for possible further analysis and AQC. All fauna will be retained under the standard codes for 2 years or as agreed with E.ON for further analysis and AQC should this be required.

The taxonomic literature should include the most up to date taxonomic keys and other more recent taxonomic publications or workshop (NMBAQC) proceedings and reporting nomenclature will use the World Register of Marine Species (WoRMS) database (Appeltans, 2011) or Howson, C.M. & Picton, B.E., 1997 as required.

Biomass

Biomass analysis will be performed by wet weight (tissue blotted) and carried out either for each taxa or for the five major taxa types (polychaeta, crustacea, mollusca, echinodermata and others) in each sample following agreement with E.ON and statutory bodies. Each item to be weighed will be placed on blotting paper for a minimum of 30 seconds to allow absorption of preservative into the blotting paper after which the individuals are placed on the microbalance and the reading taken. Animals with shells are weighed with shells attached and for bivalves any fluid will be drained off prior to weighing whilst echinoids will be punctured and drained before weighing. The macrofaunal organisms should then be placed back in their respective pots and stored. Biomass calculations should include all identifiable fragments and calculated to $\pm 0.1\text{mg}$ and all biomass data will be recorded in grams or fractions thereof. An estimation of dry weight biomass will be made using available published conversion factors for the predominant taxonomic groups from Rumohr *et al* (1987).

Particle Size Analysis

Particle Size Analysis should be carried out as per NMBAQC guidelines and undertaken using a combination of dry sieving and laser granulometry methods as appropriate. Unless samples are processed immediately they should be frozen for longer term storage. Upon processing each of the sediment samples will be mixed thoroughly until homogeneity is

reached. A sub-sample should then be taken to split the coarse and fine fraction with sediments passed through a 500 micron or 1mm mesh sieve to remove the fine fraction which should then analysed by laser granulometry. The remainder of the homogenised sample should then dried for 48 hours at 8°C to remove all moisture and weighed. The sample will then be passed through a series of sieves at 0.5 phi fractions from 0 to -6.5 phi on a sieve shaker. Each sample should be sieved for a minimum of 10 minutes and material retained on each sieve fraction weighed.

The data generated from the analysis of both the coarse and the fine fractions can be combined to produce a complete particle size distribution for each sample for further analysis. When the full distribution has been constructed the sample should be assigned a description based on the Folk classification system (Folk, 1974) and/or the Wentworth classification system (Wentworth, 1922). Statistics relating to particle size distributions including mean/median grain size, skewness, kurtosis, sorting coefficient and bulk sediment classes (e.g. % silt, sand & gravel) should then be calculated and described following the formulae given in Dyer (1986) using appropriate software.