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VINEYARD WIND

Draft Construction and Operations Plan

Volume III Appendices

Vineyard Wind Project

October 22, 2018

Submitted by

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Submitted to

Bureau of Ocean Energy Management
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October 22, 2018

Appendix III-D

Benthic Habitat Monitoring Plan

Vineyard Wind Project

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Prepared for:

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BENTHIC HABITAT MONITORING PLAN

1.0 Introduction

Vineyard Wind LLC (Vineyard Wind) will implement a benthic monitoring plan to document the disturbance to and recovery of marine habitat and benthic communities as a result of construction and installation, (1) within the Inter-array Cable Corridors in the Wind Development Area (WDA); (2) next to Wind Turbine Generator (WTG) scour protection in the WDA; and, (3) in the Offshore Export Cable Corridor (OECC). A monitoring program focusing on seafloor habitat and benthic community will be undertaken to measure potential impacts and the recovery of these resources comparable to controls outside the areas of construction activity.

2.0 Program Schedule

A pre-construction baseline survey will be conducted in all monitoring and control sites prior to construction activities to identify and document the natural background conditions at each site, with increased attention on any hard bottom habitats that are in the direct path of the planned cable.

Post-construction monitoring surveys are planned for years one, three, and, five after completion of construction. These surveys will assess recovery progression of the various habitats that overlap the Project, species composition at monitoring sites, and presence of Sand Lance (*Ammodytes dubius* and *A. americanus*). Specifically, as outlined in McCann (2012), monitoring of the following parameters will be conducted:

- ◆ Changes to the seafloor morphology and structure;
- ◆ Changes in median grain size;
- ◆ Changes in abundance, diversity, and cover of species, with special focus on those that are ecologically or anthropogenically important;
- ◆ Reef effects in WDA; and
- ◆ Changes in the infaunal density, diversity, and community structure.

Following the year three monitoring survey, an assessment of recovery will be made such that if the benthos has largely returned to its original state, and presence of Sand Lance is consistent with control sites, the year five monitoring will not be conducted. A benthic ecologist will be contracted prior to initiation of the survey program to develop the metrics necessary to make this decision. Program updates will be shared with the appropriate federal and state agencies, throughout the monitoring study, in the form of processed reports. Monitoring reports will include:

- ◆ methods employed to conduct the monitoring study;
- ◆ summary of monitoring results;

- ◆ analysis and summary of habitat recovery; and,
- ◆ list of planned monitoring activities to be conducted at the next survey interval.

3.0 Site Locations and Survey/Sampling Configurations

Existing benthic grab samples collected in the WDA in 2016 and earlier, and along the OECC in 2017 and 2018, in addition to seabed information from the underwater video and sonar mappings (Figures 1, 2, and 3), will be used to help determine and position suitable monitoring sites along the final planned cable alignments. A total of ten monitoring sites, two sites from the five different bottom habitat types present in the WDA and OECC, will be sampled before and after construction for comparative analyses. Two sites of each habitat type will be chosen to ensure reliability in conclusions and increase statistical power of the data (Franco et al., 2015). Three control sites outside of, but near to, the project area and with comparable physical and environmental characteristics will also be sampled to monitor natural environmental shifts that occur unrelated to the project. The habitat monitoring sites and control sites will be monitored in accordance with Section 2.0 timelines.

Table 1 summarizes the five general habitat types and associated control sites that will be addressed by the monitoring plan. Monitoring Site #1 will be positioned at the edge of a WTG scour protection and will be designed to address the impact of that material's placement on adjacent benthic habitats in the WDA. Monitoring Sites #2 through #5 will cover locations along the Inter-array Cable Corridors and OECC, representative of the different benthic conditions that exist along the alignments. A control site for the mobile sand layer habitat is not believed necessary due to the high sediment turnover rate and rapidly changing seafloor which will make it difficult to generate comparable datasets. The sand wave areas have also been identified as the least productive habitat present. For more information on habitats and the classification thereof, refer to Section 5 and Appendix H of the Volume II-A report (CR Environmental, 2017; ESS Group, 2017; Normandeau, 2017).

To assess the presence of Sand Lance, ten sites will be selected in the project area for sampling. Sand Lance link lower and upper trophic levels in the food web and are an important food source for commercially important fish species such as Atlantic Cod (*Gadus morhua*), marine mammals such as the Humpback Whales (*Megaptera novaeangliae*), and sea birds such as the endangered Roseate Tern (*Sterna dougallii*) (Nelson and Ross 1991; MA DFW, 2015). Generally, Sand Lance are schooling, diurnal, semi-demersal foragers that burrow into sandy sediments at night for rest and predator evasion (Auster and Stewart, 1986). Previous research on other Sand Lance species indicates they associate with habitats containing sandy substrates with less than ten percent fine material and high bottom current velocities, which keeps interstitial substrate aerated (Reay 1970; Wright et al., 2000). Although trawls are not efficient at capturing Sand Lance, long-term trawl sampling data from the Massachusetts Division of Marine Fisheries (DMF) show a varied distribution through the project area with semi-consistent occurrence through Muskeget Channel and south of Martha's Vineyard and Nantucket (M. Staudinger, Massachusetts Department of Marine Fisheries [DMF] DOI Northeast Climate Adaptation Science Center, personal

communication). Sampling stations for this monitoring plan will be chosen using long-term trawl data from DMF, sediment samples and assessments from Vineyard Wind's 2017 and 2018 Marine Surveys seabed sampling, and consultation from regional experts.

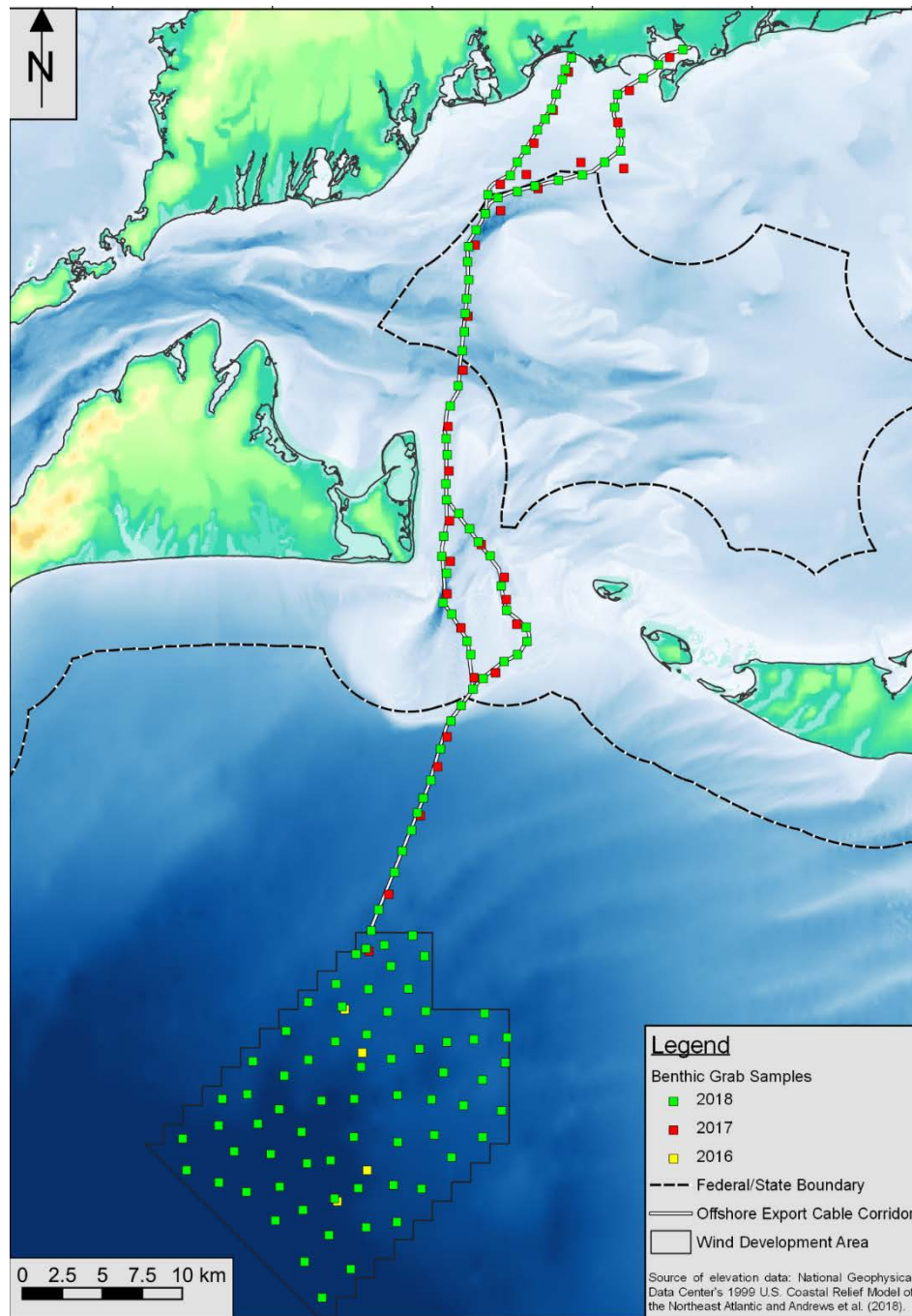


Figure 1. 2016 benthic grab samples collected in the WDA (yellow squares), 2017 benthic grab samples acquired in the OECC (red squares), and 2018 benthic grab samples acquired in the OECC and WDA.

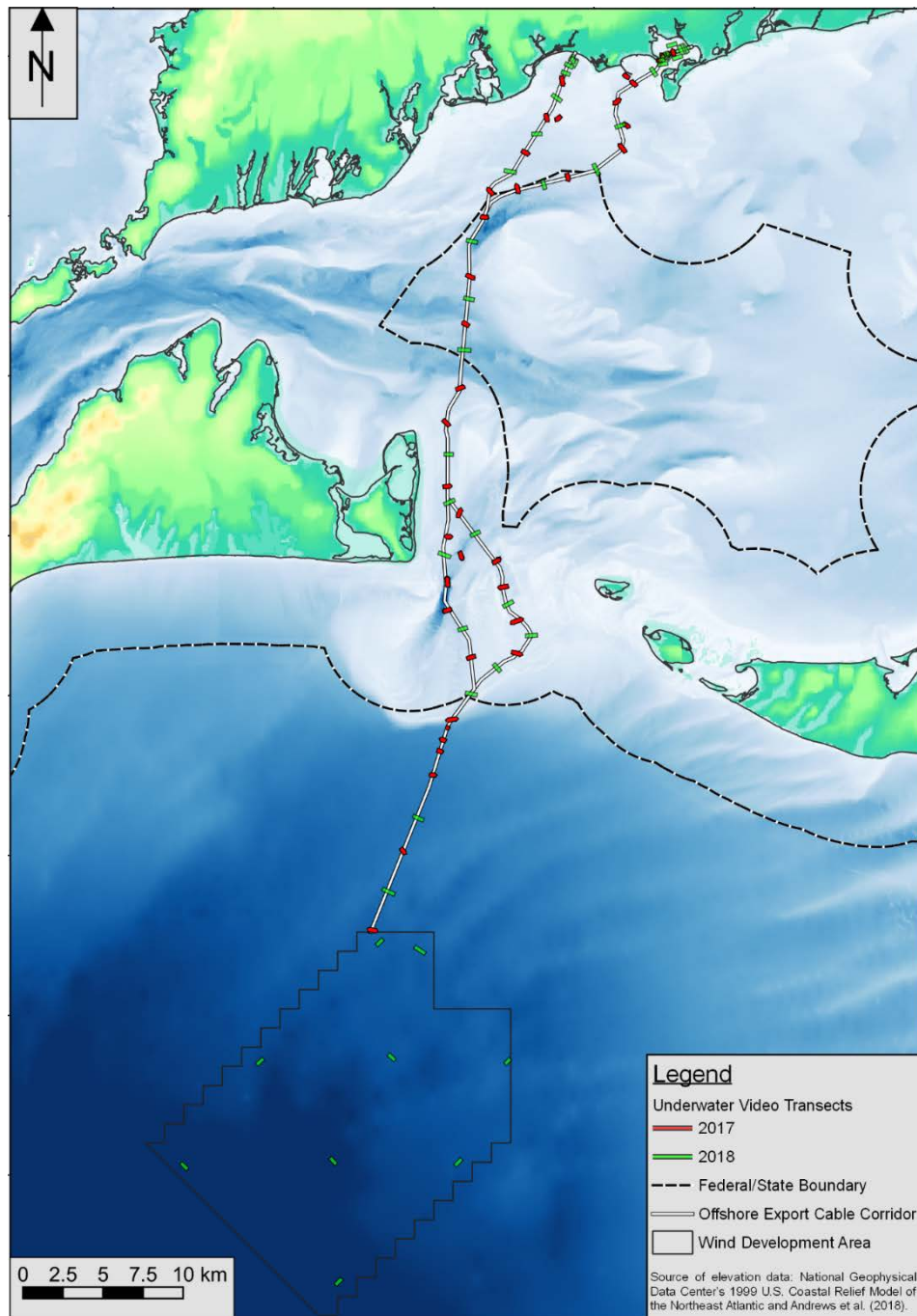


Figure 2. 2017 underwater video transects crossing the OECC (red rectangles) and 2018 underwater video transects collected in the OECC and WDA (green rectangles).

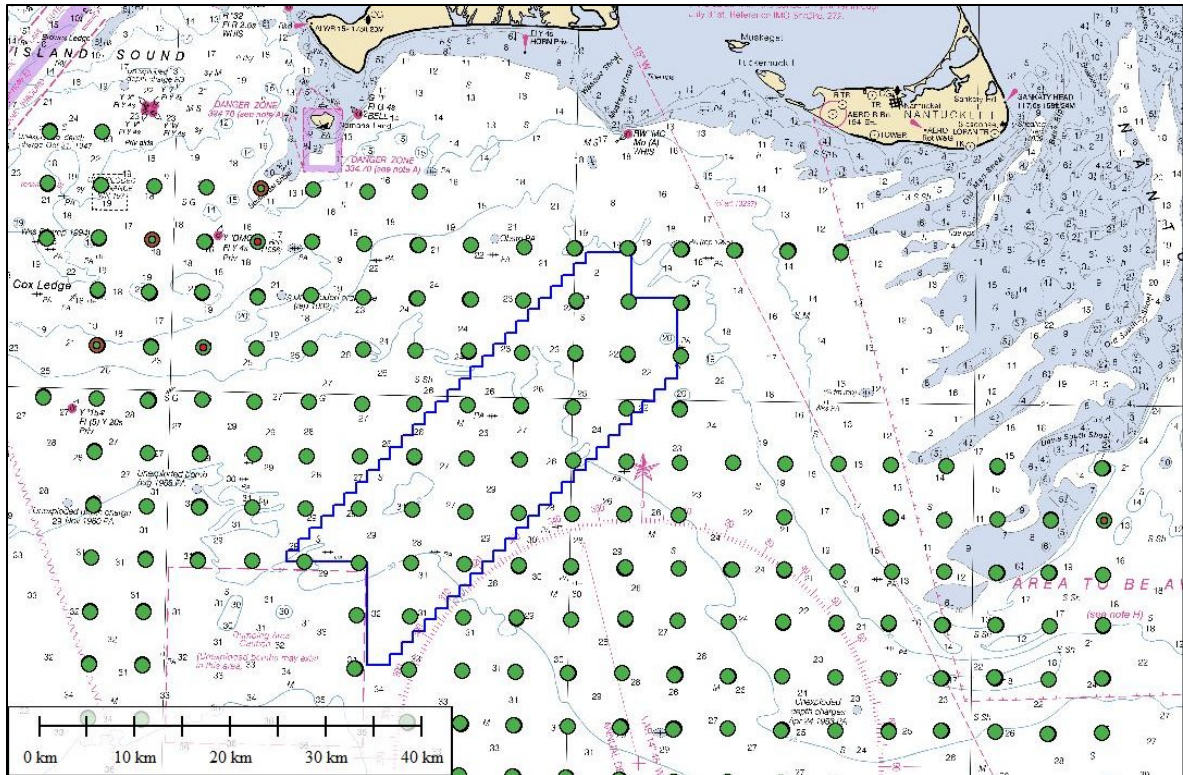


Figure 3. 2013 and 2014 benthic video survey locations conducted by SMAST for research studies in the Massachusetts Wind Energy Area (green dots).

Table 1 Summary of Five General Areas and Associated Control Sites that will be Addressed by the Monitoring Plan

Site #	Location	General Habitat
Monitoring Sites		
1	WTG location in the WDA (edge of scour protection)	Flat sand-mud habitat, deeper water offshore
2	Inter-array cable corridor in the WDA	Flat sand-mud habitat, deeper water offshore
3	Export cable corridor in Muskeget Channel area	Pebble-cobble with sponge, hard bottom habitat
4	Export cable corridor west or east of Horseshoe Shoal	Mobile sand layer habitat
5	Export cable corridor in shallower water approaching the Cape Cod landfall	Shell aggregate habitat
Control/Reference Sites		
6	Offshore, outside of WDA	Flat sand-mud habitat; this site can serve as control for the cables and WTGs in the offshore area
7	Along but at least 600m from OECC in Muskeget Channel area	Pebble-cobble with sponge (hard bottom) habitat
8	At least 600m from OECC along approach to Cape Cod landfall	Shell aggregate habitat

Figure 4 is a schematic of the proposed surveying and sampling strategy to be utilized for each successive mapping of the sites. Proposed individual site dimensions are 800 meters (m) in length by 100 m wide to ensure coverage of the area of impact. Multibeam depth sounding coverage will be obtained within each site boundary (light green shading in figure), continuous underwater video coverage will be recorded on four transects along and across the cable route (blue lines in figure), and a series of three benthic grab samples and/or sediment profile imaging (SPI) stations will be oriented along and across the as-built cable (red squares in figure) (McCann, 2012). This sampling and mapping configuration is designed to document the benthic variability in and around the zone of disturbance in each monitoring site.

For sampling directed at Sand Lance, 10 stations within the Project Area will be sampled with night time benthic grabs in order to sample fish during their nocturnal burial. Within each site, three replicate grabs within a 100m radius of the station position will be taken to ensure statistical power of data (Ware et al., 2010; McCann, 2012).

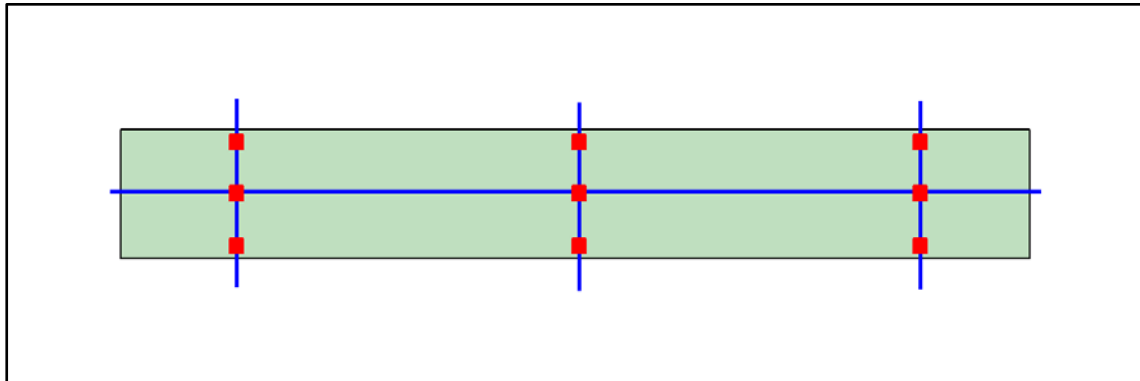


Figure 4. Schematic of survey and sampling layout in a monitoring site.

4.0 Monitoring Methodologies

Pre- and post-construction monitoring surveys will be conducted using the same gear and in the same locations to maximize comparability between the two. Table 2 summarizes the methods that may be integrated into the monitoring plan. Further details on these techniques are discussed in the following sections.

It is important to note that the type and quantity of monitoring may vary slightly dependent upon the substrate present and oceanographic conditions in each of the sites. A decision on survey/sampling methodologies and program design will be finalized with the benthic ecologist prior to the start of the program.

Table 2 **Summary of Methods Proposed for the Benthic Habitat Monitoring Plan**

Monitoring System	Focus Area	Purpose
Grab sampler and/or SPI camera	Surface and Subsurface; epifaunal, infaunal organisms, Sand Lance, and structures	Identify surface and subsurface organisms and features. Provides specific organism-level evidence concerning habitat recovery.
Multibeam depth sounder	Surface; seafloor morphology	Pre- and post- changes in bottom morphology and micro-relief, changes in the seabed scar over time. Data can show the detailed topographic differences in the seafloor between successive mappings.
Underwater video	Surface; benthic habitats, epifaunal organisms	Identify gross habitat changes pre- and post- as well as during the recovery process. Documents epifaunal activity for comparison between mappings.

4.1 *Benthic Grab Sampling and Analysis*

An industry standard benthic/sediment grab sampler (e.g., Van Veen, Day, Ponar) will be employed to retrieve sediments from the seabed for analysis. These sampling devices recover material from the seabed by using lever arms to force two halves of a metal bucket closed after the unit has been lowered to the bottom. Material from the upper 10 to 20 centimeters (cm) of the seabed is then raised to the deck of the vessel for photographs and subsampling.

Two or more subsamples of the same specified volume (to the extent possible) will be removed from the grab for sieving and lab analysis. Subsample volumes will be documented in a field logsheet along with other sediment and benthic descriptors. This information supports estimates of species abundance values and ensures all data and results are comparable. For Sand Lance-specific sampling grabs, the entire sample volume will be processed.

After the grab samples are collected, they will be processed onboard, passed through a 0.5-mm sieve and fixed in ten percent neutral buffered formalin. Rose bengal can be added in the field or in the lab. Once delivered to the lab and prior to being sorted, the sample material will be emptied in its entirety into a 0.5-millimeters (mm) mesh sieve. Tap water will then be gently run over the sieve to rinse away the formalin fixative and any additional fine sediment that is not removed during the initial sieving process. Rinsed samples will be preserved in 70% ethanol. Each sample will then be sorted to remove benthic organisms from residual debris.

Samples will be sorted in their entirety under a high-power dissecting microscope (up to 90X magnification). All sorted organisms will then be identified by a qualified taxonomist to the lowest practicable taxonomic level using a dissecting microscope with magnification up to 90X and readily available taxonomic keys. Identification of slide-mounted organisms will be conducted under a compound microscope with magnification up to 1,000X. Enumerations

of macroinvertebrates will be made and species abundances from each sample will be standardized to number of individuals per square meter, considering the sampling equipment dimensions and sub-sampling effort.

To describe existing conditions and compare pre- and post- construction conditions, measures of benthic macrofaunal diversity, abundance, and community composition will be made for each sampling site. Changes in community structure will be determined using multidimensional scaling plots to compare pre-and post-construction species compositions. Results can be presented as tabular data and plots annually in order to track recovery status and progress.

4.2 *Sediment Profile Imaging Acquisition and Processing*

A SPI camera is another option for obtaining detailed information on the benthos to support the planned monitoring program. The profile camera is a high resolution digital camera mounted vertically on top of a prism and aimed straight down at a mirror that is oriented at a 45° angle to the clear face plate. The system acts like an upside-down periscope and takes photographs as the prism penetrates to take cross sectional images of the sediment-water interface and upper 20-30 cm of the seabed. The sediment is simply pushed aside slightly during the prism penetration. The system is mounted on a sturdy metal frame to which a second plan view camera is attached for acquiring still images of the surface prior to the profile imaging.

The digital images are then processed and analyzed to assess the physical and biological condition of the benthos. Repeated measurements at the same stations over a period of time allow comparison of the benthic environmental quality.

Some of the information that can be obtained from this method include:

- ◆ Major sediment grain sizes and range;
- ◆ General sediment compaction and consolidation based on prism penetration;
- ◆ Sediment-water interface boundary roughness, morphology;
- ◆ Presence of epifauna and other biological features;
- ◆ Depth to the apparent RPD (Redox Potential Discontinuity);
- ◆ Degree of bioturbation, presence of infaunal organisms;
- ◆ Presence of subsurface structures;
- ◆ Calculation of the Organism-Sediment Index; and,
- ◆ Determination of infaunal successional stage.

If the SPI is used, a suite of images, analysis results, and reports would be developed for each station during each monitoring period. Data comparisons will be performed between different stations for each monitoring program as well as a direct comparison of each post-construction monitoring survey to the pre-construction background conditions.

The SPI method provides additional and slightly different seabed information than the standard lab analysis of benthic samples from sediment grabs. It could be used effectively to monitor benthic disturbance gradients within each monitoring event and between successive monitoring programs to assess the recovery of the benthos over the long term from the installation of linear transmission cables or pipelines.

4.3 *High Resolution Multibeam Depth Sounding and Video Survey*

Vineyard Wind will conduct high resolution multibeam depth sounding and video surveillance within the designated monitoring sites. Seabed surface mapping to centimeter level resolution will be done using a multibeam depth sounding system to allow detailed comparisons of bottom morphology and detection of minute changes between successive mappings. An underwater camera system or remotely operated vehicle (ROV) will be utilized to record continuous video imagery along pre-planned transects. A USBL (ultra-short baseline system) underwater acoustic positioning tracking system will be used to accurately position the camera/ROV on the seabed.

Pre- and post-construction video and digital terrain maps will be analyzed and compared to track changes in seabed morphology within the monitoring sites. A marine biologist/benthic specialist with past experience conducting this analysis will review these data, and at a minimum the following observations will be made:

- ◆ Presence and general characterization of the substrate (three dimensional features and regularity);
- ◆ Presence and general characterization of epibenthic invertebrates (e.g., lobster and crabs);
- ◆ Presence and general characteristics of shellfish (e.g., clams, scallops);
- ◆ Changes in invasive species coverage;
- ◆ Evidence of burrowing activity;
- ◆ Presence and general characterization of benthic and nektonic habitats observed; and,
- ◆ Location and changes in surface features.

Results will be documented in the form of high resolution digital terrain model (DTM) surfaces of the seabed and difference maps between mappings. Still images of the video footage will be captured of discrete objects or obvious changes in the substrate. Findings will be summarized in a technical report with a supporting series of charts/figures for each monitoring program documenting results from all survey methodologies performed and comparisons with previous surveys.

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