OCS Study
BOEM 2018-029

Field Observations During Wind Turbine Foundation Installation at the Block Island Wind Farm, Rhode Island

Appendix E3: Seafloor Monitoring Survey 3 Report

US Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

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May 2018

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FUGRO

Seafloor Disturbance and Recovery Monitoring Program
Survey 3 May 2017
Block Island Wind Farm, USA

Fugro Job No.: 04.81150001
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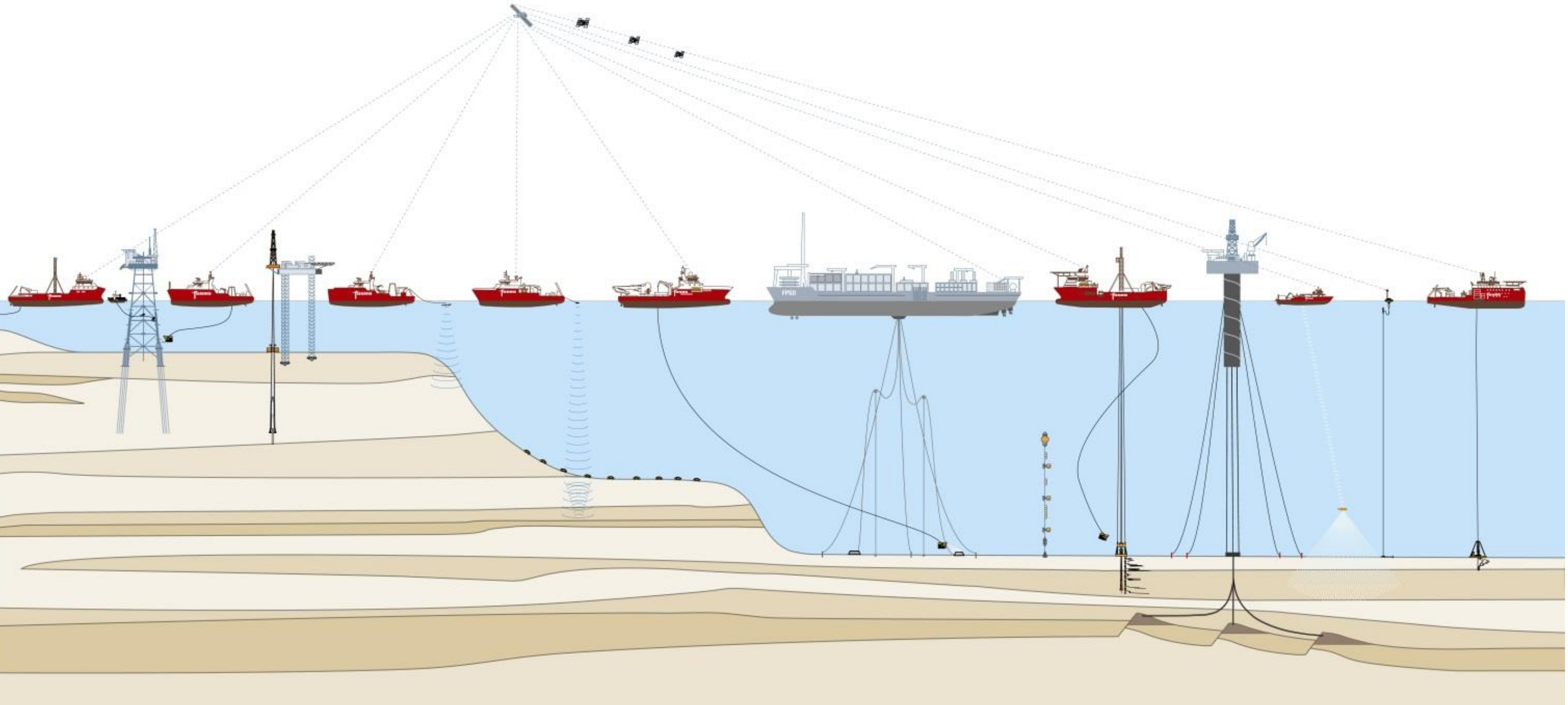

Seafloor Disturbance and Recovery Monitoring Program Survey 3 May 2017

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APPENDICES

1. INTRODUCTION

1.1 Real-Time Opportunity for Development Environmental Observations (RODEO) Program

The United States (U.S.) Department of Interior's Bureau of Ocean Energy Management (BOEM) is responsible for managing the exploration and development of the nation's offshore energy resources. The BOEM conducts environmental reviews, including National Environmental Policy Act (NEPA) analyses, for each major stage (leasing, site assessment, construction, operations, and decommissioning) of proposed offshore energy development projects. Through these reviews and analyses, the BOEM evaluates potential environmental impacts from the proposed offshore activities on the human, coastal, and marine environments. The NEPA analysis is used to inform the decision-making process for whether and/or how to proceed with the approval of the offshore energy development.

To conduct the required analyses and effectively analyze the potential environmental impacts under NEPA, the BOEM requires data on impact-producing factors (stressors) and their effects on ecosystems and individual receptors. Development of offshore wind energy is new to the U.S.; therefore, data necessary for assessment of environmental impacts are not readily available. Thus, the BOEM has initiated the Real-Time Opportunity for Development Environmental Observations (RODEO) Program. The purpose of this program is to make direct, real-time measurements of the nature, intensity, and duration of potential stressors during the construction and/or initial operations of selected offshore wind facilities.

Data collected under the RODEO Program may be used as input to analyses or models that are employed to evaluate effects or impacts from future offshore activities. The first facility to be part of the RODEO Program monitoring is the Block Island Wind Farm (BIWF) Project, which is located off the coast of Rhode Island.

1.2 Seafloor Disturbance and Recovery Monitoring

The seafloor can be disturbed by various activities during the construction and operational phases of a wind farm development. During construction and/or maintenance, vessel anchoring activities and spud can penetrations may result in depressions in the seafloor. In addition, while a lift boat is positioned on site, scour can develop around the legs that penetrate the seafloor. Evidence of those impacts on the environment can disappear as sediment is reworked and transported due to natural processes after construction equipment is removed from the seafloor. The recovery rate from a seafloor disturbance primarily depends on sediment type, bottom current flow conditions (e.g. speed, duration, direction, etc.), and size of the disturbance feature.

This study utilizes repeated bathymetric surveys for use as a multi-temporal analysis tool to monitor for disturbance and recovery of the seafloor.

1.3 Block Island Wind Farm

Deepwater Wind (DW) recently constructed the BIWF, which is located approximately five kilometers (km) southeast of Block Island, Rhode Island. The BIWF is comprised of five wind turbine generators with a name-plate capacity of 30 megawatts (MW). Figure 1 presents the location of the BIWF and survey area. The BIWF was constructed during two construction seasons.

1.3.1 2015 Construction Season

During 2015, DW installed foundations for the five wind turbine generators (WTGs). The lift boats used to install the WTG foundations were the L/B *Robert*, L/B *Lacie Eymard*, and the L/B *Michael Eymard*. The foundations installed are four-legged jackets that used 1524-millimeter (60-inch) diameter piles. Appendix D provides typical construction drawings of the foundations. Construction activities occurred from late spring 2015 through December 2015.

1.3.2 2016 Construction Season

Construction activities during the 2016 season included installing the towers, nacelles, blades, inter-array cable, export cable, and finishing works on the foundations. Towers, nacelles, and blades were installed using Fred Oslen's L/B *Brave Tern.* Foundation works were performed during May and June 2016. Cabling was installed during June and July using a jet trenching technique. The L/B *Brave Tern* installed the towers, blades and nacelles during July and August. Final cable pulls into the turbines, concrete mats and ancillary works were performed in September. Concrete mattresses were placed where the cable installation did not reach the desired burial depths. In areas near the WTGs, the cable was intentionally left unburied until the final cable pull into the turbine was performed. After the pull, concrete mats were placed on the short section of exposed cable on the seafloor near each turbine. Appendix D provides typical construction drawings that depict the various cable and turbine installation details and methods.

1.4 Purpose and Scope

The Seafloor Disturbance and Recovery Monitoring Study is using periodic bathymetric surveys to identify seafloor disturbance features and monitor seafloor recovery from the disturbances. The survey extent encompassed the area denoted by DW as the "Work Area." The Work Area was the primary area where construction vessels were positioned during construction. Table 1.1 provides a summary of the various construction activities and bathymetric surveys conducted as part of the monitoring program.

Table 1.1: Summary of Construction Activities and Surveys

Time	Activity
Construction Season 1 Late Spring through December 2015	Installation of Jacket Foundations
May 11 and 12, 2016	Survey 1 (Construction Season 1 Baseline Survey)
Construction Season 2 May through September 2016	▪ Installation of tower, nacelles, and blades ▪ Installation of inter-array and export cables ▪ Ancillary foundation works
October 2 to 5, 2016	Survey 2 (Construction Season 2 Baseline Survey)
May 18 and 19, 2017	Survey 3 (current report)

This report presents the findings of the third bathymetric survey conducted by Fugro at the BIWF during May 18 and 19, 2017. The multibeam data from previous bathymetry surveys of the area (conducted by Fugro on May 11 and 12, 2016 and October 2 to 5, 2016) were compared to the May 2017 data to evaluate seafloor recovery from disturbances created during the 2015 and 2016 Construction Seasons.

1.5 Authorization

Authorization for this work was provided by HDR Master Service Agreement No. MSA2015-1165, under task order TO 003, 0000023102, between HDR and Fugro, dated July 24, 2015.

2. DATA COLLECTION, PROCESSING, AND INTERPRETATION METHODS

2.1 Survey Overviews

During May 18 and 19, 2017, Fugro conducted the third hydrographic survey (Survey 3) of the Work Area surrounding the five Block Island wind turbines. Figure 1 and 2a and Chart 1 show the extent of the hydrographic survey. Survey 3 encompassed the same area that was surveyed during Survey 1 on May 11 and 12, 2016 and Survey 2 on October 2 to 5, 2016. All hydrographic surveys were conducted using a pole-mounted multibeam echosounder aboard a small research vessel. A detailed description of the survey vessel, instrument offsets, calibration tests, data acquisition and processing methods are provided in Appendix A of this report. Table 1.1 provides a summary of the surveys and phases of construction.

2.2 Hydrographic Surveys

The Construction Season 1 (2015) baseline survey was conducted in May 2016 and the results from that survey were provided in the Survey 1 report. Survey 1 was conducted using the chartered vessel R/V *Jamie Hanna.* The R/V *Jamie Hanna* is a 55-foot long purpose-built survey vessel. Surveys 2 and 3 were conducted using the chartered vessel R/V *Westerly*. The R/V *Westerly* is a 50-feet long purpose-built, catamaran style survey vessel (Appendix A, Figure A-3). Surveys 2 and 3 were conducted in October 2016 and May 2017, respectively. Survey 2 represents the Construction Season 2 baseline survey. This report describes the data acquisition, processing and evaluation of the data from Survey 3.

The survey vessels were equipped with a pole-mount for the echosounder transducers. All the hydrographic surveys were conducted at speeds ranging from four to seven knots using a Reson SeaBat 7125 ultra-high resolution multibeam echosounder (designed to operate in water depths ranging from 0.5 meters to 300 meters). Reson states the vertical resolution of this instrument to be six millimeters; however, the nominal vertical resolution of post-processed data is likely to be closer to 10 centimeters (depending on sea state, tidal error, seafloor gradient, sounding position along track, and other factors).

Multibeam data from the surveys were collected in WinFrog software and were visually monitored during the survey for quality assurance. The WinFrog *.s7k files were then brought into CARIS for bathymetric processing. Subsequently, corrections for vessel offsets, patch test calibration, and static draft measurements were input into the software. Sound Velocity Profiles (SVPs) were then used to correct the bathymetric data for sound refraction or ray bending.

After each line was examined and cleaned in CARIS' Swath Editor, the tide corrections were loaded and the lines were merged. The merged dataset was then examined to identify tidal discrepancies, sound velocity errors, motion errors, and data gaps. Once all processing was completed, a digital terrain model (DTM) was generated with CARIS at a 0.5 meter bin size. The ASCII XYZ grid file of easting, northing, and depth values in meters was then output from CARIS for interpretation.

All data from all the surveys were projected in metric measurement (meters) with the Universal Transverse Mercator (UTM) Zone 19 North coordinate system, using the World Geographic System of 1984 (WGS84) geodetic datum. The real-time navigation and position data were used as the geodetic control, receiving differential global navigation satellite system (GNSS) corrections via a G2 subscription to Fugro's OmniStar service. All real-time positioning data were converted to WGS84 (g1150) using an Applanix POS MV positioning system. This real-time positioning was used to process the multibeam survey lines. Horizontal positioning error at the vessel's common reference point (CRP) is estimated to be less than one meter (during optimal conditions).

Bathymetric data from all the surveys were reduced to mean lower low water (MLLW) based on the National Oceanic and Atmospheric Administration (NOAA) VDatum model (http://vdatum.noaa.gov). This model provides separation values from the GNSS ellipsoid down to the chart datum of MLLW for the survey area. These values were then applied to the bathymetry using the CARIS HIPS Compute GPS Tide routine.

2.2.1 Data Variability and Repeatability

Samples of water depth values from a selected area within the BIWF that was interpreted to undergo no significant seafloor change between the three surveys were used to establish a baseline degree of variability between the three surveys. The elevation difference between the surveys was obtained by extracting data within the analysis area and then subtracting values on a bin node-by-node basis. The results are summarized in Table 2.1.

Table 2.1: Comparison of Elevation Measurements

Statistic	May 2016 / May 2017 Comparison	Oct. 2016 / May 2017 Comparison
Analysis area size (square meters)	11,640	11,640
Minimum Difference (meters)	-0.12	-0.06
Maximum Difference (meters)	0.03	0.13
Mean Difference (meters)	-0.04	0.02
Standard Deviation (meters)	±0.02	±0.02

An average systematic bias of -0.04 and 0.02 meters was observed in the sample set that can likely be attributed to tidal error, subtle boat draft discrepancies, and normal limitations associated with multibeam head calibration. Significant systematic bias can also be attributed to survey line direction. In addition, some components of random variability are evident in the sample set and are likely due to sea state, horizontal positioning uncertainty, and other factors. If the assumption of no bathymetric change for the benchmark area is valid, the standard deviation (±0.02 meters) reflects the uncertainty of vertical difference calculated for the three surveys and can be used to help identify areas likely to be of significant seafloor change across the BIWF study area. Seafloor difference values greater than two standard deviations (±0.04 meters) are interpreted to represent bathymetric change that is likely (at the 95% confidence interval) to be significant with respect to the data limitations of the surveys.

2.3 Data Quality

Sea states during the May 2016 survey were relatively calm, resulting in good raw data quality. Minimal data processing was required to generate bathymetric deliverables that were relatively free of motion artifacts and other surface noise. Sea states during the October 2016 were fair to marginal. Quality of the raw data collected during the October 2016 survey was reported to be affected by the marginal sea states and motion artifacts were noted on the outer portions of the bathymetric swath. Post-acquisition data processing resulted in final deliverables of good quality; however, some motion related artifacts are still observable in the final DTM but they data are deemed adequate for meeting the study's objectives. Data quality for the raw data collected for the May 2017 survey was reported to be affected by some motion in the moonpool at the time of the survey; however, the overall data quality was good and post-acquisition data processing resulted in final deliverables of good quality.

3. MULTI-TEMPORAL ANALYSIS OF SEAFLOOR CHANGE

This study is performing a multi-temporal analysis to identify seafloor disturbances related to wind farm construction activities and monitor the recovery from those seafloor disturbances. High-resolution bathymetric data acquired during periodic surveys are being analyzed to evaluate the seafloor changes.

The BIWF was constructed during two separate construction seasons (Construction Season 1 in 2015 and Construction Season 2 in 2016, respectively). The “Work Area,” as designated by DW, was the primary area where construction vessels were positioned during construction. The bathymetric surveys encompass the Work Area delineated as the Survey Area displayed in Figure 1. This report describes the results from the third survey which evaluates the recovery from disturbances created during Construction Season 1 (2015) and Construction Season 2 (2016).

3.1 Seafloor Disturbance Features

Multibeam bathymetry data acquired during the survey were processed, rendered and evaluated to identify seafloor disturbance features inferred to be related to construction activities. Processed multibeam data were interpolated to create a DTM with a 0.5-meter bin size as described in Section 2.2. Sun-illuminated, hillshaded-relief renderings of the seafloor DTM were also created to enhance seafloor features and aid in visually identifying seafloor disturbances. Interpreted seafloor disturbance features are classified based on the following:

- Spud: Circular or rectangular depressions arranged in a pattern that match one of the lift boats and are generally located near a WTG. Likely created when a lift boat was on position during installation of the turbine.
- Circular Depression: Circular depression not associated with a geometric pattern that would have been created when a lift boat was on position and had all 3 or 4 legs deployed. Circular depression was generally located away from WTG position and may be related to a spud depression or anchor drop.
- Drag Mark: Elongated or linear disturbance feature likely created from the dragging of a spud leg or anchor.
- Scour: Scour feature that formed around the leg of the jacket foundation or around the concrete mat cable protection.

Figure 2b and Chart 2 presents the locations and classifications of the seafloor disturbance features from Construction Season 1 (2015) and Construction Season 2 (2016) that were still visible in Survey 3 (May 2017). Figures 3 through 7 present a series of maps focused on each turbine area. The information presented on each respective series includes:

- “a” series (Figures 3a, 4a, …) - Bathymetric contours,
- “b” series (Figures 3b, 4b, …) - Interpreted disturbance features symbolized based on type of feature, and
- “c” series (Figures 3c, 4c, …) - Interpreted disturbance features symbolized based on the associated Construction Season. Figures also include the baseline footprint of each feature.

This report presents the results from the third survey. Surveys 1 and 2 represent the baseline surveys for Construction Seasons 1 and 2, respectively. Table 3.1 provides a summary of the seafloor disturbances that were interpreted from the respective baseline surveys.

We are not aware of any construction or maintenance activities that occurred on site in between Surveys 2 and 3. However, Survey 3 revealed new features inferred to be scour that developed near WTG 1 and 2 (Figure 2b and Charts 2). Twelve scour-related features were identified that comprise an area of approximately 844 m^2 (Chart 3 and Table C-2).

3.1.1 Wind Turbine Generator 1

Wind Turbine Generator 1 (WTG 1) is located in the northeastern-most section of the study area and is associated with several well-resolved seafloor disturbances. The surficial sediment around WTG 1 is coarse- to medium-grained sand with fine gravel and contains patches of rippled sand and gravel. Figures 3a, 3b, 3c, and Chart 2 present the local bathymetry and interpreted seafloor disturbances that have occurred around WTG 1. Seafloor disturbances that were created during Construction Season 1 and those that were created during Construction Season 2 are differentiated in Figure 3c. Construction Season 1 and 2 feature extents are outlined from Surveys 1 to 3 (if possible) to aid in discerning if changes in their size or position has occurred (Figure 3c).

<u>Post-Construction Features</u>: Several new scour features (F263 through F268 labeled in Chart 3) have formed since the completion of the Construction Season 2 activities. These scour features formed on either side of the concrete mats that were placed on top of the inter-array cable to provide protection of the section of cable that was intentionally not buried when initially installed. The depth of scour ranges from 5 to 20 centimeters and extends up to approximately 3 meters from the concrete mats. Scour development appears to be more extensive in both depth and size on the northwest side of cable, possibly indicating a dominant flow direction of bottom currents.

3.1.2 Wind Turbine Generator 2

Wind Turbine Generator 2 (WTG 2) is located in the northeastern section of the study area and is associated with several seafloor disturbances. The surficial sediment surrounding WTG 2 is similar to WTG 1, and is composed of mixed coarse- to medium-grained sand with fine gravel and contains alternating patches of rippled sand and gravel in the vicinity. Figures 4a, 4b, 4c, and Chart 2 present the local bathymetry and interpreted seafloor disturbances that have occurred around WTG 2. Seafloor disturbances that were created during Construction Season 1 and those that were created during Construction Season 2 are differentiated in Figure 4c. Construction Season 1 and 2 feature extents are outlined from Surveys 1 to 3 (if possible) to aid in discerning if changes in their size or position has occurred (Figure 4c).

<u>Post-Construction Features</u>: Several new scour features (F270 through F274 labeled in Chart 3) have developed since the completion of Construction Season 2 activities. These scour features formed on either side of the concrete mats which were placed on top of the inter-array cable where it had not been buried to provide protection. The depth of the scour ranges from approximately 5 to 20 centimeters and extends up to approximately 3 meters from the concrete mats. Scour development appears to be more extensive in both depth and size on the northwest side of cable, possibly indicating a dominant flow direction of bottom currents.

3.1.3 Wind Turbine Generator 3

Wind Turbine Generator 3 (WTG 3) is located in the central section of the study area, in a slightly deeper channelized area of the seafloor with wave ripples becoming more dominant. The surficial sediment surrounding WTG 3 is predominantly medium-grained sand with a minor component of fine gravel. Figures 5a, 5b, 5c, and Chart 2 display the local bathymetry and the interpreted seafloor disturbances that have occurred around WTG 3. Seafloor disturbances that were created during Construction Season 1 and those that were created during Construction Season 2 are differentiated in Figure 5c. Construction Season 1 and 2 feature extents are outlined from Surveys 1 to 3 (if possible) to aid in discerning if changes in their size or position has occurred (Figure 5c).

Post Construction Features: No new seafloor disturbance features were identified in Survey 3 data.

3.1.4 Wind Turbine Generator 4

Wind Turbine Generator 4 (WTG 4) is located in the southwestern section of the study area. The surficial sediment surround WTG 4 is a coarse sand and contains alternating patches (ridges/furrows) of sand and gravel, with wave ripples of up to 10 centimeters being apparent. Figures 6a, 6b, 6c, and Chart 2 display the local bathymetry and the interpreted seafloor disturbances that have occurred around WTG 4. Seafloor disturbances that were created during Construction Season 1 and those that were created during Construction Season 2 are differentiated in Figure 6c. Construction Season 1 and 2 feature extents are outlined from Surveys No. 1 to 3 (if possible) to aid in discerning if changes in their size or position has occurred (Figure 6c).

Post Construction Features: No new seafloor disturbance features were identified in Survey 3 data.

3.1.5 Wind Turbine Generator 5

Wind Turbine Generator 5 (WTG 5) is located in the southwestern-most section of the study area. The surficial sediment surrounding WTG 5 is predominantly medium sand. Figures 7a, 7b, 7c, and Chart 2 display the local bathymetry and the interpreted seafloor disturbances that have occurred around WTG 5. Seafloor disturbances that were created during Construction Season 1 and those that were created during Construction Season 2 are differentiated in Figure 7c. Construction Season 1 and 2 feature extents are outlined from Surveys No. 1 to 3 (if possible) to aid in discerning if changes in their size or position has occurred (Figure 7c).

Post Construction Features: No new seafloor disturbance features were identified in Survey 3 data.

3.1.6 Seafloor Disturbance Elsewhere in the Work Area

We did not identify new disturbance features outside the wind turbine generator areas described in Sections 3.1.1 through 3.1.4.

3.2 Seafloor Disturbance Recovery

The rate of recovery from the initial disturbance back to a natural seafloor is dependent on a variety of factors. Some of the main influences on seafloor recovery are bottom current speeds, surficial sediment type, and the influence of large storm events (which can drastically alter the normal flow conditions at a site). Seafloor features identified in the May 11 and 12, 2016 bathymetric survey and subsequently in the October 2 through 5, 2016 survey represent baseline conditions from Construction Season 1 (2015) and Construction Season 2 (2016), respectively.

The third survey data were also compared to the first and second survey data to evaluate what changes (e.g. recovery), if any, had occurred to seafloor disturbance features created during the two construction seasons. Figures 3c, 4c, 5c, 6c, and 7c symbolize the features based on the construction season they were created. Also, the baseline footprints are shown as light gray (Construction Season 1) and dark gray (Construction Season 2) outlines on the Survey 3 renderings in Figures 3c, 4c, 5c, 6c, and 7c to compare how those features changed between surveys. Figure 8 displays a time series from Survey 1 (May 2016) to Survey 3 (May 2017) for each WTG location to depict seafloor changes observed during the surveys. Each WTG location is discussed in further detail below in Section 3.2 of this report.

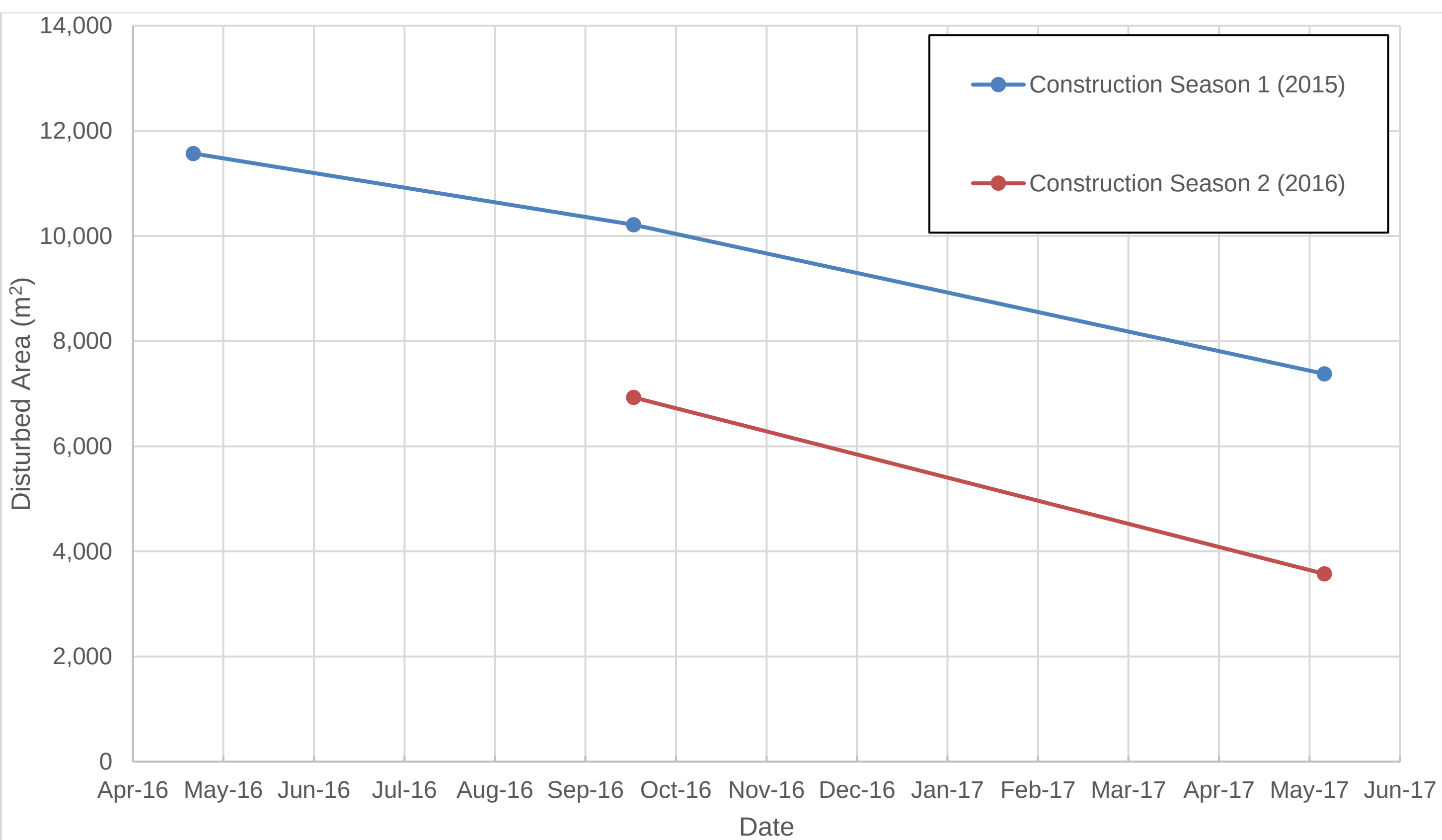
Construction Season 1 and 2 baseline surveys identified 160 and 103 disturbance features, respectively (Charts 4 and 5). Survey 3 data indicate that 75 and 60 of Construction Seasons 1 and 2 features, respectively have completely healed. Observations of Survey 3 data suggest all construction disturbance features appear to be undergoing either infilling and/or decrease in size albeit at varying rates. Figures 3c, 4c, 5c, 6c, and 7c and Chart 6 present the baseline footprints of the disturbance features (Construction Season 1 outlined in light gray and Construction Season 2 outlined in dark gray) and their extents as observed in Survey 3.

Table C-1 (Appendix C) lists the features that were originally catalogued from Survey 1 and 2 and the observed relative changes (e.g. some change, mostly healed, etc.) that were interpreted to have occurred between October 2016 and May 2017. Table 3.1 presents a summary of the observed recovery from Construction Season 1 and 2 disturbances.

Table 3.1: Summary of Seafloor Recovery

	Construction Season Baseline Disturbance						Construction Season 1 (2015) Disturbances						Construction Season 2 (2016) Disturbances			2015 and 2016 Disturbances Recovery	
	Construction Season 1 (2015) Features		Construction Season 2 (2016) Features		Construction Seasons 1 and 2 Total		Recovery Since Baseline at Time of Survey 2 (Oct. 2016)			Recovery Since Baseline at Time of Survey 3 (May 2017)			Recovery Since Baseline at Time of Survey 3 (May 2017)				
Interpreted Features	Number of Features	Area (m^2)	Number of Features	Area (m^2)	Number of Features	Area (m^2)	Partially Healed Features	Completely Healed Features	Completely Healed Area (m^2)	Partially Healed Features	Completely Healed Features	Completely Healed Area (m^2)	Partially Healed Features	Completely Healed Features	Completely Healed Area (m^2)	Completely Healed Area (m^2)	Percent Disturbed Area Completely Healed
Spud	26	1,102	37	4,152	63	5,254	19	0	0 (0%)	8	18	663 (60%)	25	12	830 (20%)	1,493	28%
Circular Depressions	69	2,803	51	1,595	120	4,398	0	3	58 (2%)	31	38	1,454 (52%)	8	43	1,298 (81%)	2,752	63%
Drag Marks	44	6,414	13	1,129	57	7,543	1	12	1,300 (20%)	25	19	2,077 (32%)	1	12	1,061 (94%)	3,138	42%
Total	160	11,570	103	6,928	263	18,498	20	15	1,358 (13%)	64	75	4,194 (36%)	34	68	3,189 (46%)	7,383	40%

Note: Features were categorized as partially healed if the disturbance feature had lessened in size or depth but still remained discernible. A feature was labelled as completely healed if the feature was no longer discernible in the data set. Scour features were not included in these statistics since they are likely to be present as longs as the structures (e.g. foundations) are present.



Inset graph (left) presents a summary of the disturbed seafloor area interpreted from each survey.

3.2.1 Wind Turbine Generator 1

Construction Season 1 Features: Twelve of the 21 seafloor disturbances (F77, F96, F98-F101, F103-F104, and F106-F109) that were originally cataloged in the baseline survey for Construction Season 1 (Survey 1—May 2016) appear to have completely healed and are not discernable in the May 2017 (Survey 3) survey data (Figure 3c and Table C-1). Five seafloor disturbance features (F82, F92, F95, F97 and F105) seem to have diminished in depth associated with sediment infilling (up to 8 centimeters). The remaining four (F122–F125) of the 21 seafloor disturbances features created during Construction Season 1 displayed no significant change in the Survey 3 (May 2017) bathymetric data.

Construction Season 2 Features: Thirty-three of the 48 seafloor disturbance features (F198-F200, F202-F208, F218, F222-F230, F233-234, F238-F243, F254-F256, and F260-F261) that were originally cataloged in the baseline survey for Construction Season 2 (Survey 2—Oct. 2016) appear to have completely healed and are no longer discernable in the May 2017 (Survey 3) survey data (Figure 3c and Table C-1). The remaining fifteen seafloor disturbances (F160-F163, F201, F217, F219-F221, F231-F232, F235-F237, and F262) that are still discernable around WTG 1 that occurred during Construction Season 2 all experienced change associated with sediment infilling. The most prominent of these features which remain visible, are the four spud depressions associated with the L/B *Brave Tern* (F160-F163). Although the area of these features has approximately remained the same (approximately 150 square meters), they have all undergone infilling ranging from 0.1 to 0.4 meters (Figures 3b and 3c and Table C-1). The remaining features appear to have experienced sediment infilling of approximately three to 6 centimeters.

3.2.2 Wind Turbine Generator 2

Construction Season 1 Features: Four of the 10 seafloor disturbances (Features F112 and F114-F116) that were originally identified in the Construction Season 1 baseline survey (Survey 1—May 2016) appear to have completely healed and are no longer discernable in the May 2017 (Survey 3) survey data (Figure 4c and Table C-1). Two of the seafloor disturbance features (F102 and F111) seem to have undergone shallowing associated with sediment infilling by approximately three centimeters and feature F110 appears to have widened in extent to the northwest by about 1.5 meters. The remaining three features (F113 and F126-F127) associated with Construction Season 1 experienced little to no change.

Construction Season 2 Features: Seven of the 16 seafloor disturbance features (F185-190, and F214) that were identified in the Construction Season 2 baseline survey (Survey 2—Oct. 2016) appear to have completely healed and are no longer discernable in the May 2017 (Survey 3) survey data (Figure 4c and Table C-1). The remaining nine seafloor disturbance features (F102, F111, F164-F167, and F209-F213) all seem to have experienced some degree of change associated with sediment infilling. The most notable of these features which underwent change, were the spud depressions associated with the L/B *Brave Tern* (F164-F167). Although all four of these spud depressions experienced sediment infilling (ranging from 0.35 to 0.70 meters), the two depressions to the southeast (F164 and F165) infilled up to 35 percent more than their northwestern counterparts (F166 and F167) (Figure 9). A possible explanation for this observation is that features F164 and F165 appear to be on the edge of an actively reworking sand ripple field as well as a slightly deeper channelized area, which would facilitate their more rapid infilling rate. This differential sediment infilling rate is most evident by feature F165 being the only spud depression from the L/B *Brave Tern* which appears to be almost completely healed (Figure 4b and Figure 9). A more detailed discussion about sediment mobility and recovery is presented in Section 3.2 of this report.

3.2.3 Wind Turbine Generator 3

Construction Season 1 Features: The four of the original eight seafloor disturbance features (F89, F94, and F128-129) which remained visible in the October 2016 survey data (Survey 2) and were originally identified from the Construction Season 1 baseline survey (Survey 1—May 2016) displayed no significant change in the May 2017 bathymetry data.

Construction Season 2 Features: The four spud depressions (Features F168-F171) that were identified from the Construction Season 2 baseline survey (Survey 2—Oct. 2016) and associated with the L/B *Brave Tern* all appear to have undergone change associated with sediment infilling, with one (F170) appearing to be completely healed in the May 2017 (Survey 3) survey data (Figures 5b, 5c and Table C-1). The remaining three spud depressions infilled on average by approximately one meter.

3.2.4 Wind Turbine Generator 4

Construction Season 1 Features: Four of the original nine seafloor disturbance features (F78, and F117-119) which remained visible in the October 2016 survey data (Survey 2) and were originally identified from the Construction Season 1 baseline survey (Survey 1—May 2016) appear to have completely healed and are no longer discernable in the May 2017 (Survey 3) survey data (Figures 6b, 6c and Table C-1). The remaining five seafloor disturbance features (F81, F120-F121, and F130-F131) associated with Construction Season 1 experienced little to no change.

Construction Season 2 Features: Six of the 10 seafloor disturbance features (F246-F251) that were identified in the Construction Season 2 baseline survey (Survey 2—Oct. 2016) appear to have completely healed and are no longer discernable in the May 2017 (Survey 3) survey data (Figure 6c and Table C-1). The remaining four features (F172-F175) which were created during Construction Season 2 activities and are still discernable in the May 2017 survey data, are the four spud depressions attributed to the L/B *Brave Tern* (Figure 6b and 10). Although all four spud depressions can still be identified, the two depressions to the southwest (F174-F175) have infilled by approximately twice as much sediment than the two to the northeast (F172-F173) (Figure 6b, 10, and 11). This difference in sediment infill could be because the spud depressions to the southwest (F174 and F175) are located in an actively migrating sand ripple field, and this migration of bedforms and sediments produced a more rapid infill rate.

3.2.5 Wind Turbine Generator 5

Construction Season 1 Features: None of the disturbances (F132–F135) that existed in this area prior to the May 2016 survey displayed significant change in the May 2017 bathymetry data (Table C-1).

Construction Season 2 Features: All four of the seafloor disturbance features (F176-F179) that were identified in the Construction Season 2 baseline survey (Survey 2—Oct. 2016) appear to have completely healed and are no longer discernable in the May 2017 (Survey 3) survey data (Figures 7b, 7c, and Table C-1).

3.2.6 Recovery from Seafloor Disturbance Elsewhere in the Work Area

Construction Season 1 Features: Based on our review of the Survey 3 data, all of the disturbances associated with Construction Season 1 activities showed some change as a result of sediment infilling. In addition, approximately forty-five percent of the seafloor disturbance features attributed to Construction Season 1 activities and located outside the immediate vicinity of the WTG's appear to have been completely healed.

Construction Season 2 Features: Based on our review of the Survey 3 data, all of the disturbances associated with Construction Season 2 activities showed some change as a result of sediment infilling. In addition, approximately eighty-seven percent of the seafloor disturbance features attributed to Construction Season 2 activities and located outside the immediate vicinity of the WTG's appear to have been completely healed.

3.2.7 Surficial Sediment Mobility

Seafloor recovery rates are anticipated to vary across the scale of a wind farm. Recovery primarily occurs as bottom currents (1) transport sediments that infill the disturbance features or (2) cause bedforms to organize and shift or migrate. Sediment transport of sediments by bottom currents or shifting/migration of bedforms is dependent upon bottom current speeds, flow direction and duration, and seafloor sediment type. Variation in those parameters will cause sediment mobility, and ultimately the seafloor recovery rates to vary.

The bathymetric data reveal bedforms of varying type, size, and orientation. Bedform type (e.g. ripple or dune) and size are dependent on the bottom current speed, flow direction(s), and sediment type. Stow et al. (2009) and Ashley (1990) have developed interrelationships between sediment type, current speeds, and bedforms. Furthermore, Van Rijn (1993) and Allen (1982) present relationships between bedforms, mobility, and sedimentary environments.

Through comparison of the surveys, we identify areas where bedforms have changed. By delineating areas with common bedforms and monitoring the changes in bedforms using the surveys, we will develop an understanding of how sediment mobility and the seafloor recovery will vary across this site. The periodic bathymetric surveys are being used to refine this understanding and final report will be prepared that summarizes our assessment of seafloor recovery rates at this site. The following section describes our interim evaluation of sediment mobility in the study area.

3.2.7.1 Observed Changes in Bedforms

The survey data reveal bedforms of varying size (both dune and ripple scale) and orientation. Observations from Surveys 1, 2, and 3 also indicate that the orientations and locations of individual bedforms and the extents of ripple and dune fields have changed between surveys. Areas where the bedforms appear to have changed more notably have been associated with areas where seafloor disturbances have undergone a higher sediment infill rate and thus appear to be healing more quickly.

In the region around WTG 2 and between WTG 3 and 4, dune-scale bedforms that did not appear to migrate between Surveys 1 and 2 (May and October 2016) now appear to have shifted to the northwest by 2.5 to 6 meters when comparing Survey 1 (May 2016) and 3 (May 2017) (Figure 12).

Several large ripple fields were again observed to either change in spatial extent or the ripples changed in orientation (Figure 13). Orientations of ripples in a large ripple field located between WTG 3 and 5 was observed to change between Surveys 1 and 2 (May and October 2016). During Survey 1 ripple crestlines were primarily east-west oriented but during Survey 2 they were primarily northeast-southwest oriented. It was also noted that the ripples were approximately 10 cm tall in Survey 1 but were only about 5 cm tall in Survey 2. Comparing Survey 2 to Survey 3, it was observed that these ripple fields had shifted back to their original east-west orientation and approximate height, as observed in Survey 1. This change back in orientation and height, seems to reflect seasonal differences since both Survey 1 and 3 were conducted at the end of winter and Survey 2 was completed at the end of summer. This seasonal change seems to facilitate a more rapid recovery of seafloor disturbance features located in this area of change.

3.2.7.2 Zonation based on Morphology

We categorize the survey area into zones based bedform morphology and changes inferred from data collected during Surveys 1, 2 and 3. Our observations of the survey data indicate that bedforms shift at the site at varying rates and extents of bedform zones (e.g. ripple fields) appear to change over time. We have also inferred the sediment type (e.g. grain size) based on information provided in DW project reports. The interpretive boundaries have been updated for this report (based on the May 2017 survey data). Figure 13 illustrates the three different zones and two subzones; in addition, they are summarized below:

- Zone 1: High mobility sand ridges or shoal features that are approximately 0.5 meters in relief (compared to the surrounding lows of Zone 2). Interpreted to be comprised of fine sand. These sand ridge or shoal type features were seen to slightly shift between the May 2016 (Survey 1) and May 2017 (Survey 3) bathymetric data sets.
    - Zone 1a: Slightly higher mobility sand dune features located within Zone 1 that are approximately 1.0 meter in relief (compared to the surrounding lows of Zone 2). These sand dune features are interpreted to be composed of fine sand. Shifting of up to 6 meters was noticed between the May 2016 and May 2017 Surveys (Figure 12).
- Zone 2: Moderate mobility areas which are interpreted to be comprised of medium to coarse sand-size particles. These areas were identified in all three surveys; however due to the fact that they are relatively featureless, the boundaries were difficult to notice change.
    - Zone 2a: Wave ripple fields which are moderately mobile and are comprised of medium to coarse sand particles. These wave ripple fields can be seen in all three surveys. Changes in extent and orientation were noticed within this zone.
- Zone 3: Low Mobility glacial moraine area which is interpreted to include mainly coarse gravel and cobbles. This glacial moraine area is seen in all three datasets and was not observed to shift between the any of the three surveys.

4. SUMMARY

The Seafloor Disturbance and Recovery Monitoring Program is using periodic multibeam bathymetric surveys to identify disturbances of the seafloor that resulted from wind farm construction activities. The periodic surveys are also being used to monitor recovery from those disturbances. The monitoring surveys are encompassing the area denoted by DW as the "Work Area." The Work Area is the region where construction vessels were authorized to anchor or set spuds during construction.

The Block Island Wind Farm was constructed during two construction seasons. The jacket foundations were installed during Construction Season 1 which occurred in 2015 and ended in mid-December. Survey 1 was conducted in May 2016 and represents the baseline survey for Construction Season 1 disturbance monitoring. The survey activities and results from that survey were provided in our Survey 1 Report.

During Construction Season 2, which occurred in 2016, towers, nacelles, blades, inter-array cables, and export cables were installed. Also during 2016, concrete mats were placed on cable sections that were intentionally left unburied near the turbines to allow the cables to be pulled into the turbine. Survey 2 was conducted at the end of Construction Season 2 in October 2016 and represents the baseline survey for Construction Season 2 disturbance monitoring. The survey activities and results from that survey were provided in our Survey 2 Report.

After completion of all construction activities, Survey 3 was conducted in May of 2017 to provide updated observations of the seafloor disturbance features which were created and identified during the two construction seasons, as well as identify any new features, like scour, which could have formed. This report describes Survey 3 and the results from the survey. After completion of the monitoring program, a final report will be prepared that provides a summary of the full program.

Construction Season 1 (2015) created 160 disturbance features that comprise an area of approximately 11,570 m^2. Survey 3 (May 2017) revealed that 64 of those features had partially healed and 75 have completely healed. The completely healed features comprise an area of 4,194 m^2 which indicates approximately 36 percent of the disturbed area has completely healed. Sixty of the 75 features that have completely healed were in or adjacent to areas comprised predominantly of fine-grained sand. The other fifteen features were in areas comprised of predominantly medium- to coarse-grained sand.

Construction Season 2 (2016) created 103 disturbance features that comprise an area of approximately 6,928 m^2. Survey 3 (May 2017) revealed that 34 of those 103 disturbance features had partially healed and 68 had completely healed. The completely healed features comprise an area of 3,189 m^2 which indicates that approximately 46 percent of the disturbed area has completely healed. Fifty-six of the 68 features that have completely healed were in or adjacent to areas comprised predominantly of fine-grained sand. The other thirteen features were in areas comprised of predominantly medium- to coarse-grained sand.

Survey 3 identified 12 new scour features that developed around the concrete mats placed to protect the cable at the turbine entry points. Cable sections near the wind turbines were intentionally left unburied until the cables were pulled into the wind turbines. After the cable pulls, concrete mats were placed on the unburied sections of cables for protection. This scour development was only observed on WTG 1 and 2. These features comprise an area of approximately 844 m^2. Scour appears to be notably deeper and wider on the northwestern side of the mats which potentially indicates there was a dominate bottom current flow direction.

We compared Surveys 1, 2, and 3 data and identified changes in seafloor bedforms that indicate the seafloor was active during the time between surveys. Ripple fields changed in spatial extent and ripples also changed in orientation and size between Surveys 1 and 2 and then again between Surveys 2 and 3. Ripples were two times taller in Survey 1 and 3 (conducted at the end of winter) than observed in Survey 2 (conducted at the end of summer). This report provides additional details and discussion of how and where bedforms have changed.

This report provides an interim assessment of the seabed mobility at the site and how it varies across the site. Seafloor recovery rates are anticipated to correspond to seabed mobility. Seafloor mobility within the survey area was classified into three zones (Zones 1, 2 and 3) and two subzones (Zones 1a and 2a) based on bedform shifts observed in the 2012 and May 2016 bathymetry surveys and further refined based on observations between the May and October 2016 surveys and then with the May 2017 Survey. Seafloor mobility is highest within Zone 1, moderate in Zone 2, and low in Zone 3. In general, zones of higher seafloor mobility correlate with higher sediment infill/seafloor disturbance recovery rates. Geophysical evidence exists that indicates seafloor disturbances will recover more rapidly (up to five centimeters per month) over areas of higher water column energy, shallower bathymetry, smaller particle size, faster current speeds, and/or higher sediment mobility. Therefore, seafloor disturbances within Zone 1 are likely to recover faster than those observed in Zones 2 or 3. Of the one-hundred and forty-four disturbance features noted to have completely "healed", 116 were located in or immediately adjacent to Zone 1.

Future monitoring survey will be used to refine this assessment and the final report will provide the summary or our assessment.

5. REFERENCES

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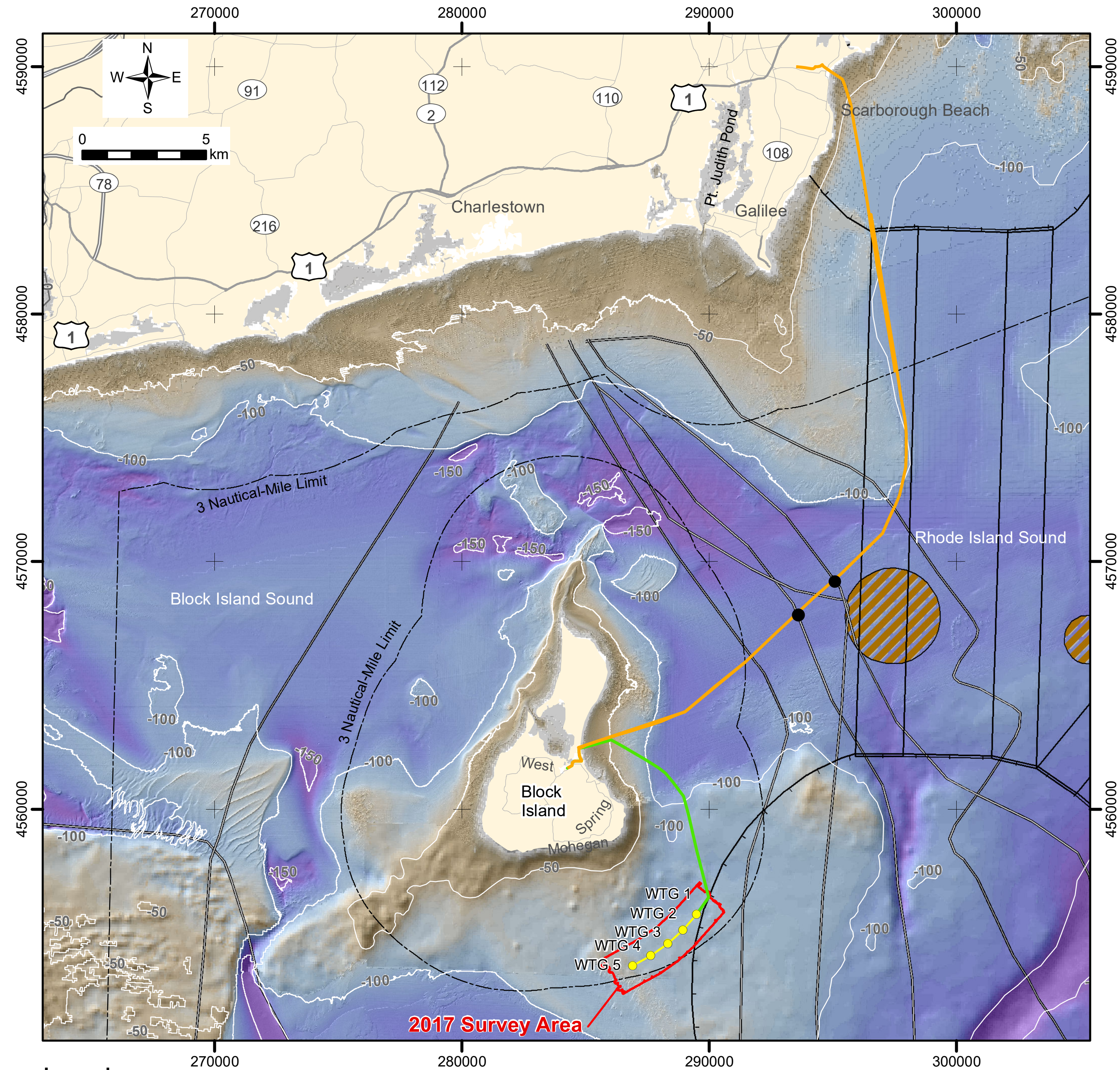
FIGURES



Legend

Block Island Wind Farm
- Turbine
- Active Cable Crossing
- BITS Alternative 1
- Export Cable
- Inter Array Cable

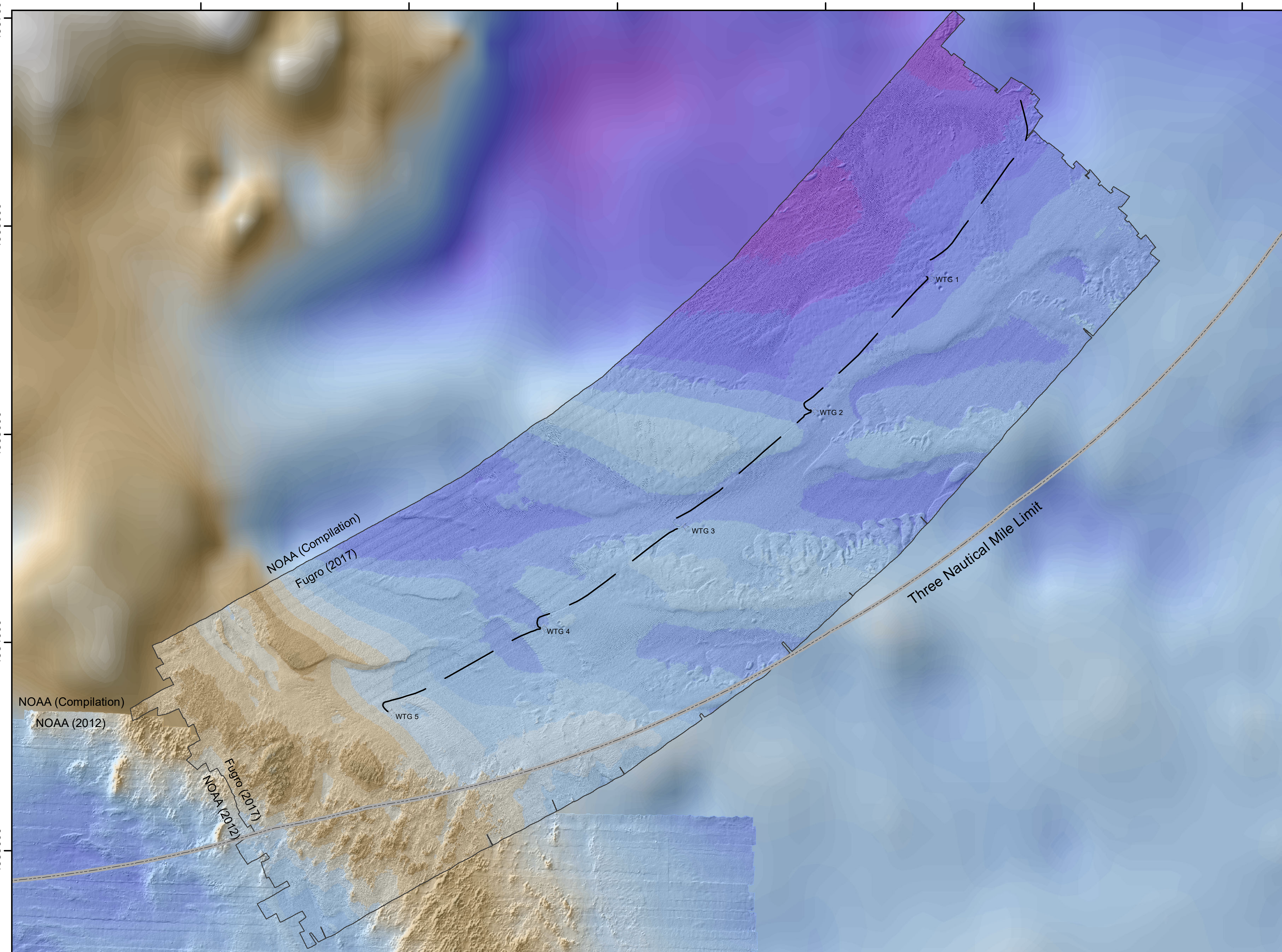
Bathymetry (MLLW, ft)
Source: compiled NOAA survey data
- Contour interval is 50 ft.
- High : 0
- Low : -220

Base Map
- Submarine Cable
- 3 Nautical Mile State Limit
- Precautionary Area
- Traffic Separation Scheme Lane
- Dumping Ground Area
- + Coordinate Grid: UTM Zone 19N, NAD83, Meters

STUDY AREA
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 1

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_3\MXD\Fig-1_Study_Area.mxd, 5/26/2017, greenwoodm



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Legend

Export Cable/Inter Array Cable

Three Nautical Mile State Limit

Bathymetry (Meter, MLLW)

- Lower than -30
- -29 to -30
- -28 to -29
- -27 to -28
- -26 to -27
- -25 to -26
- -24 to -25
- -23 to -24
- -22 to -23
- -21 to -22
- -20 to -21
- -19 to -20
- -18 to -19
- -17 to -18
- -16 to -17

Notes:

1. Fugro 2017 multibeam bathymetry was collected on May 18 and 19, 2017.

2. NOAA (2012) multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

3. Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

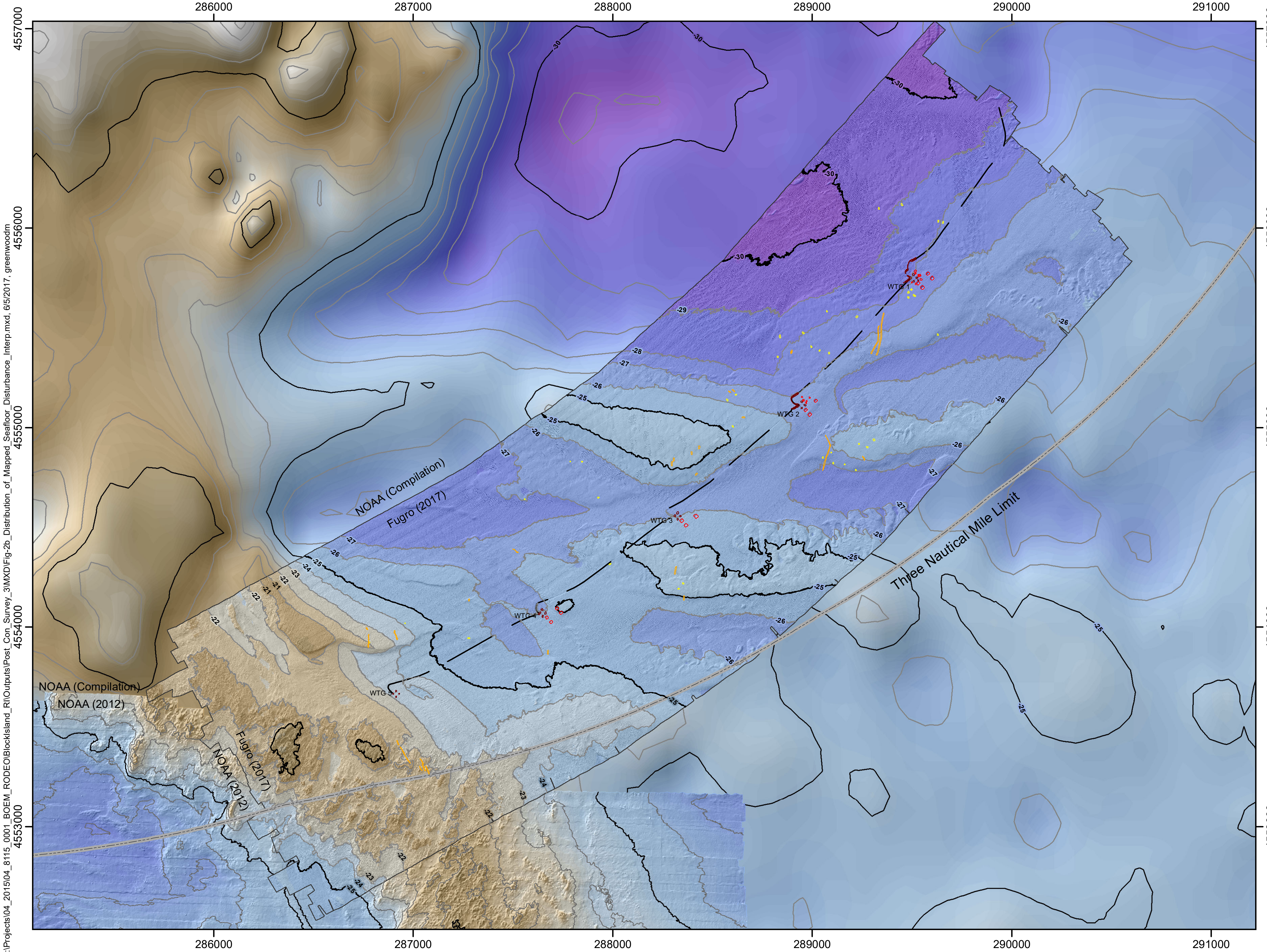
N
W E
S

0 200 400 800
Meters

Coordinate System: UTM 19N, NAD83, Meter

FUGRO 2017 BATHYMETRY
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 2a



Legend

Export Cable/Inter Array Cable

Three Nautical Mile State Limit

Bathymetry (Meter, MLLW)

Lower than -30
-29 to -30
-28 to -29
-27 to -28
-26 to -27
-25 to -26
-24 to -25
-23 to -24
-22 to -23
-21 to -22
-20 to -21
-19 to -20
-18 to -19
-17 to -18
-16 to -17

Contour interval is 5 meters.
Contour interval is 1 meter.

Interpreted Seafloor Disturbance Features

Spud Location
Scour
Linear Feature (Possible Drag Mark)
Circular Depression

Notes:

1. Fugro 2017 multibeam bathymetry was collected on May 18 and 19, 2017.

2. NOAA (2012) multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

3. Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

N W E S

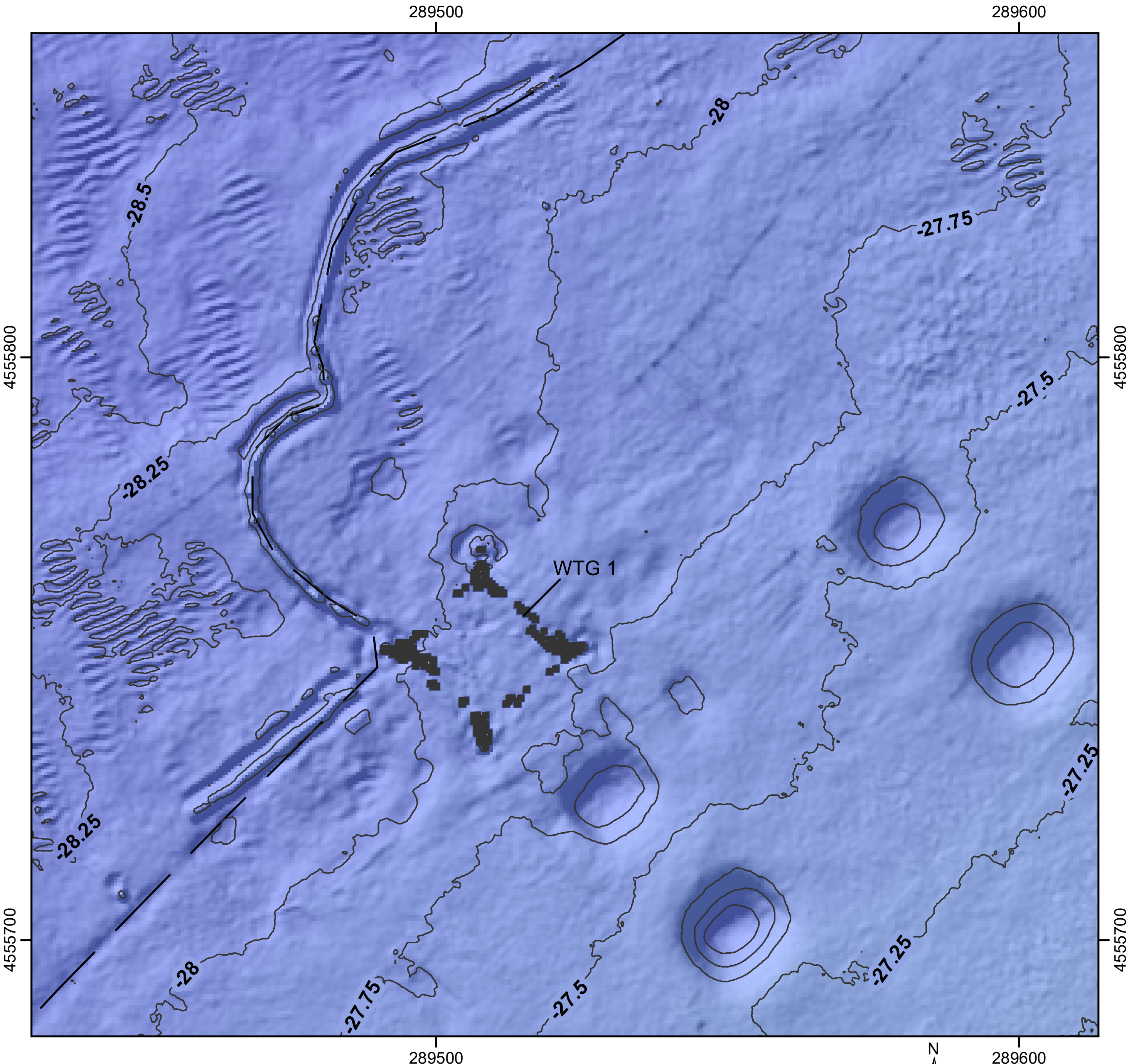
0 200 400 800 Meters

Coordinate System: UTM 19N, NAD83, Meter

INTERPRETED SEAFLOOR DISTURBANCE FEATURES
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 2b

BOEM
Project No. 04.81150001



Legend

Export Cable/Inter Array Cable

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Contour interval is 0.25 meters

N
W E
S

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

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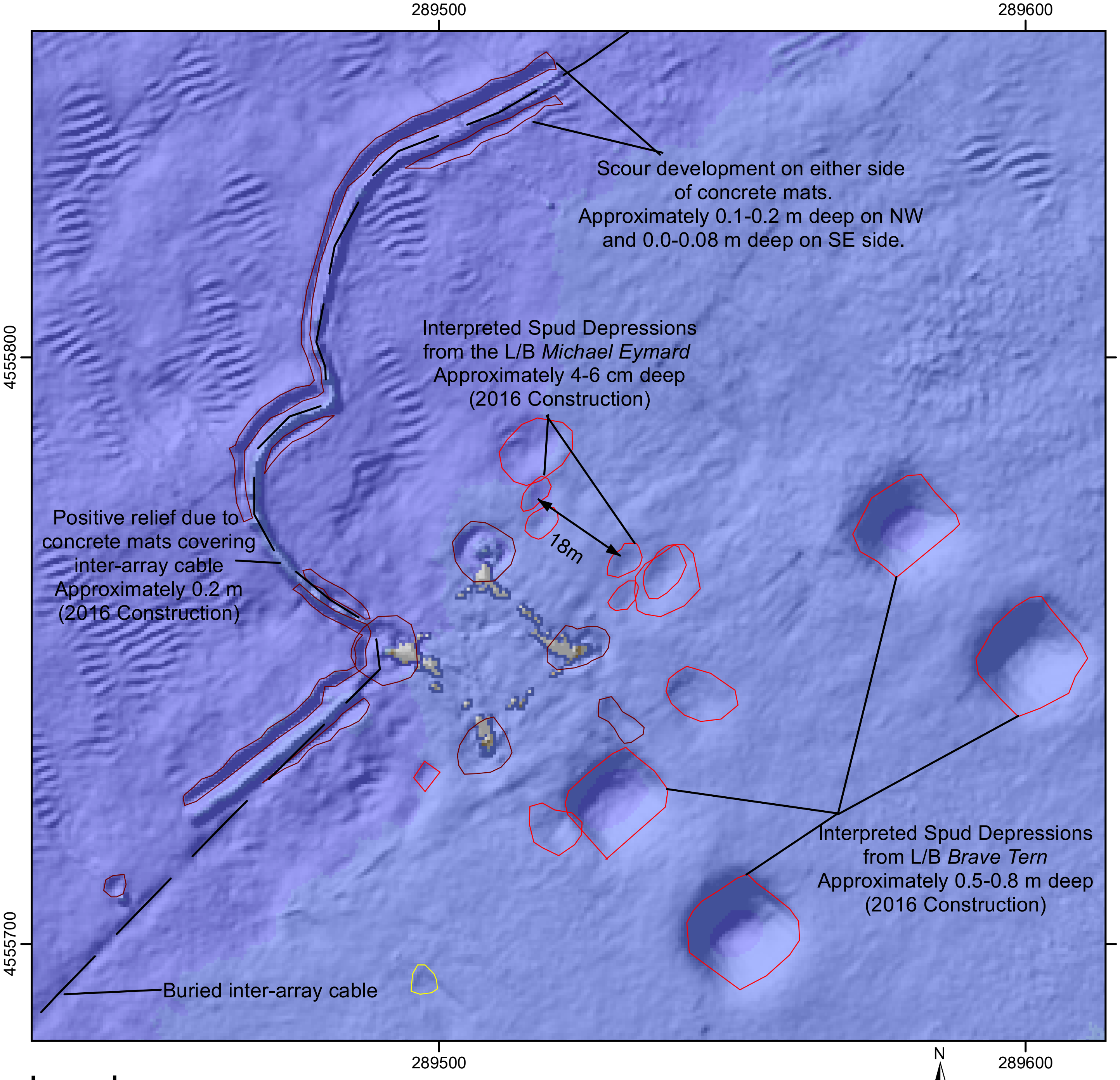
BATHYMETRY
WIND TURBINE GENERATOR NO. 1
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 3a

BOEM
Project No. 04.81150001



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Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Spud
Circular Depression
Scour

2017 Fugro Bathymetry (Meter, MLLW)

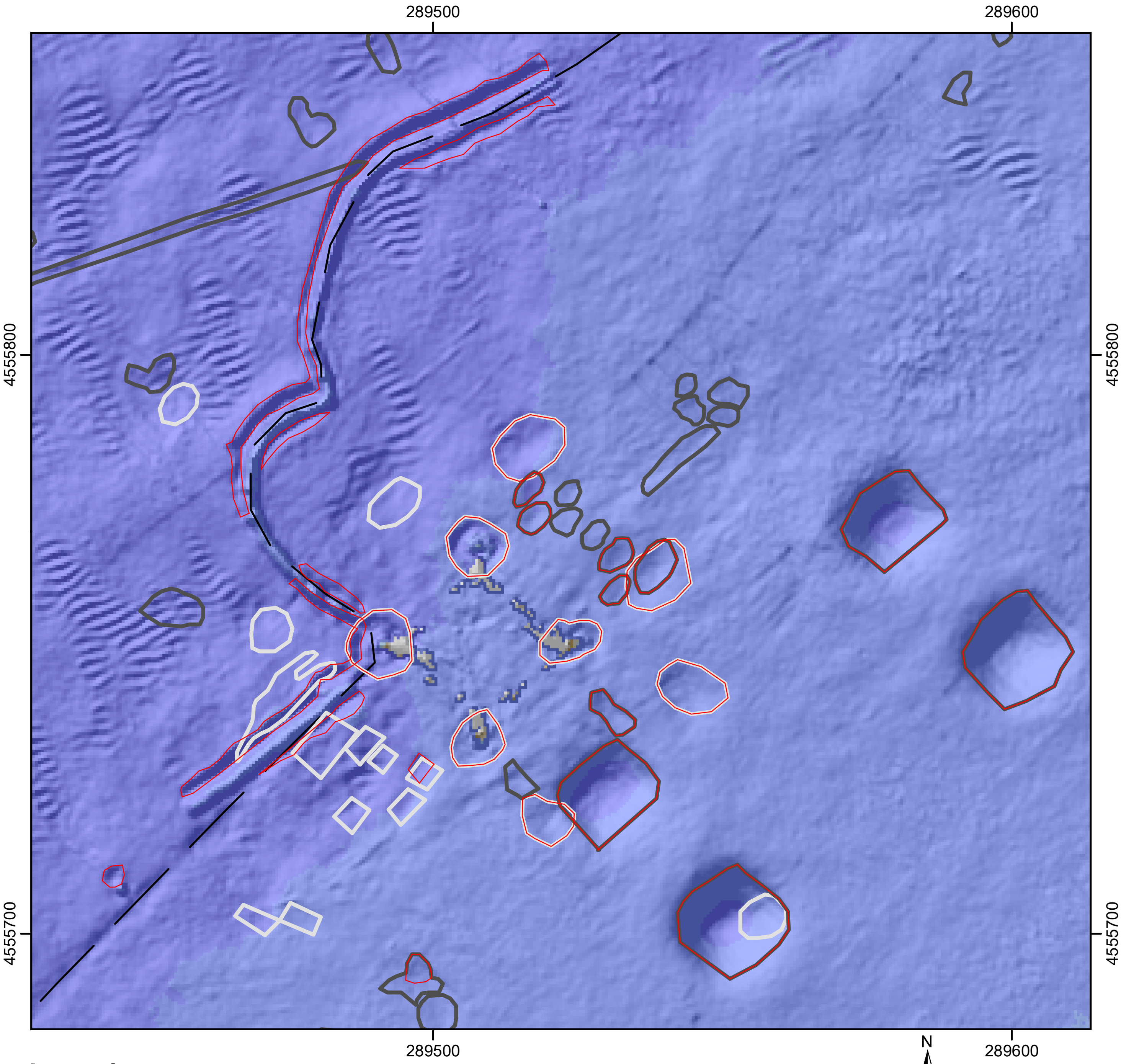
High : -17
Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

INTERPRETED SEAFLOOR DISTURBANCE TYPES
WIND TURBINE GENERATOR NO. 1
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 3b



Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Construction Season 1 (May 2016 Data)

Construction Season 2 (Oct. 2016 Data)

May 2017 Data

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 1

Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 3c

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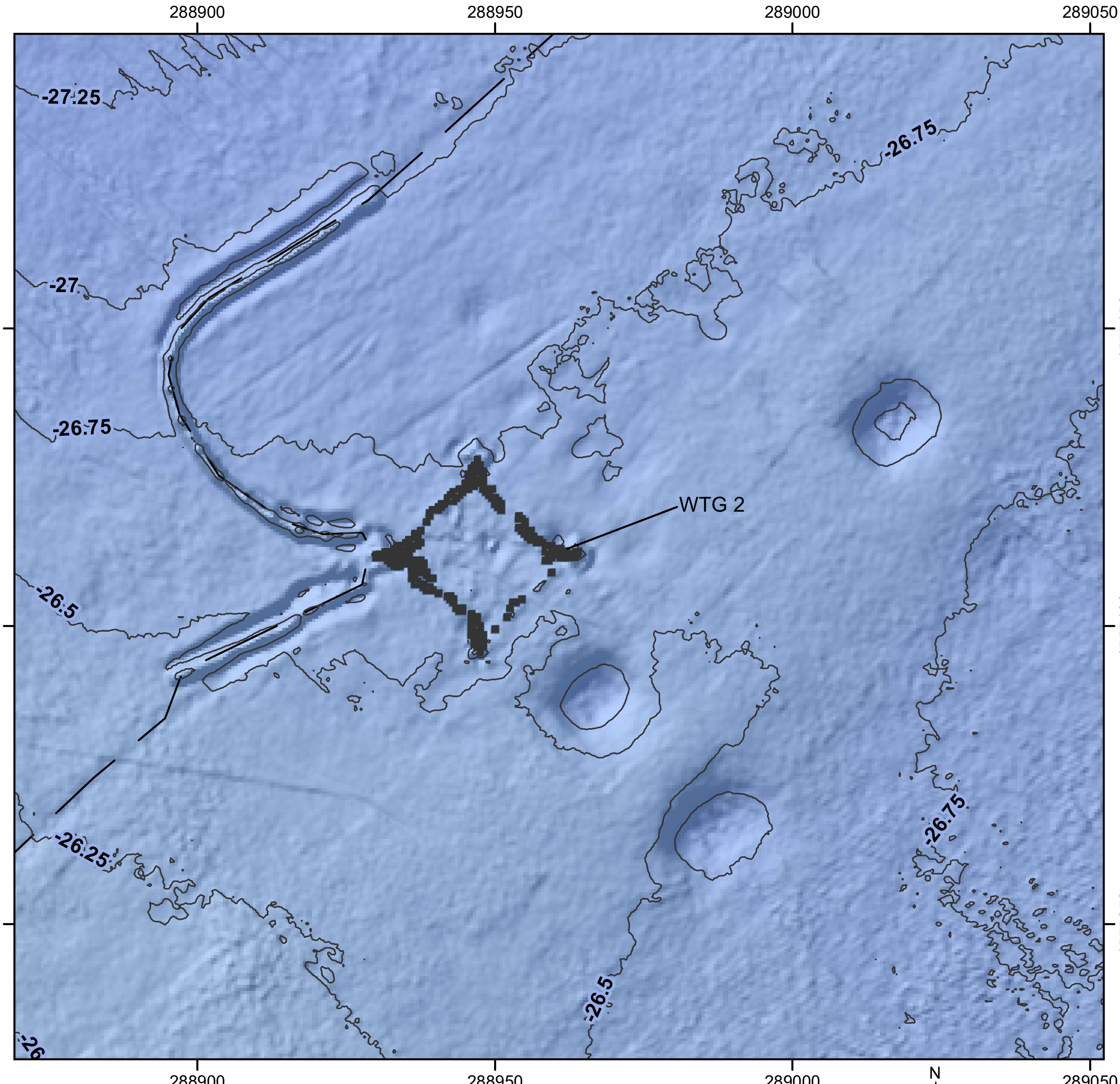

Legend

Export Cable/Inter Array Cable

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Contour interval is 0.25 meters

N W E S

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

BATHYMETRY
WIND TURBINE GENERATOR NO. 2
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 4a

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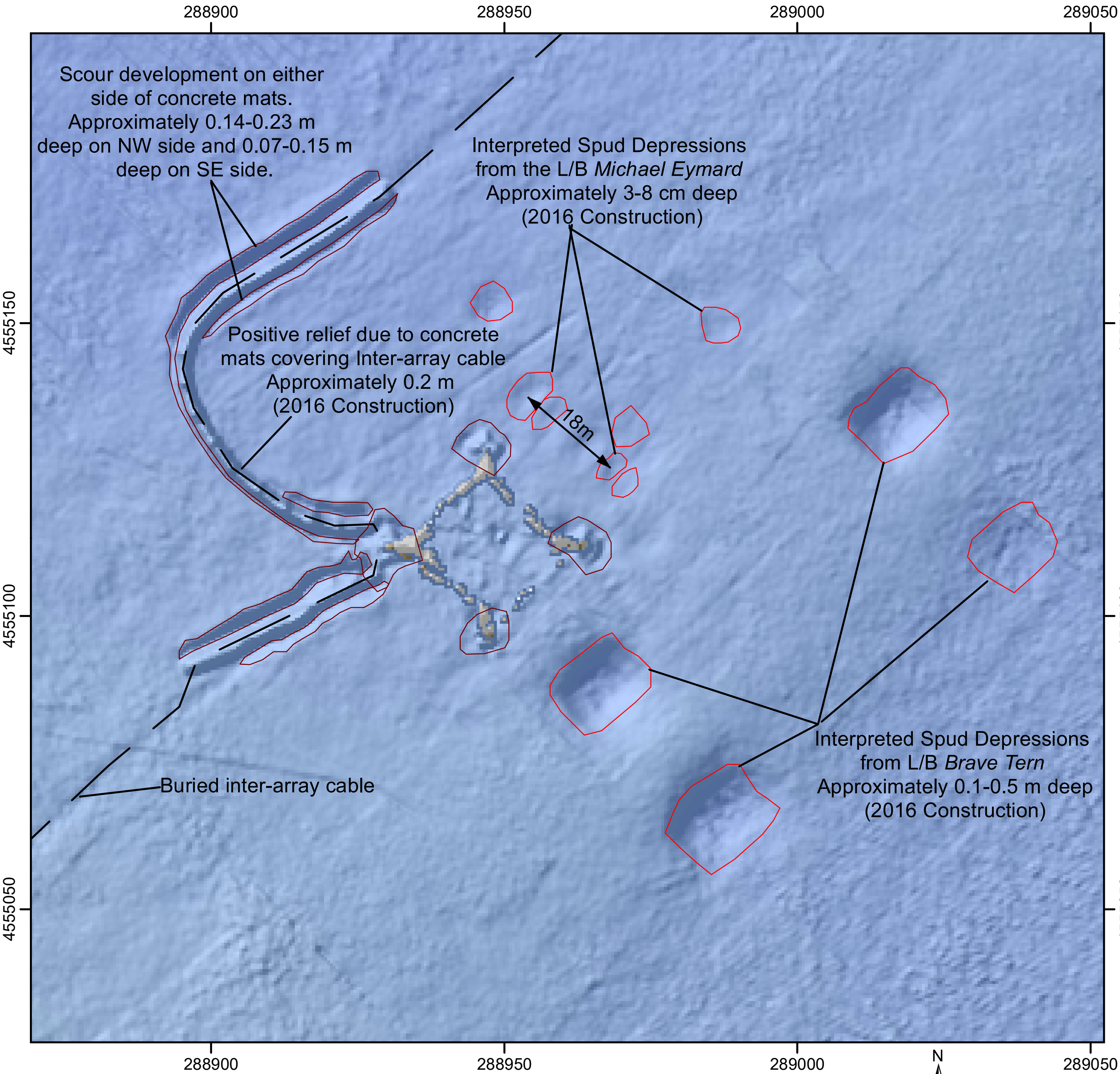

Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Spud

Scour

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

INTERPRETED SEAFLOOR DISTURBANCE TYPES
WIND TURBINE GENERATOR NO. 2
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 4b

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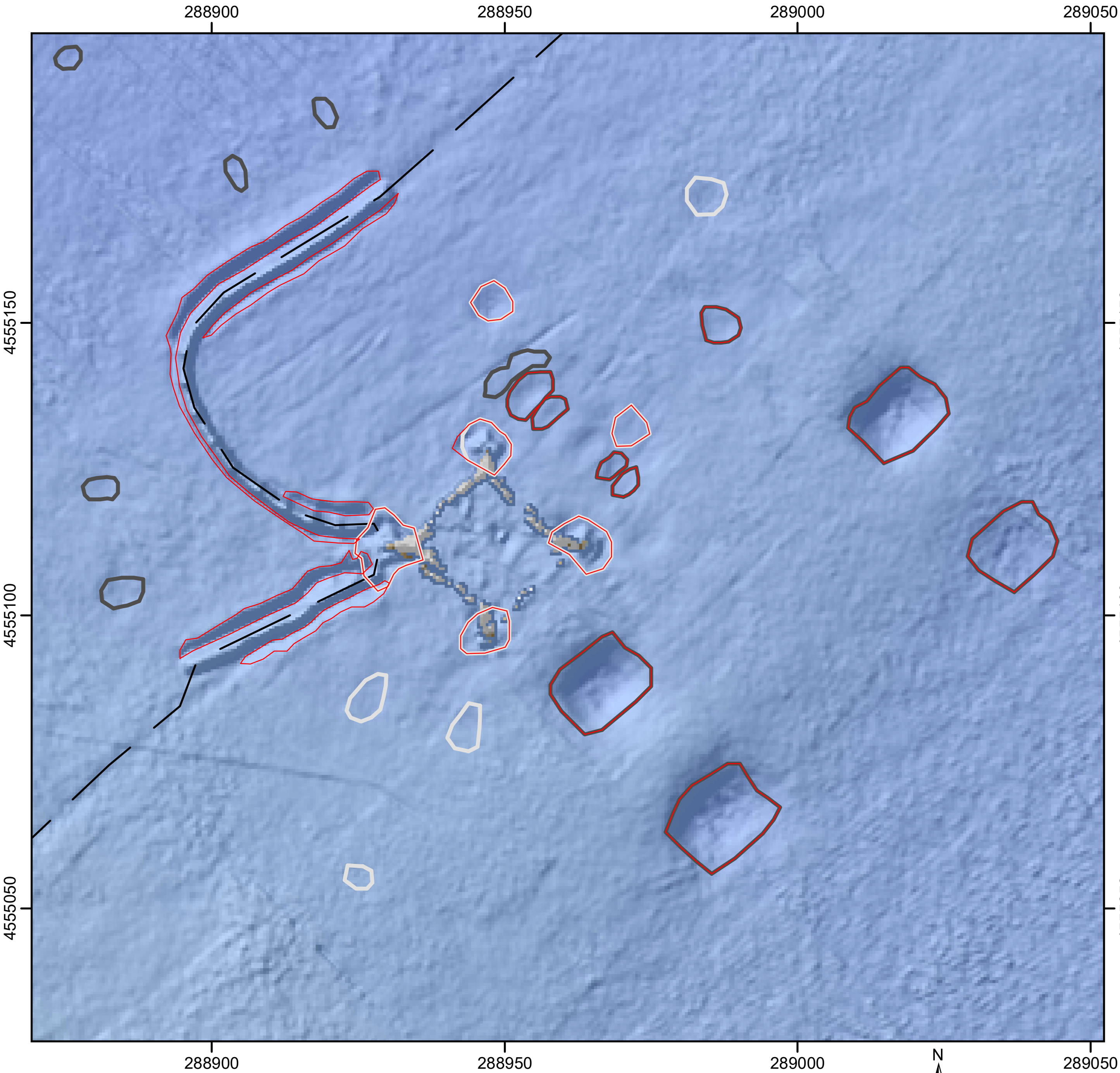

Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Construction Season 1 (May 2016 Data)

Construction Season 2 (Oct. 2016 Data)

May 2017 Data

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 2

Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 4c

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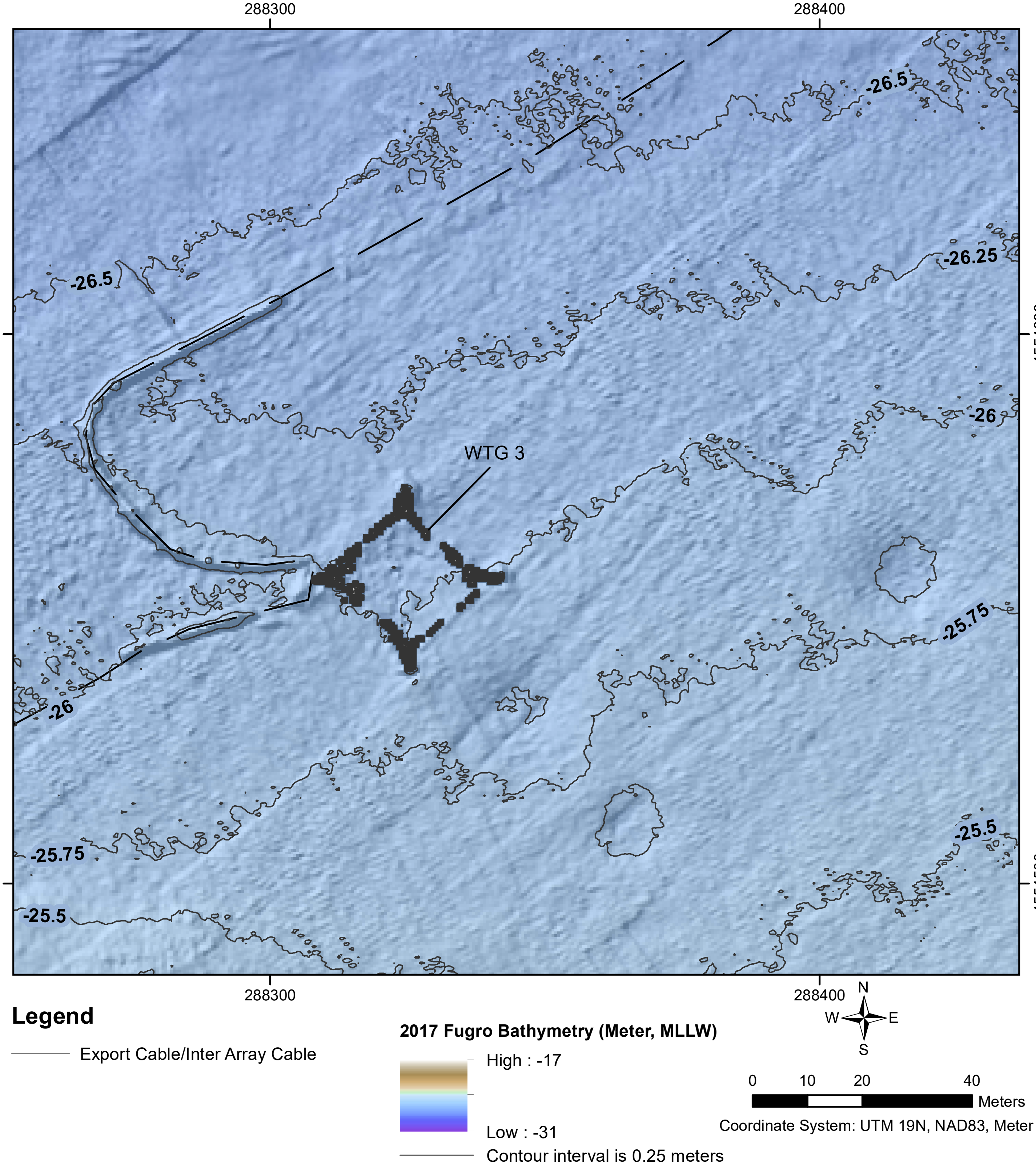

BATHYMETRY
WIND TURBINE GENERATOR NO. 3
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 5a

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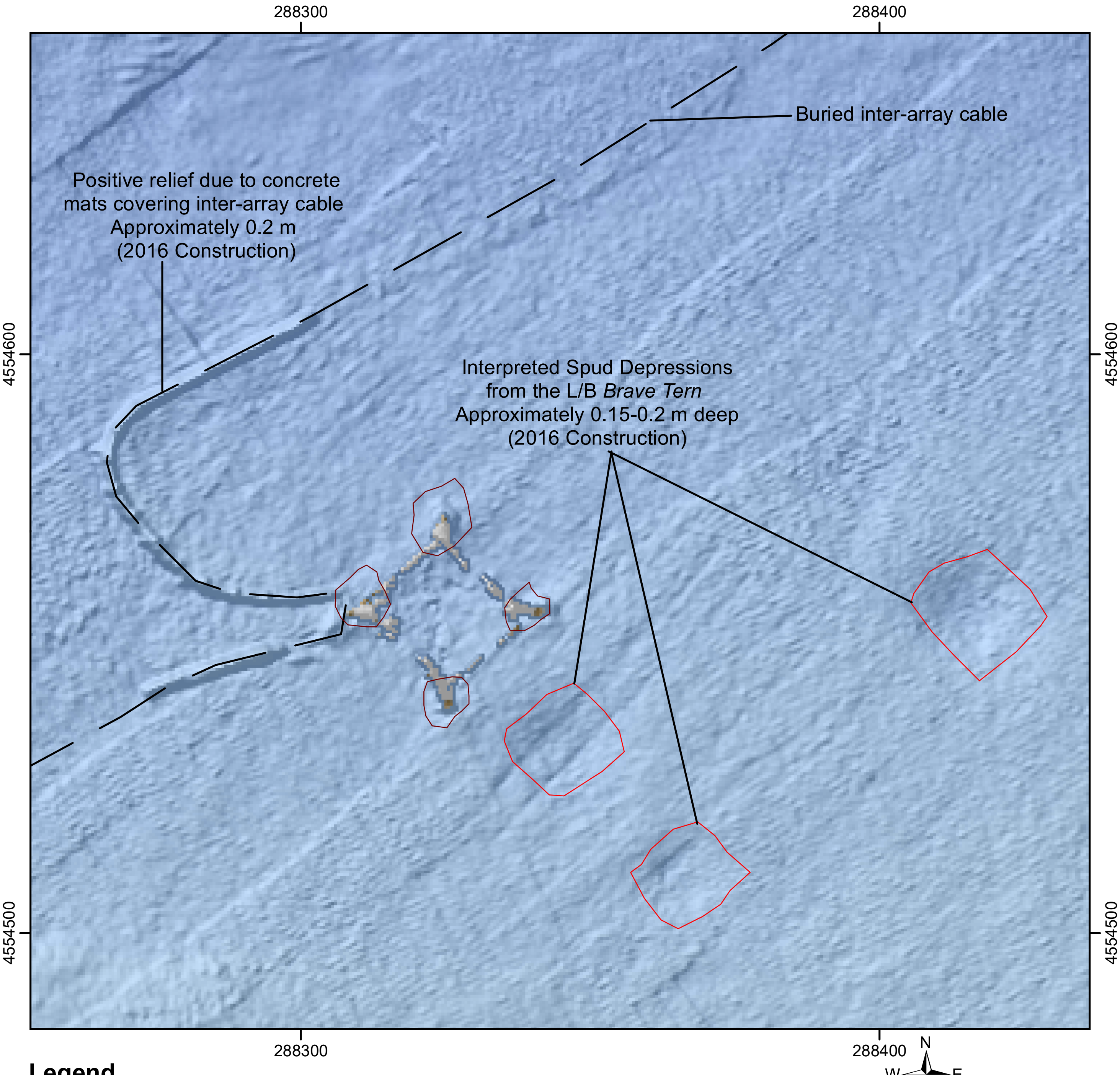


Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Spud

Scour

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

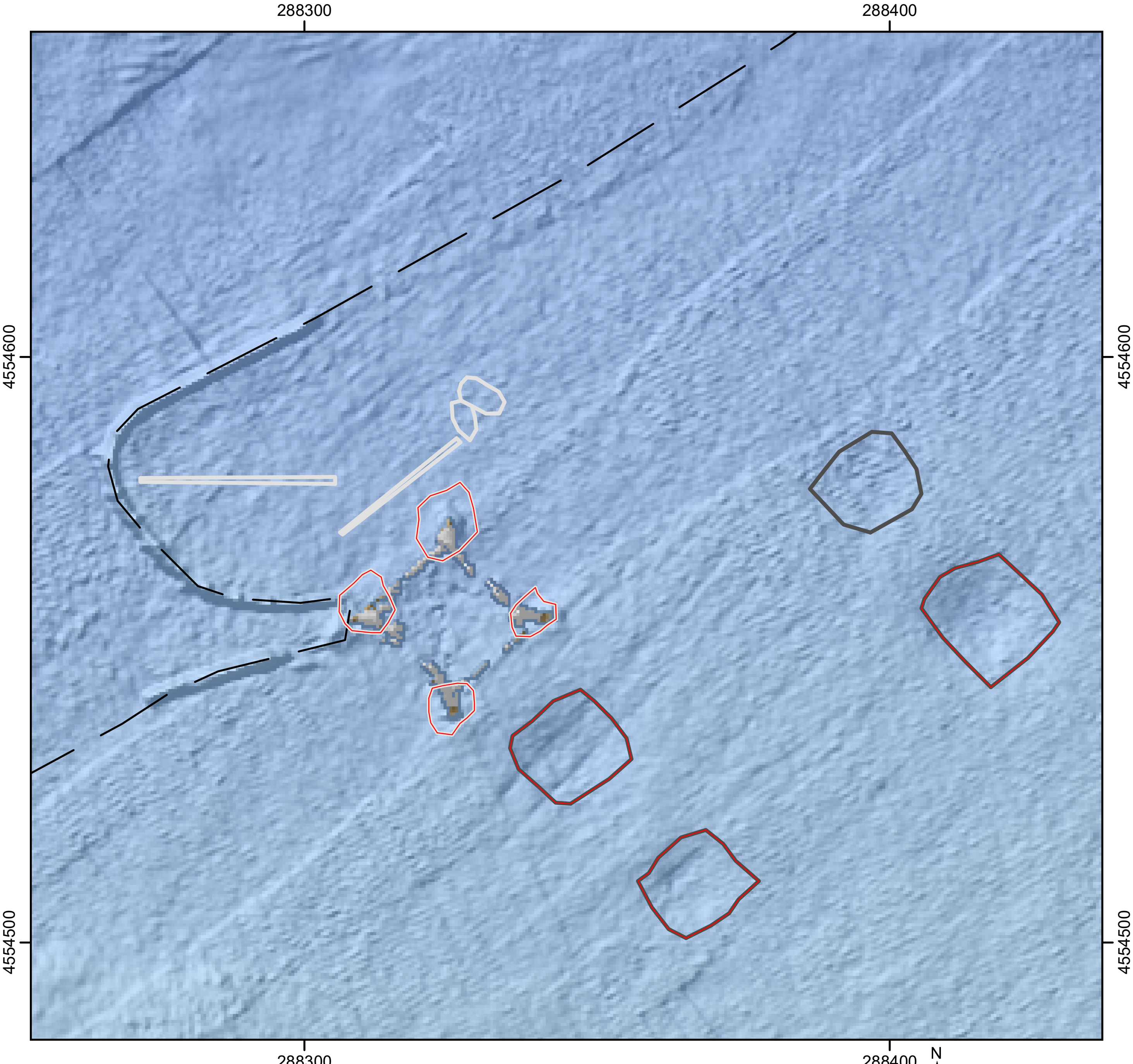
Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

INTERPRETED SEAFLOOR DISTURBANCE TYPES
WIND TURBINE GENERATOR NO. 3
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 5b



Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Construction Season 1 (May 2016 Data)

Construction Season 2 (Oct. 2016 Data)

May 2017 Data

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 3
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 5c

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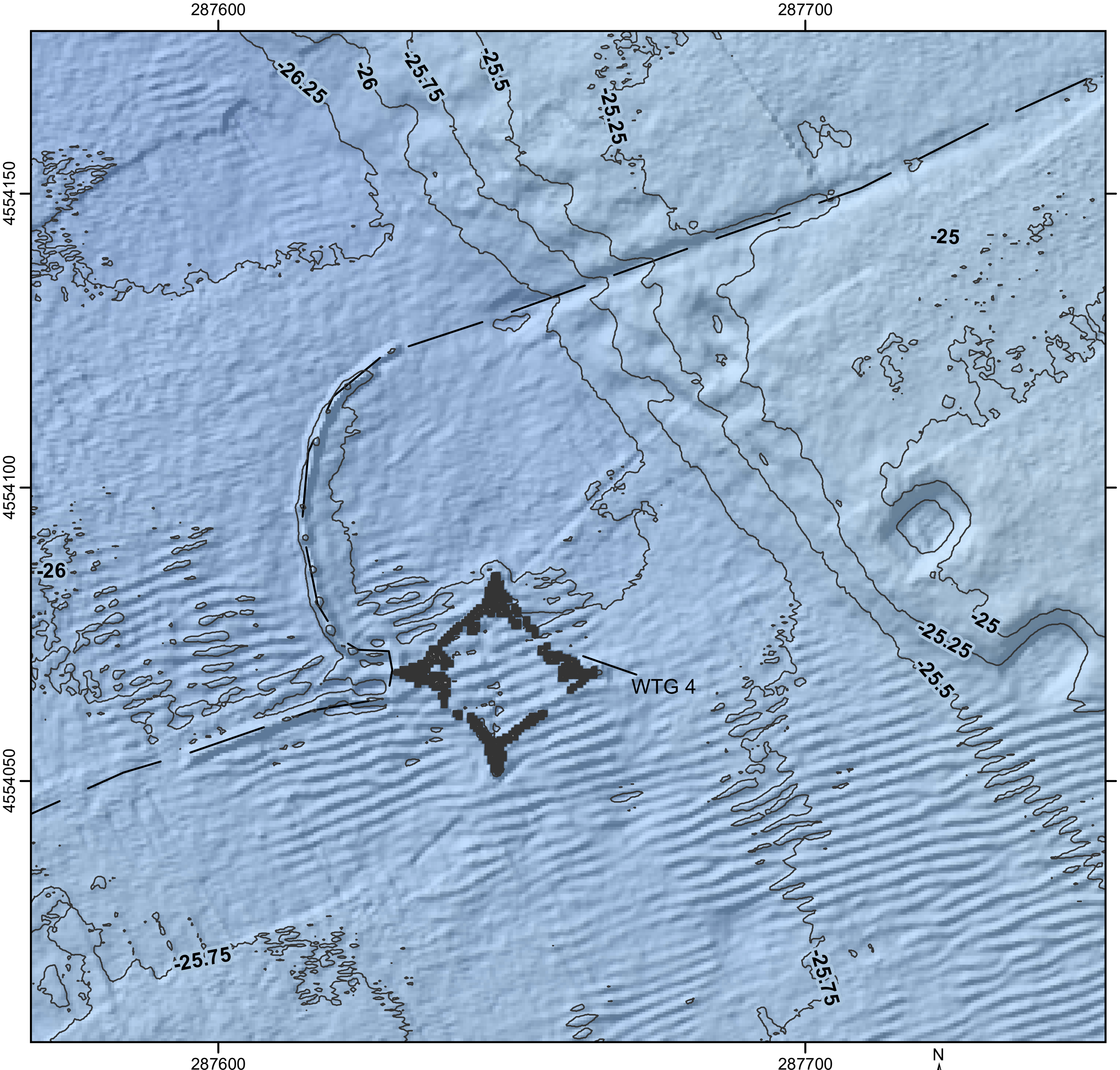

Legend

Export Cable/Inter Array Cable

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Contour interval is 0.25 meters

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

BATHYMETRY
WIND TURBINE GENERATOR NO. 4
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 6a

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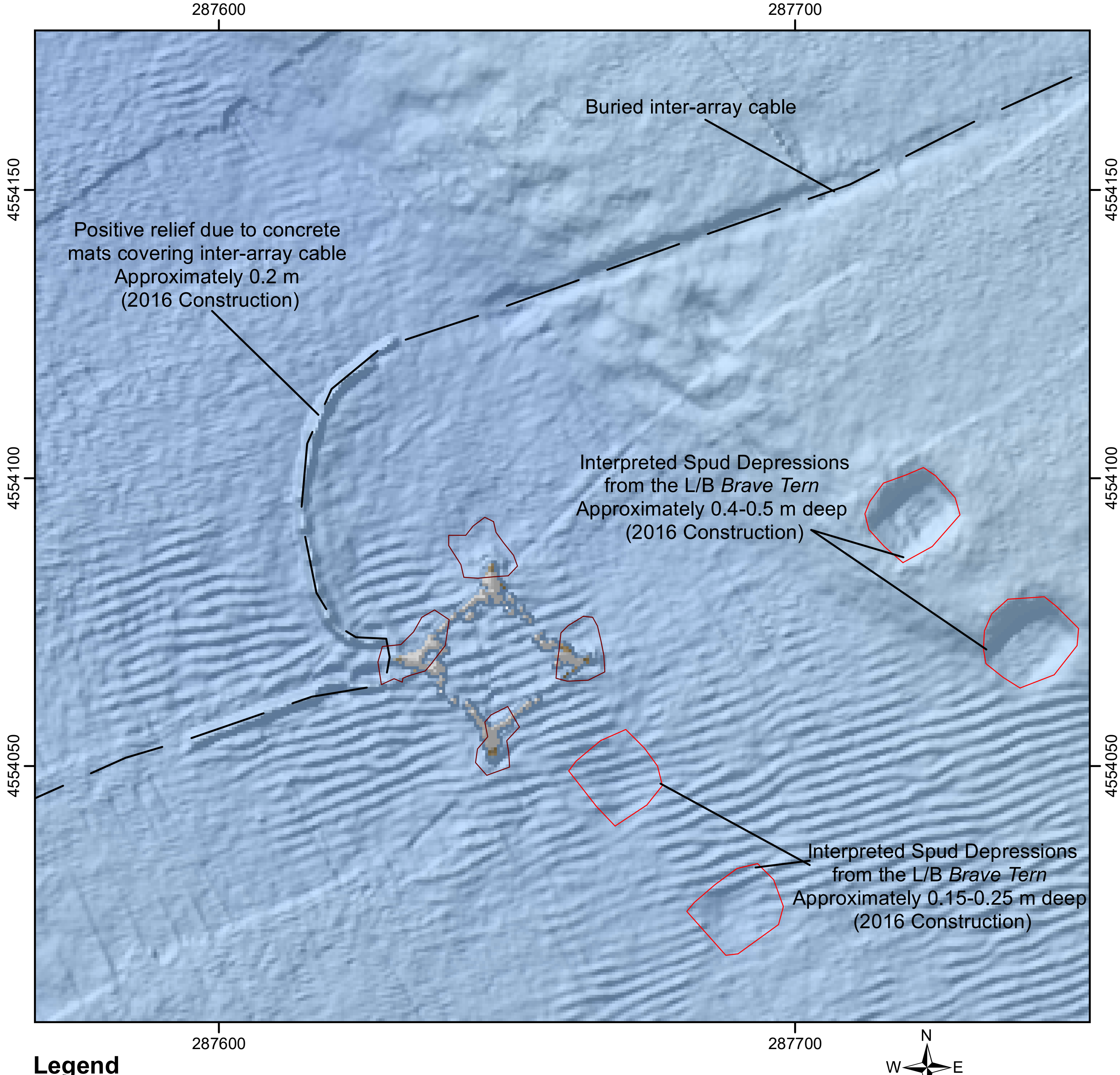


Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Spud

Scour

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

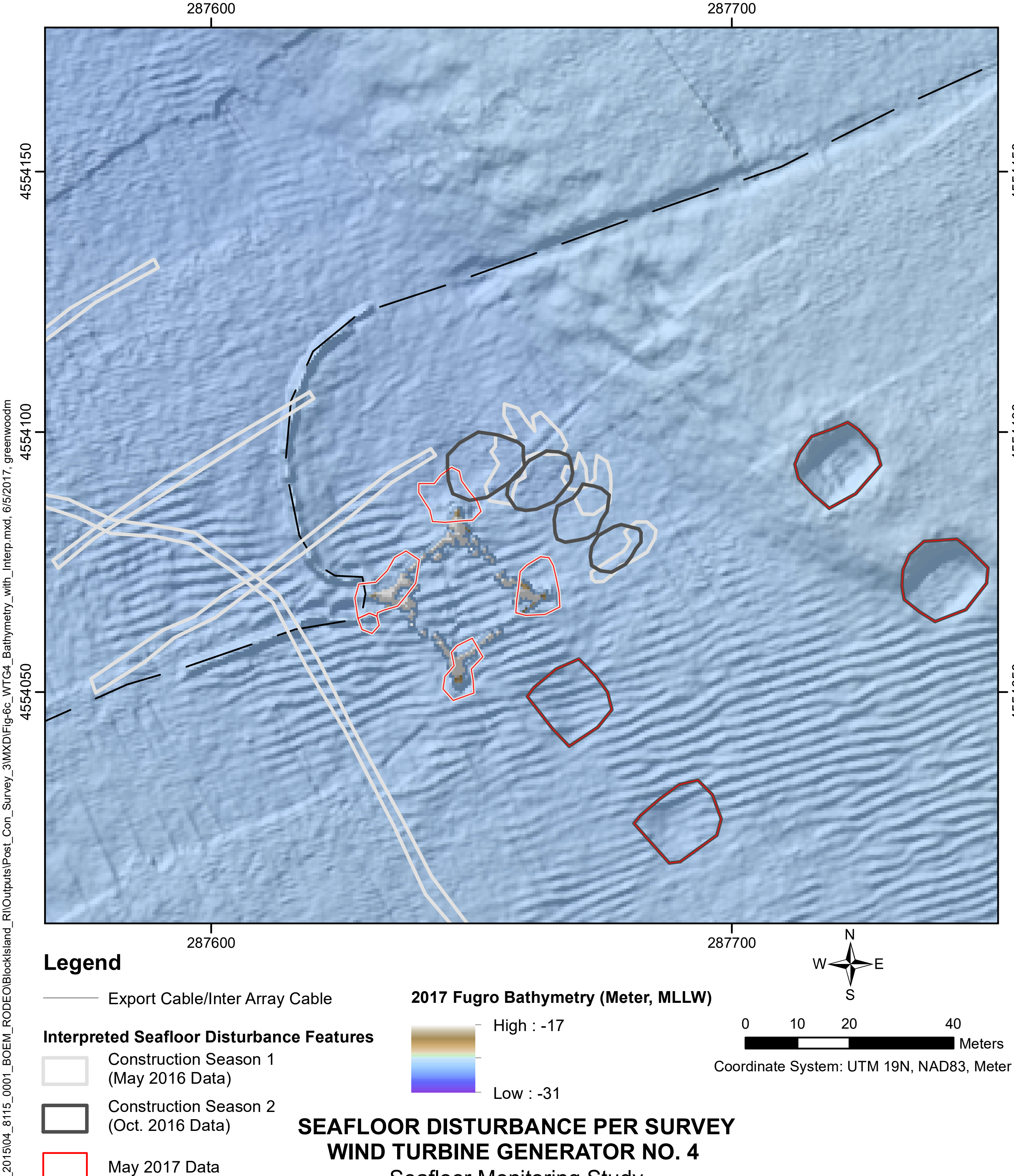
Coordinate System: UTM 19N, NAD83, Meter

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-6b_WTG4_Bathymetry_with_Interp.mxd, 6/14/2017, greenwoodm

INTERPRETED SEAFLOOR DISTURBANCE TYPES
WIND TURBINE GENERATOR NO. 4

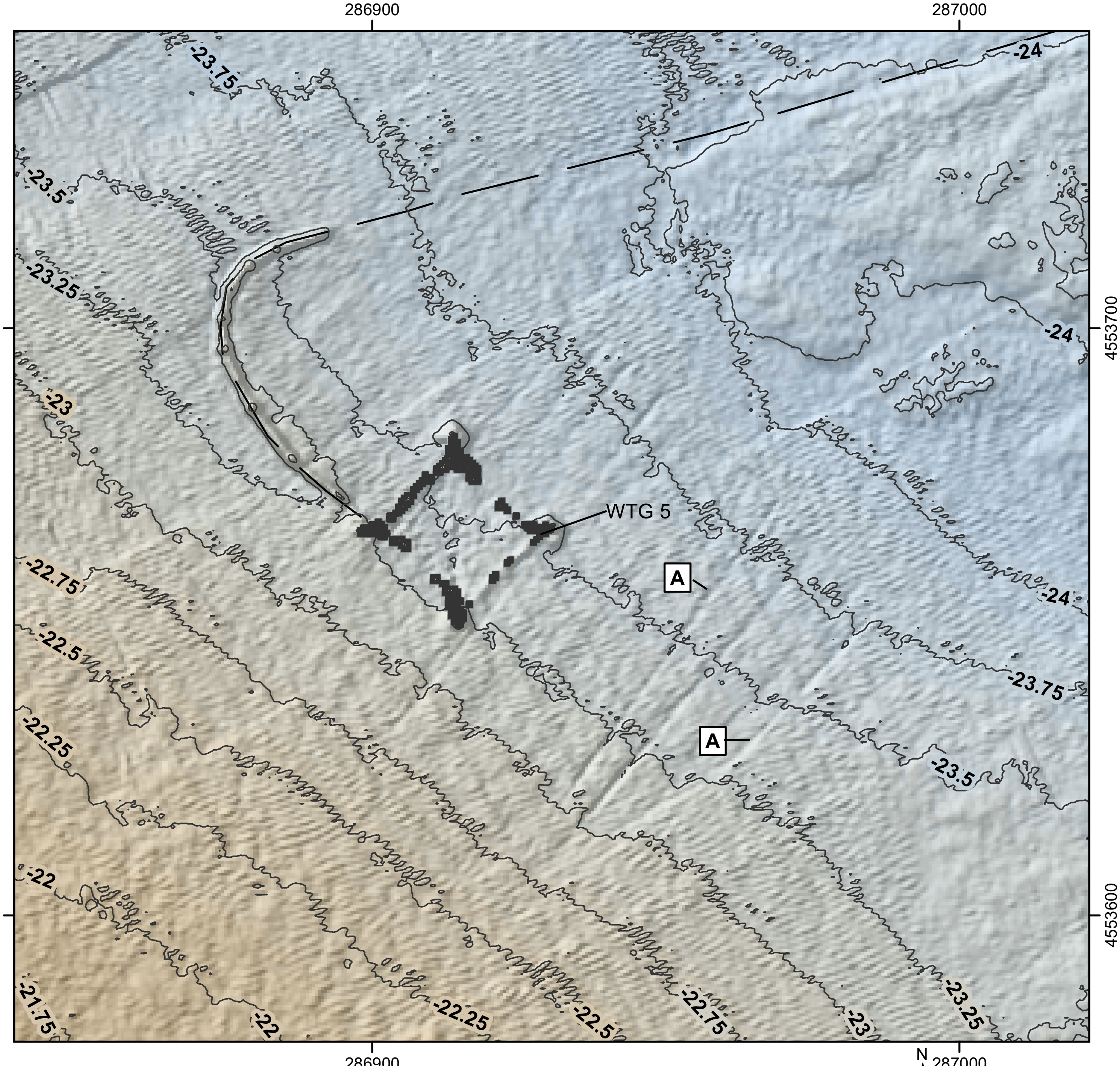
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 6b



SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 4
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 6c



Legend

Export Cable/Inter Array Cable

A Data Artifact

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Contour interval is 0.25 meters

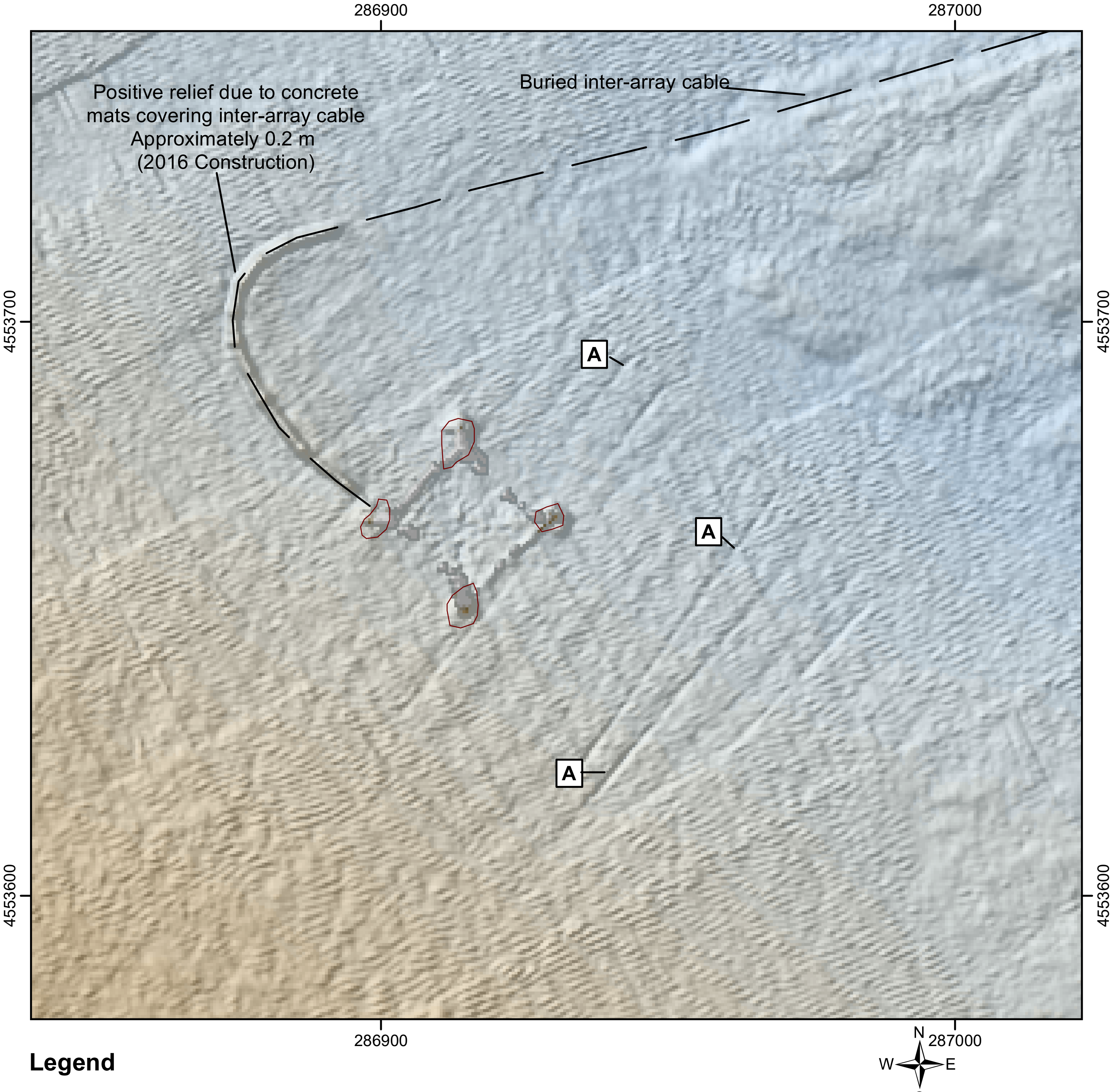
0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_3\MXD\Fig-7a_WTG5_Bathymetry_with_Contours.mxd, 6/5/2017, greenwoodm

BATHYMETRY
WIND TURBINE GENERATOR NO. 5
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 7a



Legend

Export Cable/Inter Array Cable

A Data Artifact

Interpreted Seafloor Disturbance Features

Scour

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

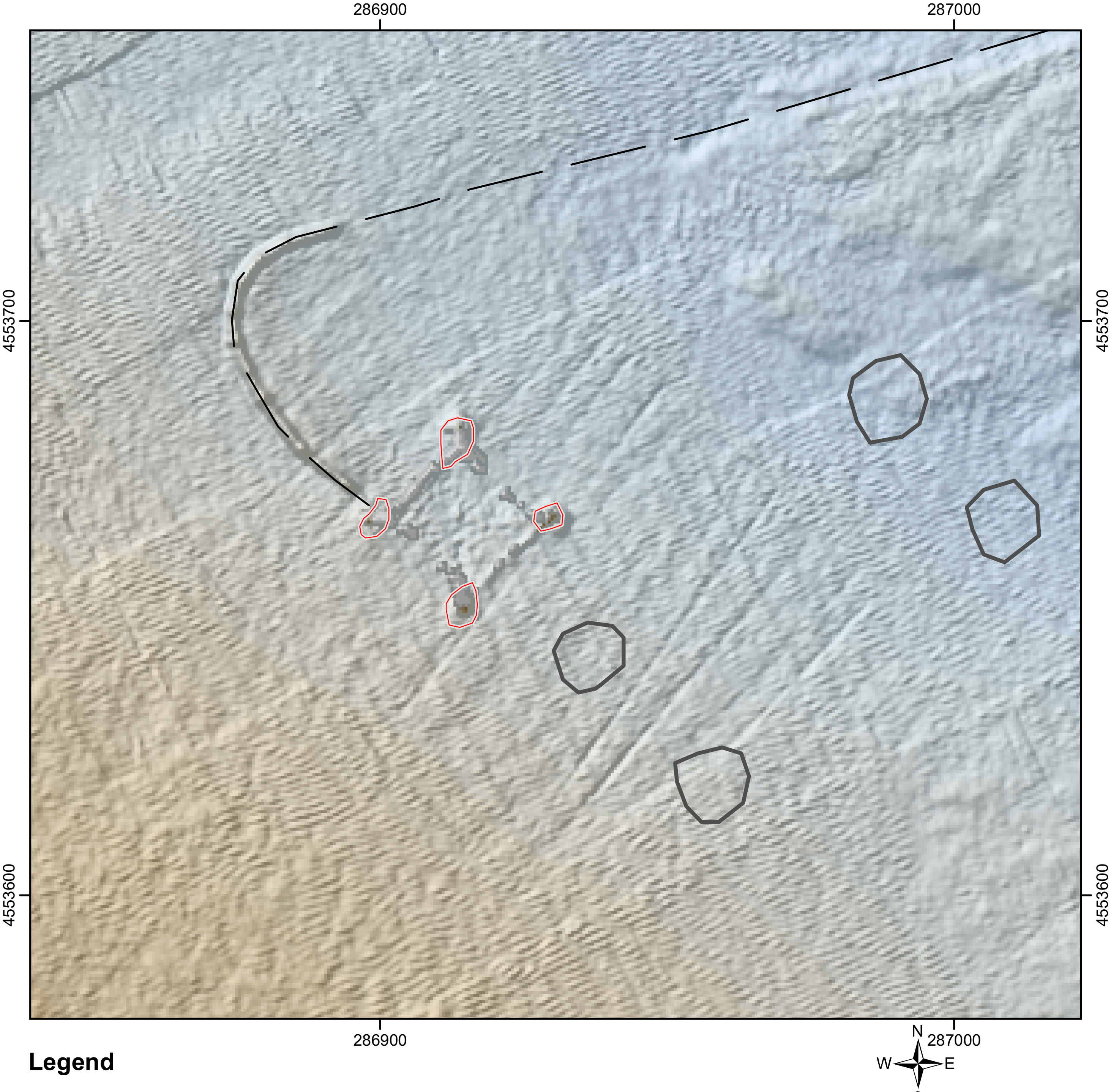
Coordinate System: UTM 19N, NAD83, Meter

INTERPRETED SEAFLOOR DISTURBANCE TYPES
WIND TURBINE GENERATOR NO. 5

Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 7b

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_3\MXD\Fig-7b_WTG5_Bathymetry_with_Interp.mxd, 6/5/2017, greenwoodm



Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Construction Season 1 (May 2016 Data)

Construction Season 2 (Oct. 2016 Data)

May 2017 Data

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

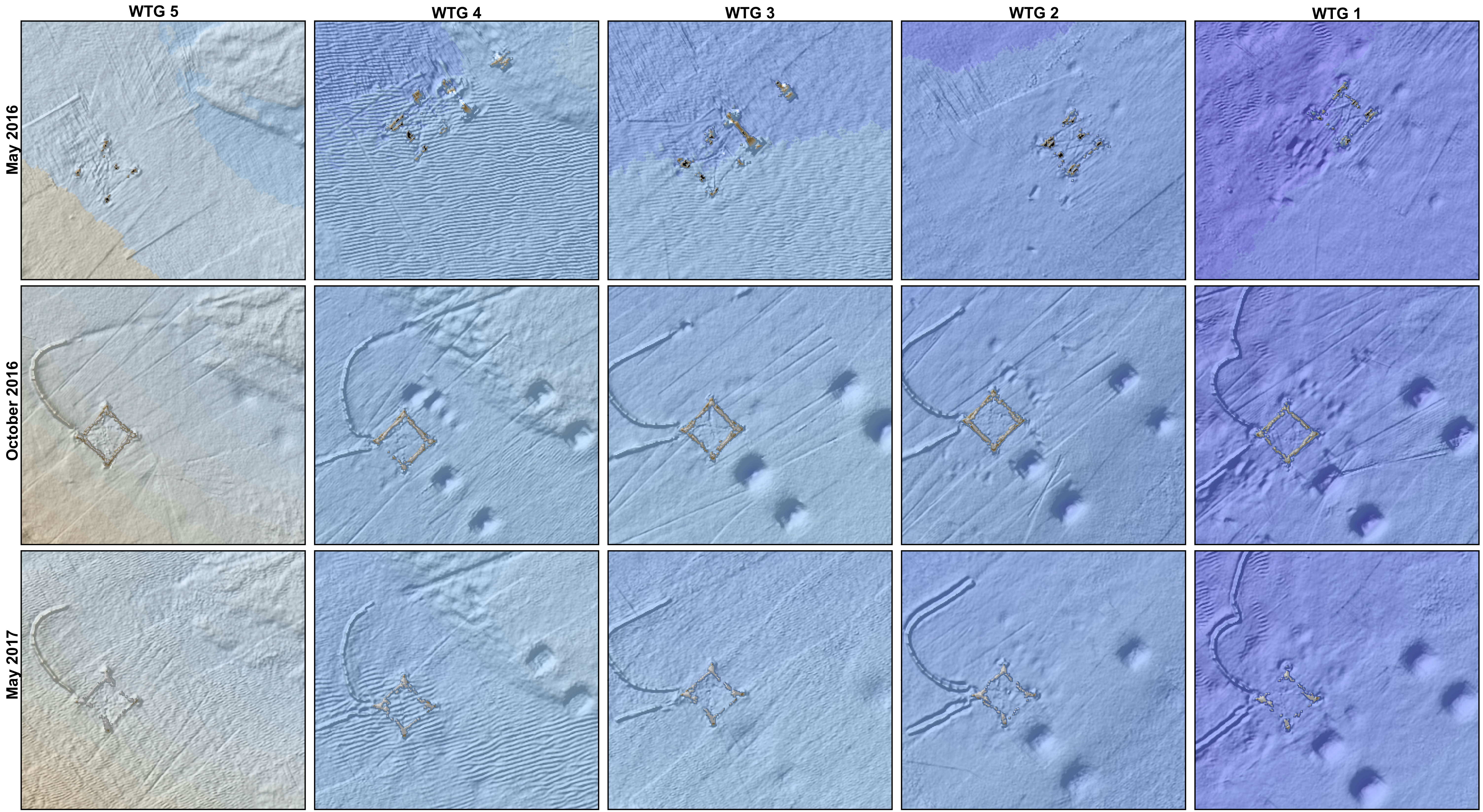
0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_3\MXD\Fig-7c_WTG5_Bathymetry_with_Interp.mxd, 6/5/2017, greenwoodm

SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 5
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 7c



Legend

0 25 50 100 Meters

Coordinate System: UTM 19N, NAD83, Meter

2017 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

N W E S

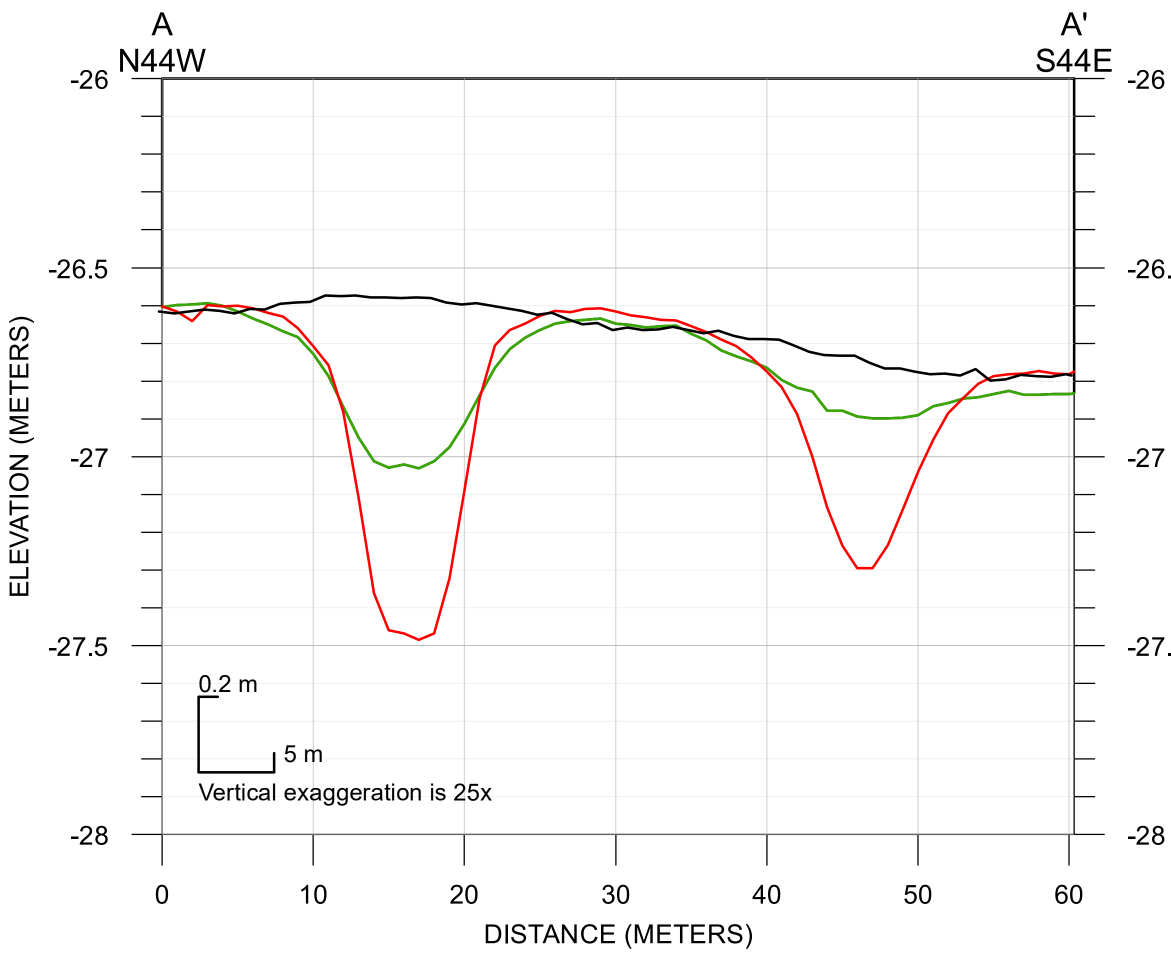
BATHYMETRY COMPARISON

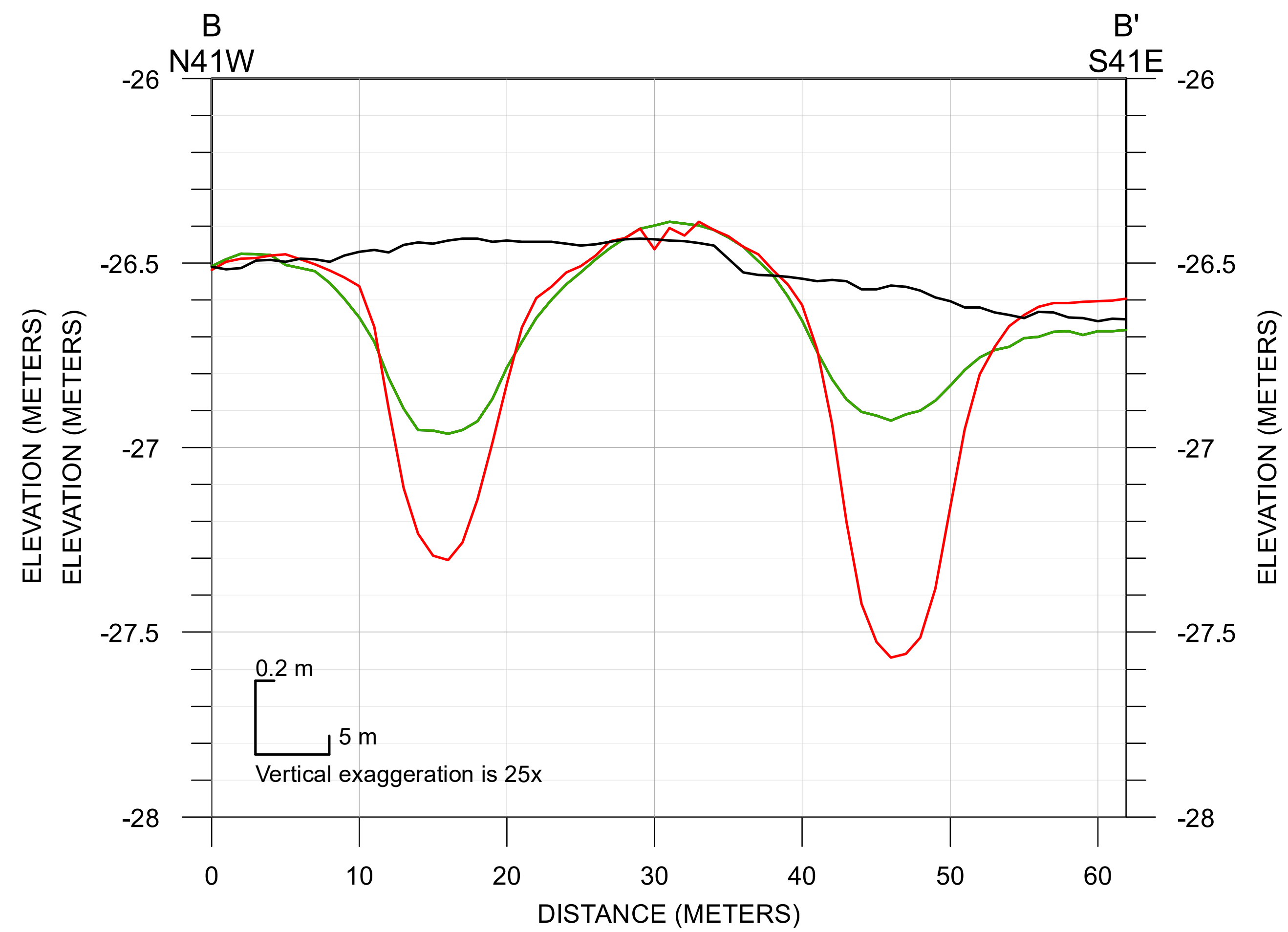
Seafloor Monitoring Study

Block Island Wind Farm and Transmission Project

Offshore Rhode Island

FIGURE 8

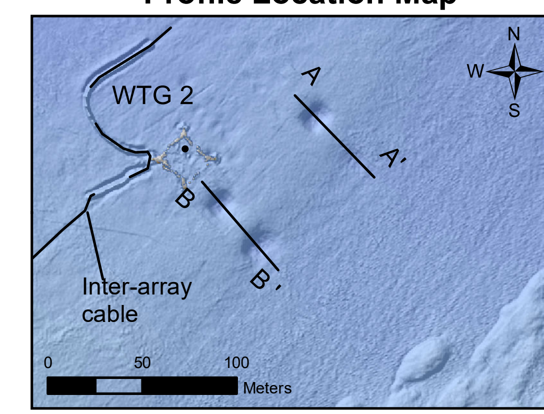


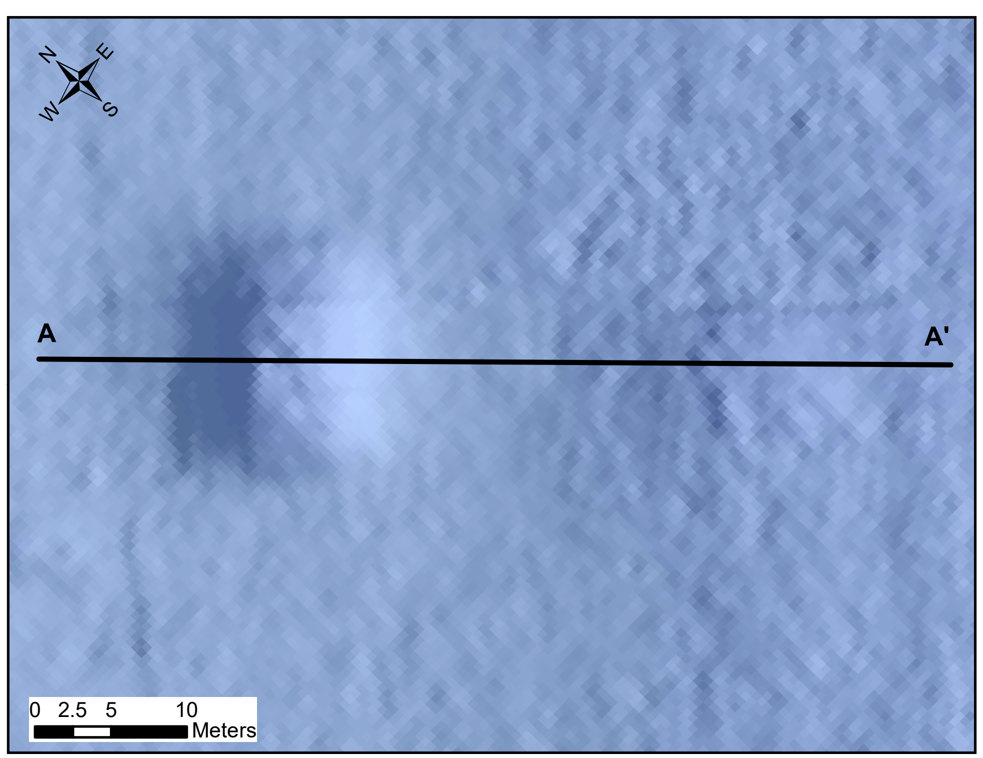


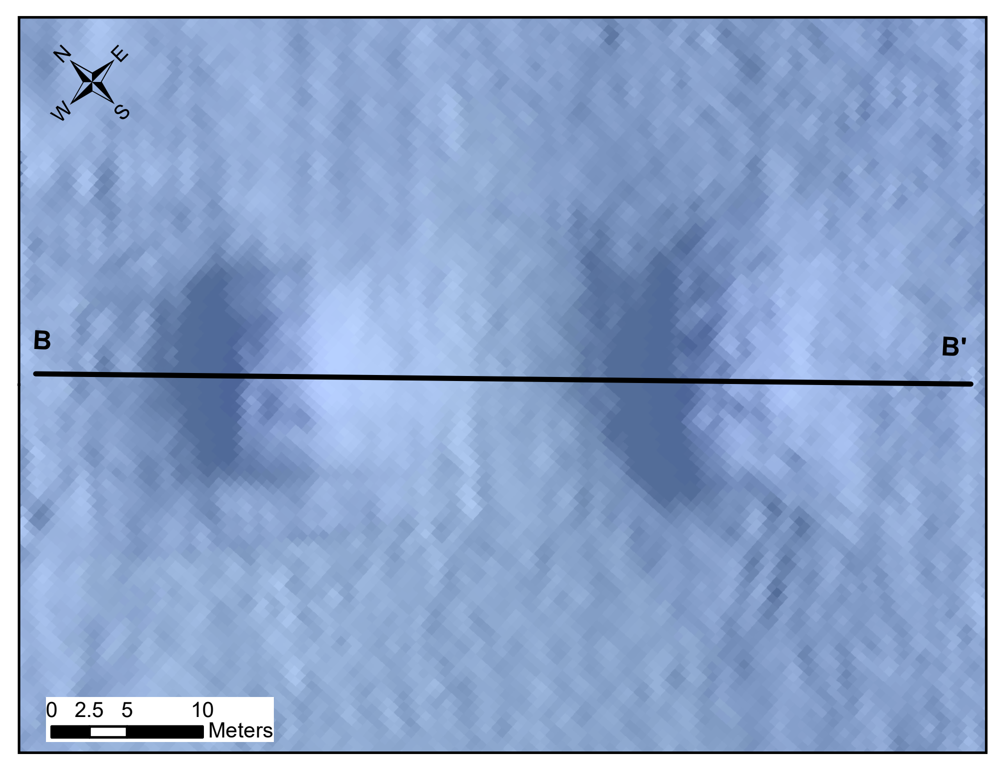
Legend

- Survey No. 1 (May 2016)
- Survey No. 2 (October 2016)
- Survey No. 3 (May 2017)

Profile Location Map





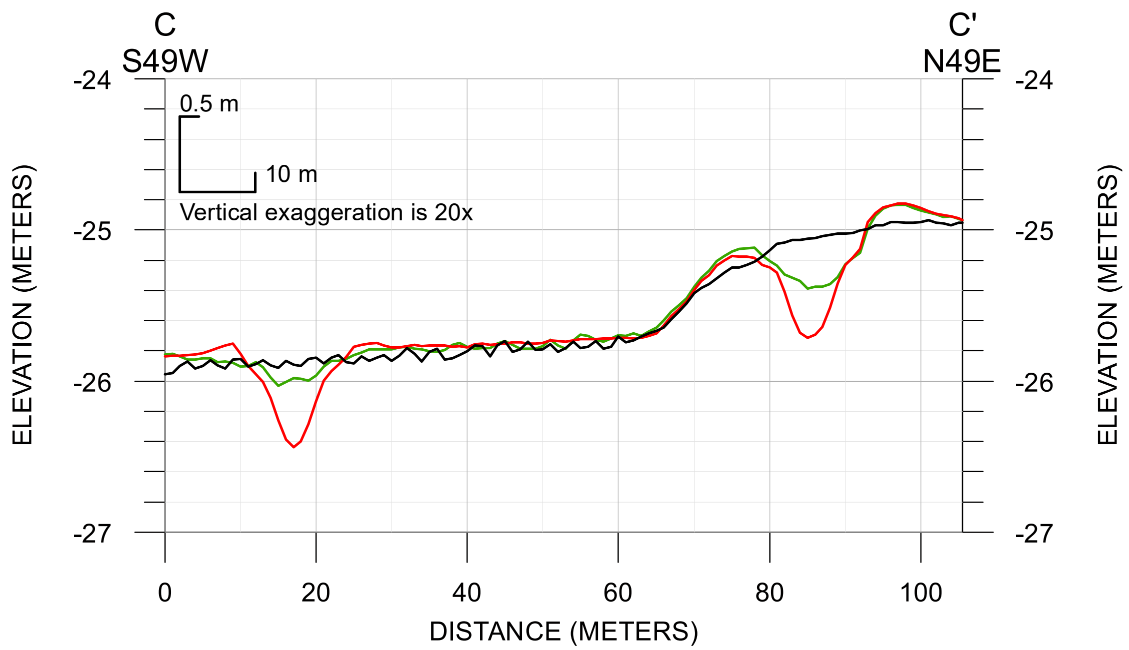


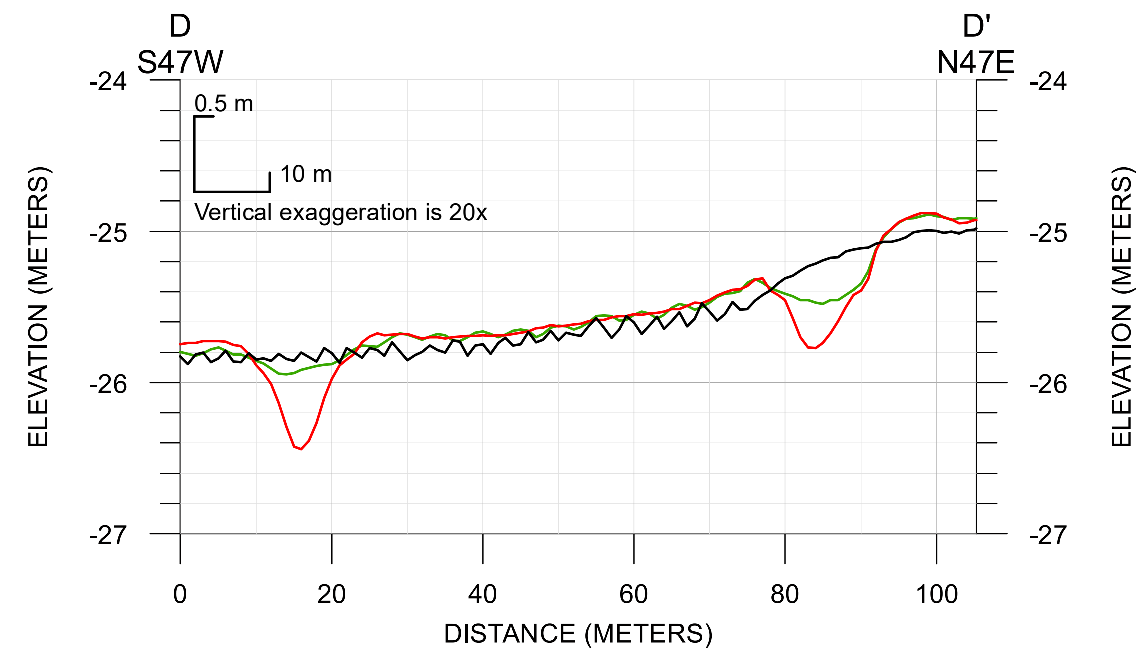
Notes:

The depressions shown in this figure were created by the L/B Brave Tern vessel while installing the wind turbine during Construction Season 2 that occurred in between Surveys 1 and 2. Bathymetry data shown in the plan views are from Survey 3.

EXAMPLE OF SEAFLOOR RECOVERY
WIND TURBINE GENERATOR NO. 2
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 9

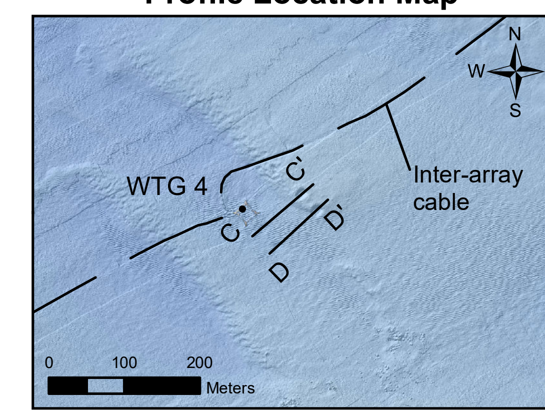


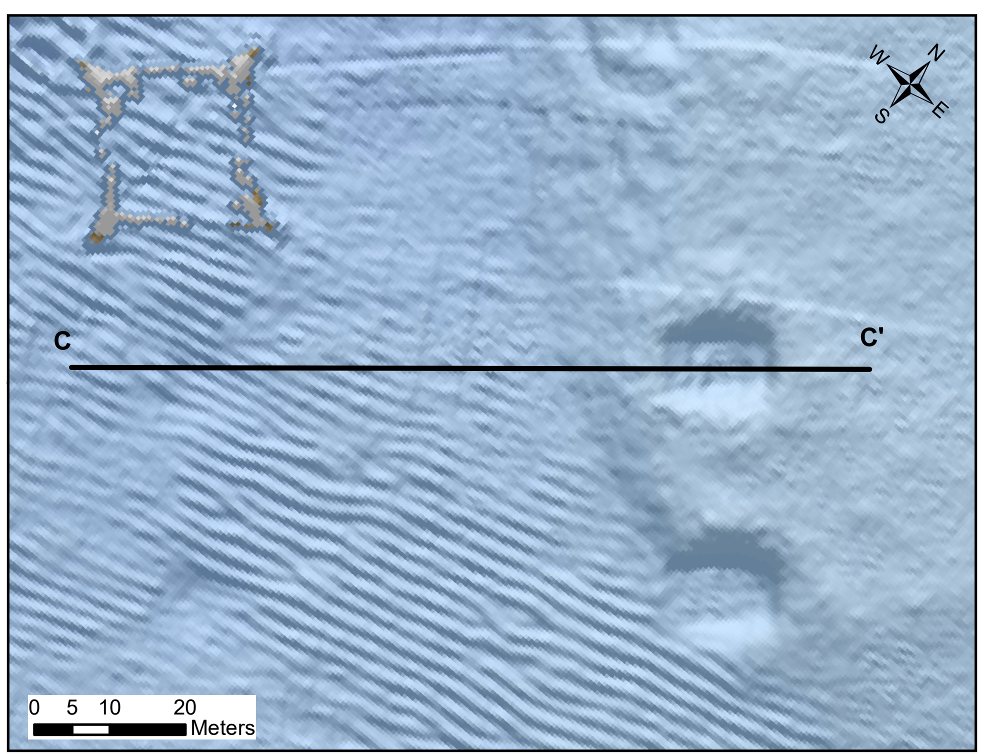


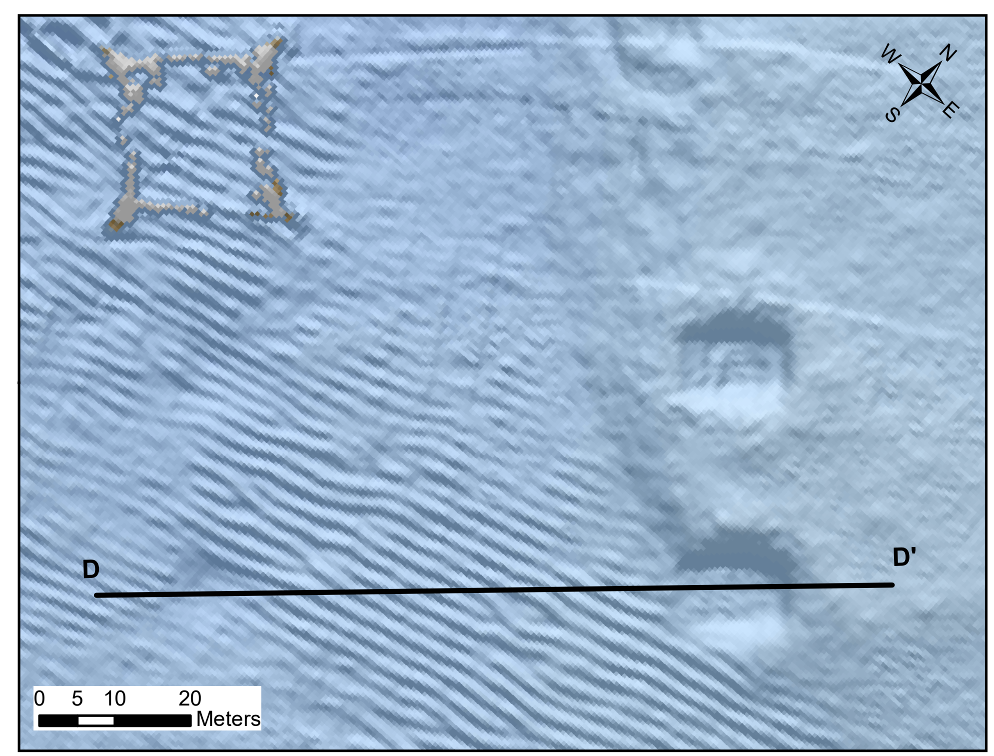
Legend

- Survey No. 1 (May 2016)
- Survey No. 2 (October 2016)
- Survey No. 3 (May 2017)

Profile Location Map







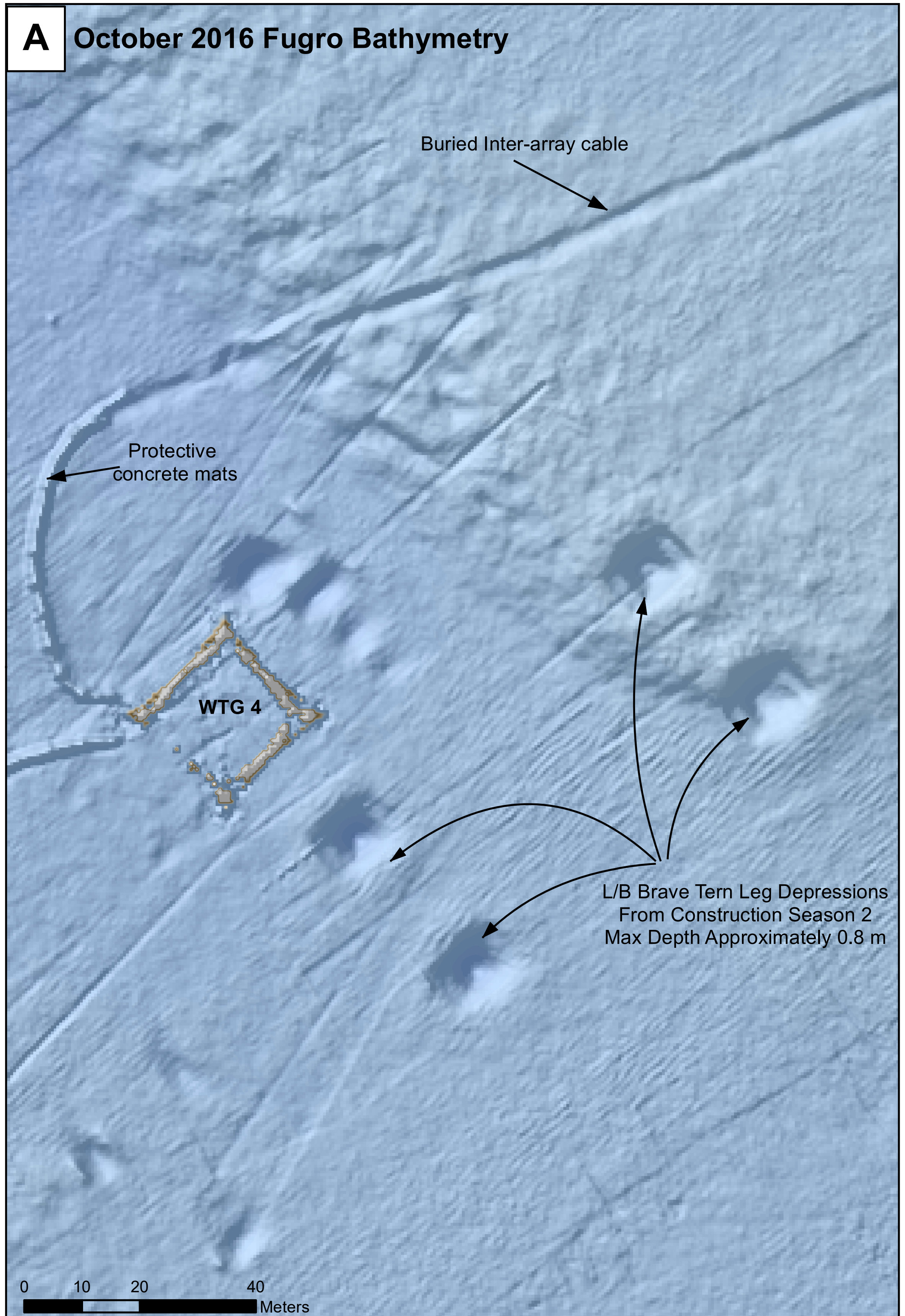
Notes:

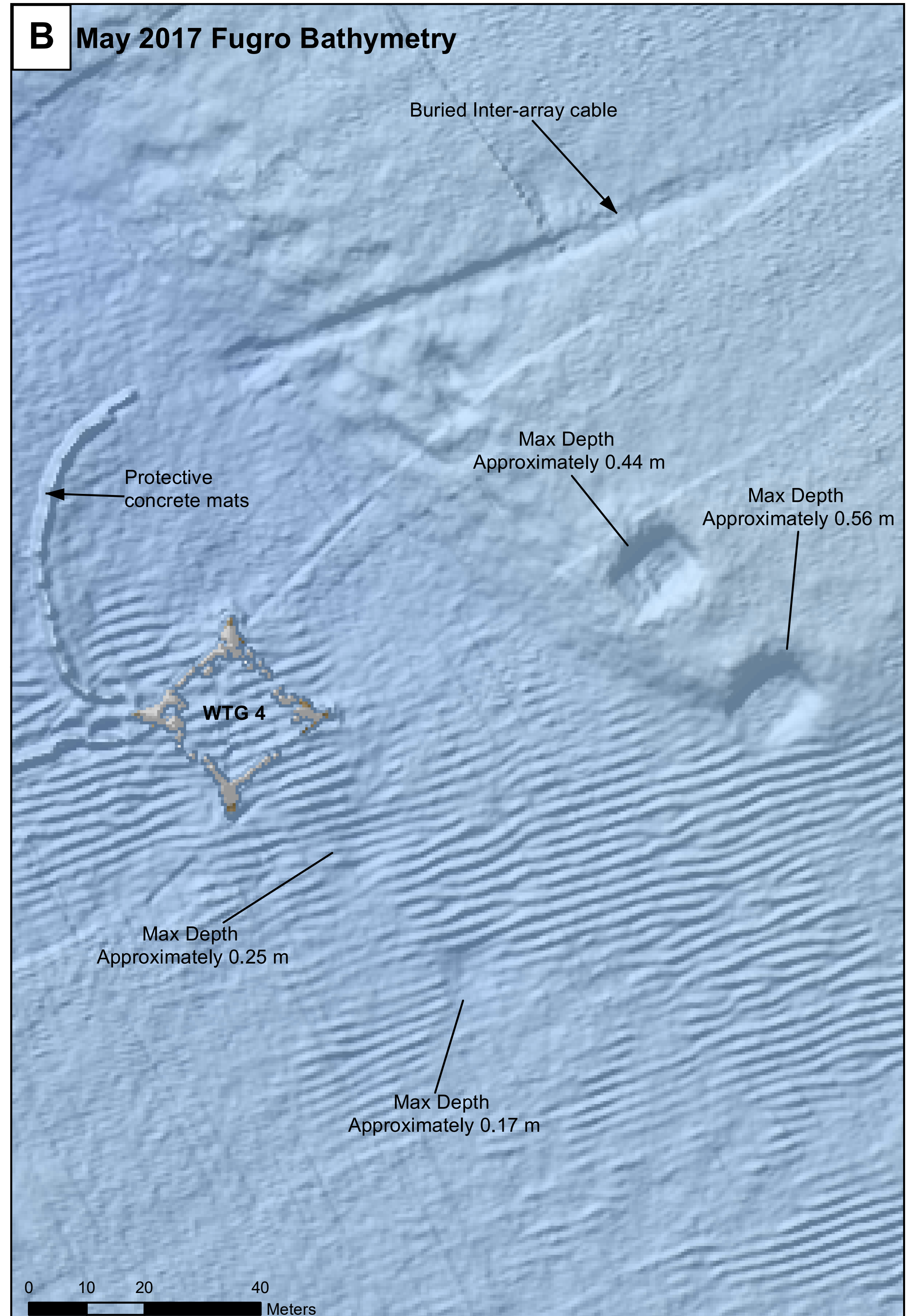
The depressions shown in this figure were created by the L/B Brave Tern vessel while installing the wind turbine during Construction Season 2 that occurred in between Surveys 1 and 2. Bathymetry data shown in the plan views are from Survey 3.

EXAMPLE OF SEAFLOOR RECOVERY
WIND TURBINE GENERATOR NO. 4
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

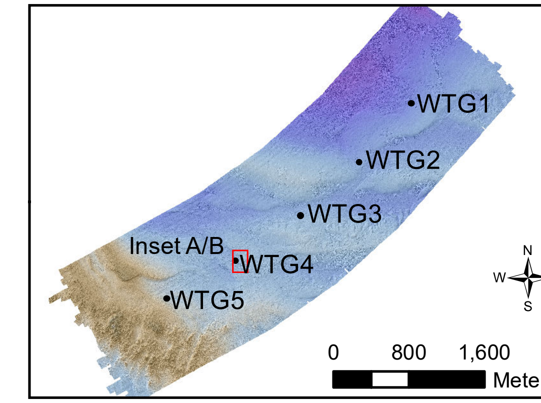
FIGURE 10

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_3\MXD\Fig-10_WTG4_Spud_Depression_Profiles.mxd, 6/19/2017, greenwoodm





Inset Map Locations



Notes:

Bathymetric data collected during October 2016 and May 2017 indicate that the prominent leg depressions from the L/B Brave Tern appear to be recovering at different rates. The two southwestern depressions are barely visible in the May 2017 survey data and have infilled (recovered) by 65 to 75 percent. Bathymetry data also reveal a prominent ripple field where the two southwestern leg depressiosn are located. The two northeastern leg depressions are clearly visible in the May 2017 data and have only infilled (recovered) by about 30 to 45 percent.

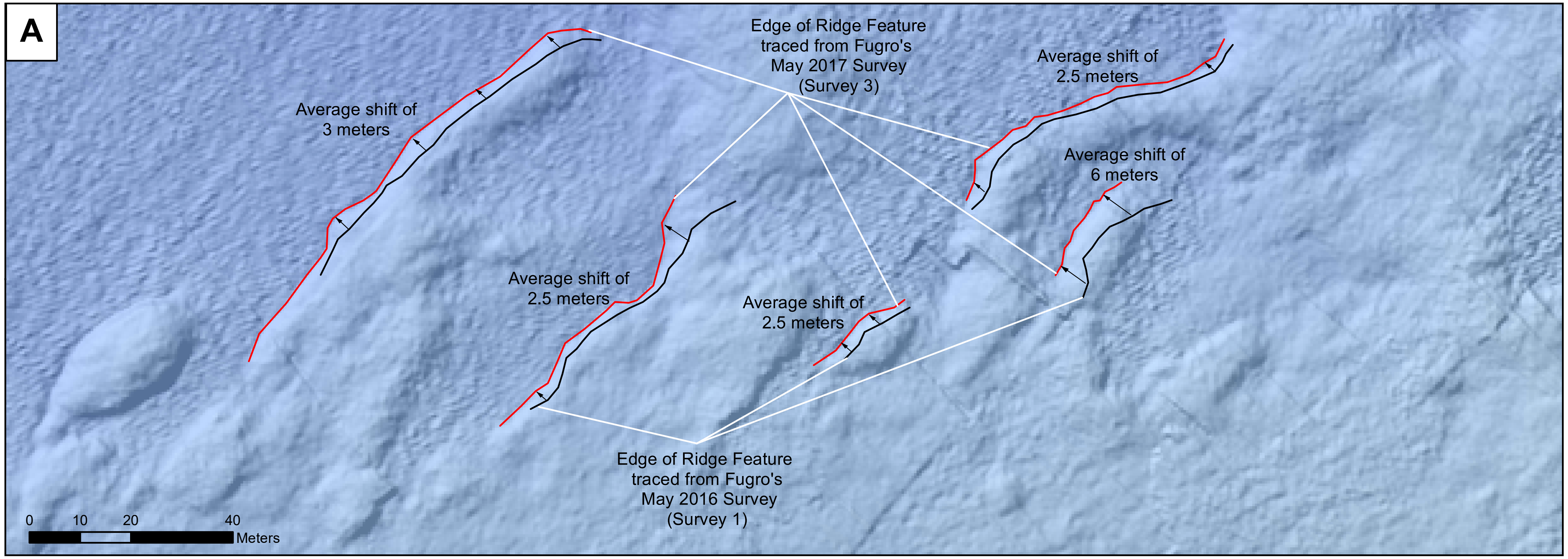
N
W E
S

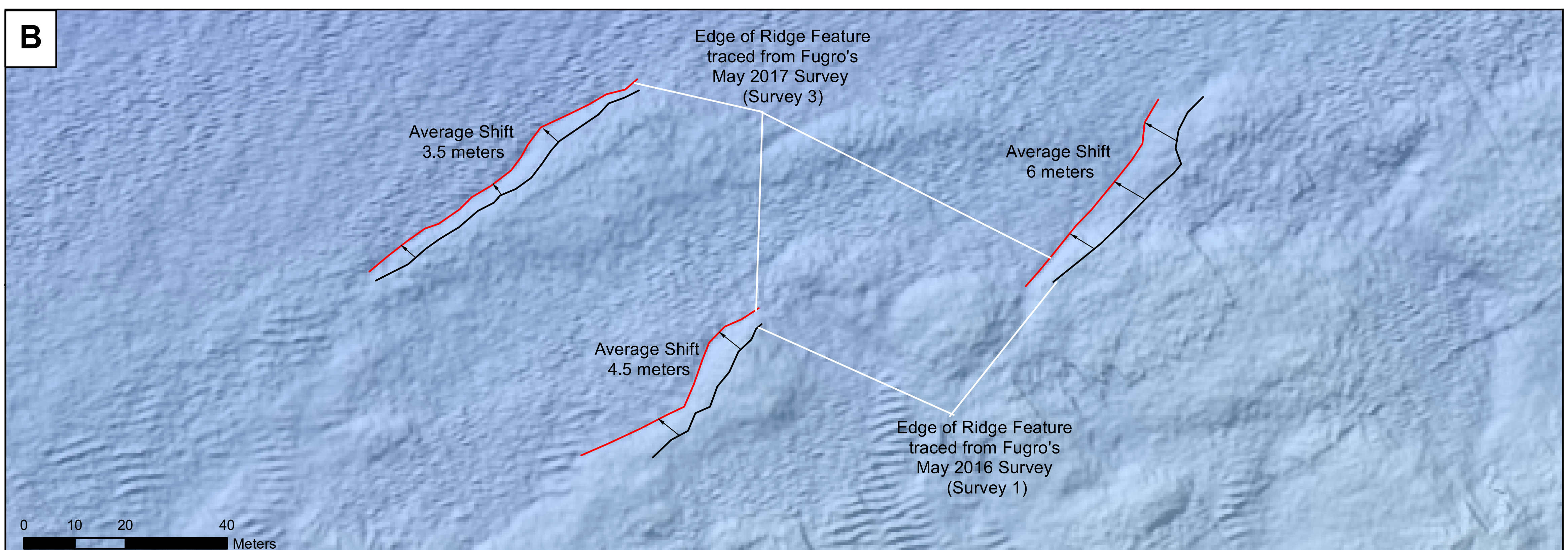
Coordinate System: UTM 19N, NAD83, Meter

SURFICIAL SEDIMENT DIFFERENTIAL RECOVERY
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

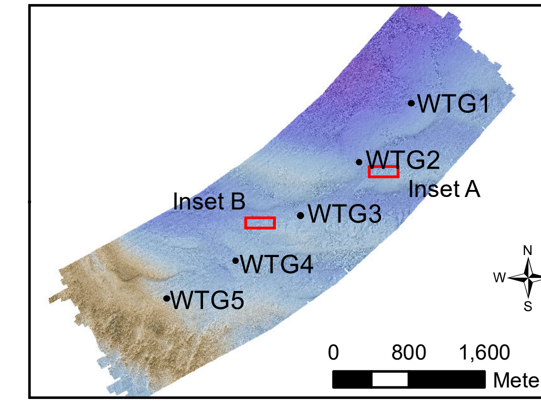
FIGURE 11

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_3\MXD\Fig-11_Surficial_Sediment_Recovery_Comparison_WTG4.mxd, 6/19/2017, greenwoodm





Inset Map Locations



Notes:

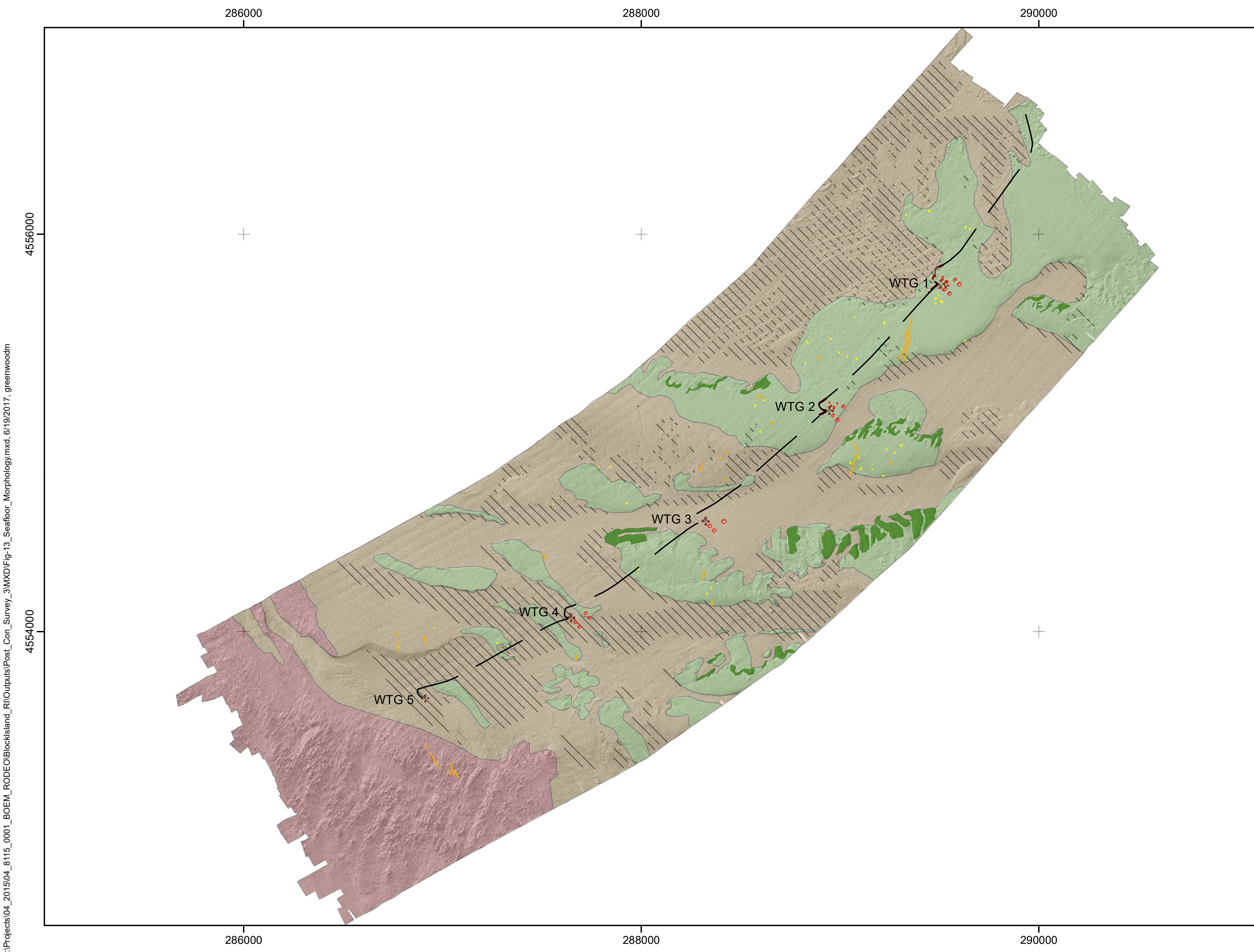
The comparison of bedform features from the two surveys (May 2016 and May 2017) conducted about one year apart, indicate that the bedorms have shifted approximately 2.5 to 6 meters to the northwest. The red and black lines represent the interpreted feature from the May 2017 and May 2016 surveys, respectively.

Coordinate System: UTM 19N, NAD83, Meter

BEDFORM CHANGES REVEALED BY MAY 2016 AND MAY 2017 SURVEYS
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 12

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_3\MXD\Fig-12_Surficial_Sediment_Mobility_Comparisons_Fugro_Bathy.mxd, 6/19/2017, greenwoodm



Legend

Interpreted Sediment Mobility Zones
(based on particle size, morphology, and comparison between 2012, 2016, and 2017 surveys)

- 1 High Mobility Ridges or Shoals (Fine Sand)
  - 1a Higher Mobility Sand Dunes
- 2 Moderate Mobility (Medium-Coarse Sand)
  - 2a Sand Ripple Area
- 3 Low Mobility Morraine Ridges (Gravel, Cobbles, and Boulders)

Interpreted Seafloor Disturbance Features

- Spud Location
- Scour
- Linear Feature Location
- Other Seafloor Disturbance

- Inter-array Cable

N
W E
S

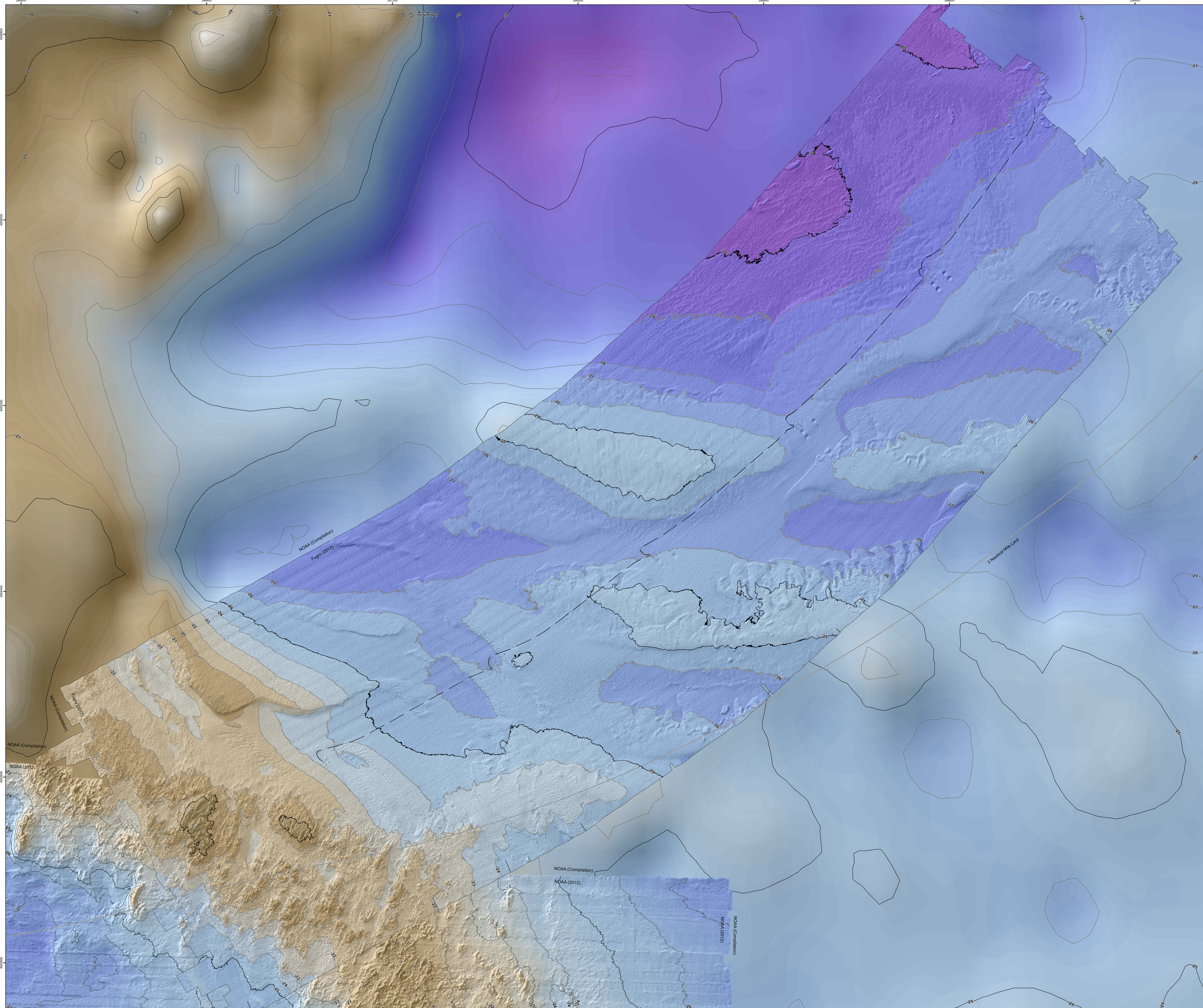
0 400 800 Meters

Coordinate System: UTM 19N, NAD83, Meter

INTERPRETED SEDIMENTARY ENVIRONMENTS
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 13

CHARTS



LEGEND

- - - Export Cable/Inter Array Cable

3 Nautical Mile Limit

Bathymetry (Meters, MLLW)

-16.9 to -16	-24.9 to -24
-17.9 to -17	-25.9 to -25
-18.9 to -18	-26.9 to -26
-19.9 to -19	-27.9 to -27
-20.9 to -20	-28.9 to -28
-21.9 to -21	-29.9 to -29
-22.9 to -22	-30.8 to -30
-23.9 to -23	

Major Contour is 5 meters

Minor Contour is 1 meter

Notes:

1. Fugro marine survey data were collected on May 18 and 19, 2017 onboard the R/V Westerly using a high-resolution integrated multibeam bathymetric survey system.

2. Differential Global Positioning System (DGPS) corrections were obtained from Fugro's OmniStar GNSS in real-time via a G2 subscription.

3. Survey equipment utilized for data collection included the following systems:
-Reson SeaBat 7125 SV2 Multibeam Echosounder (MBES)
-Applanix POS MV 320 (v4) Motion Reference Unit & Positioning System
-Applied Microsystems Limited (AML) SmartProbe for Sound Velocity Profiles
-FPI's WinFrog (v3.10.49) navigation and data acquistion software

4. NOAA (2012) Multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

5. NOAA Compiled: Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

GEODETIC INFORMATION

SPHEROID:	GRS 1980
SEMI-MAJOR AXIS:	6,378,137.0000
SEMI-MINOR AXIS:	6,356,752.3141
INVERSE FLATTENING:	298.257222101
ECCENTRICITY^2:	0.006694380
PROJECTION:	UNIVERSAL TRANSVERSE MERCATOR
ZONE:	ZONE 19 NORTH
LONGITUDE OF ORIGIN:	0°
FALSE EASTING:	500,000
FALSE NORTHING:	0

N W E S

Coordinate Grid is UTM Zone 19N, NAD 1983, Meters

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Fax: (757) 625-3352
www.fugro.com

N W E S

SURVEY 3 (MAY 2017) BATHYMETRY

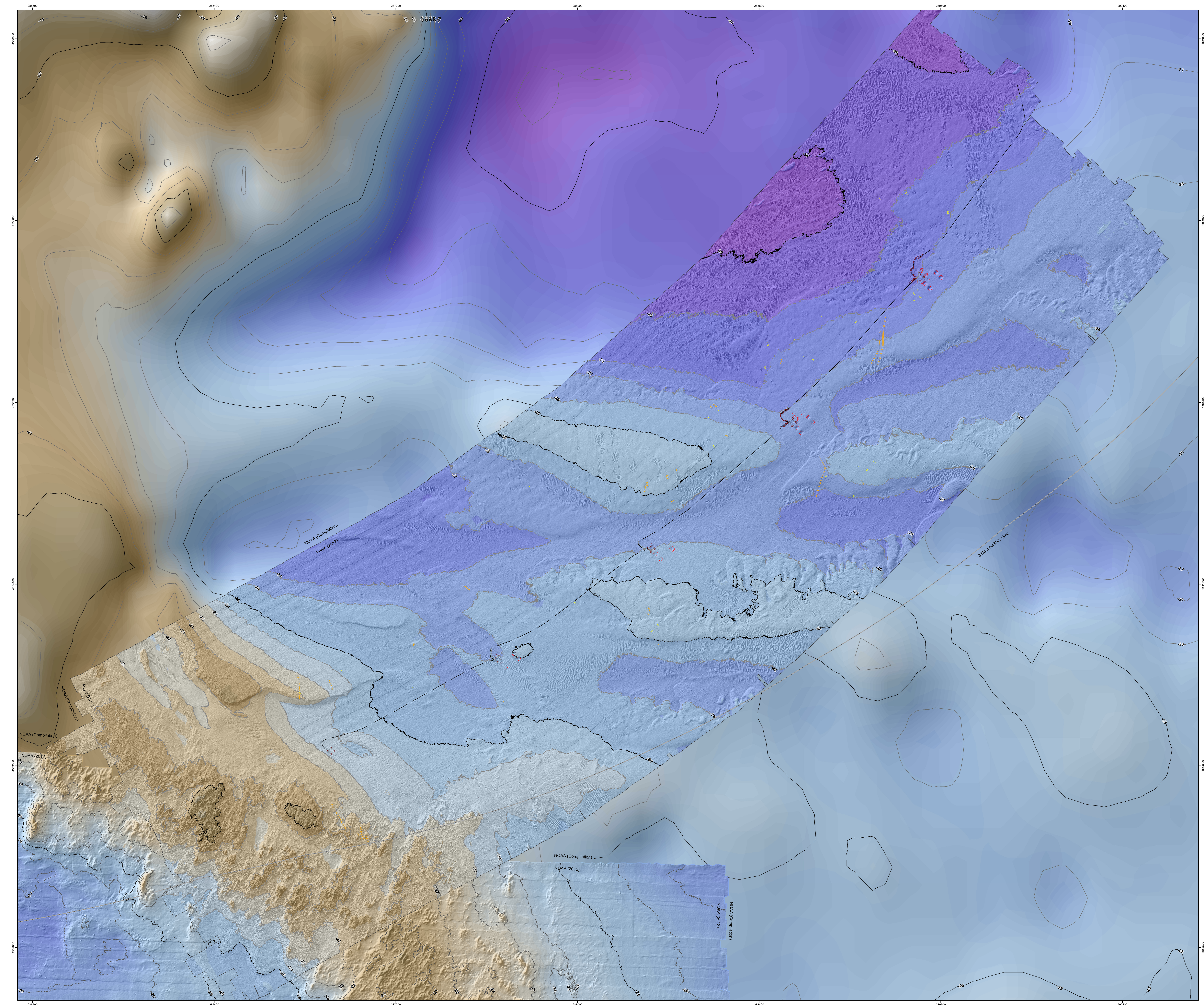
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 0.25 0.5 Kilometers

0 0.125 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2017	Survey 3 (May 2017) Report	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 CHART NO.: 1



LEGEND

- - - Export Cable/Inter Array Cable

3 Nautical Mile Limit

Bathymetry (Meters, MLLW)

-16.9 to -16	-24.9 to -24
-17.9 to -17	-25.9 to -25
-18.9 to -18	-26.9 to -26
-19.9 to -19	-27.9 to -27
-20.9 to -20	-28.9 to -28
-21.9 to -21	-29.9 to -29
-22.9 to -22	-30.8 to -30
-23.9 to -23	

Major Contour is 5 meters

Minor Contour is 1 meter

Interpreted Seafloor Disturbance Features

Spud Location

Scour

Linear Feature

Other Seafloor Disturbance

Notes:

1. Fugro marine survey data were collected on May 18 and 19, 2017 onboard the R/V Westerly using a high-resolution integrated multibeam bathymetric survey system.

2. Differential Global Positioning System (DGPS) corrections were obtained from Fugro's OmniStar GNSS in real-time via a G2 subscription.

3. Survey equipment utilized for data collection included the following systems:
-Reson SeaBat 7125 SV2 Multibeam Echosounder (MBES)
-Applanix POS MV 320 (v4) Motion Reference Unit & Positioning System
-Applied Microsystems Limited (AML) SmartProbe for Sound Velocity Profiles
-FPI's WinFrog (v3.10.49) navigation and data acquistion software

4. NOAA (2012) Multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

5. NOAA Compiled: Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

GEODETIC INFORMATION

SPHEROID:	GRS 1980
SEMI-MAJOR AXIS:	6,378,137.0000
SEMI-MINOR AXIS:	6,356,752.3141
INVERSE FLATTENING:	298.257222101
ECCENTRICITY^2:	0.006694380
PROJECTION:	UNIVERSAL TRANSVERSE MERCATOR
ZONE:	ZONE 19 NORTH
LONGITUDE OF ORIGIN:	0°
FALSE EASTING:	500,000
FALSE NORTHING:	0

N W E S

Coordinate Grid is UTM Zone 19N, NAD 1983, Meters

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Norfolk, Virginia 23510
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Fax: (757) 625-3352
www.fugro.com

N W E S

INTERPRETED SEAFLOOR DISTURBANCE FEATURES FROM SURVEY 3 (MAY 2017)

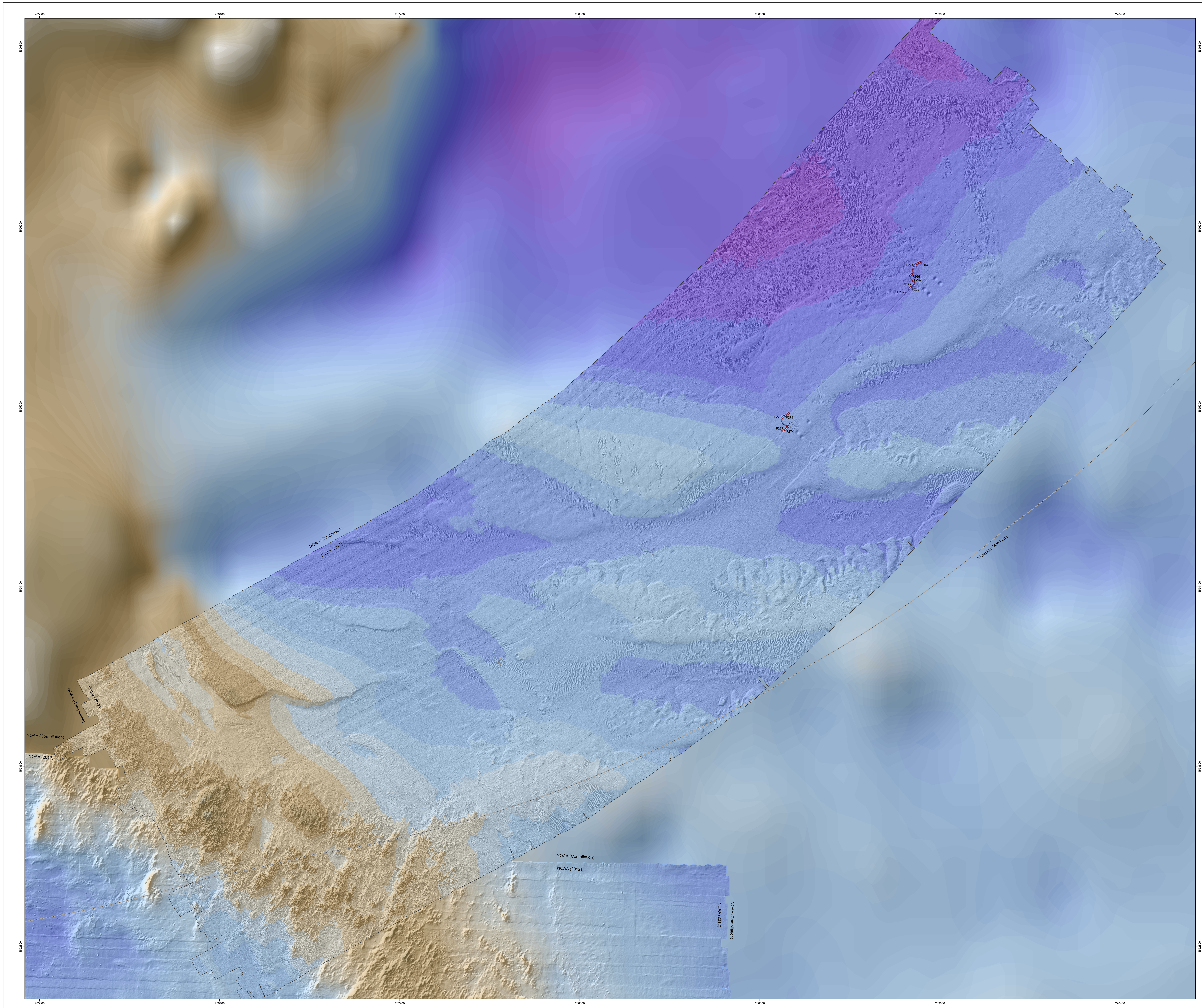
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 0.25 0.5 Kilometers

0 0.125 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2017	Survey 3 (May 2017) Report	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 CHART NO.: 2



LEGEND

3 Nautical Mile Limit

Bathymetry (Meters, MLLW)

-16.9 to -16	-24.9 to -24
-17.9 to -17	-25.9 to -25
-18.9 to -18	-26.9 to -26
-19.9 to -19	-27.9 to -27
-20.9 to -20	-28.9 to -28
-21.9 to -21	-29.9 to -29
-22.9 to -22	-30.8 to -30
-23.9 to -23	

Interpreted Seafloor Disturbance Features

Scour

Notes:

1. Fugro marine survey data were collected on May 18 and 19, 2017 onboard the R/V Westerly using a high-resolution integrated multibeam bathymetric survey system.

2. Differential Global Positioning System (DGPS) corrections were obtained from Fugro's OmniStar GNSS in real-time via a G2 subscription.

3. Survey equipment utilized for data collection included the following systems:
-Reson SeaBat 7125 SV2 Multibeam Echosounder (MBES)
-Applanix POS MV 320 (v4) Motion Reference Unit & Positioning System
-Applied Microsystems Limited (AML) SmartProbe for Sound Velocity Profiles
-FPI's WinFrog (v3.10.49) navigation and data acquistion software

4. NOAA (2012) Multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

5. NOAA Compiled: Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

GEODETIC INFORMATION

SPHEROID:	GRS 1980
SEMI-MAJOR AXIS:	6,378,137.0000
SEMI-MINOR AXIS:	6,356,752.3141
INVERSE FLATTENING:	298.257222101
ECCENTRICITY^2:	0.006694380
PROJECTION:	UNIVERSAL TRANSVERSE MERCATOR
ZONE:	ZONE 19 NORTH
LONGITUDE OF ORIGIN:	0°
FALSE EASTING:	500,000
FALSE NORTHING:	0

N W E S

Coordinate Grid is UTM Zone 19N, NAD 1983, Meters

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Norfolk, Virginia 23510
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Fax: (757) 625-3352
www.fugro.com

N W E S

SEAFLOOR DISTURBANCE FEATURE CATALOGUE FROM SURVEY 3 (MAY 2017)

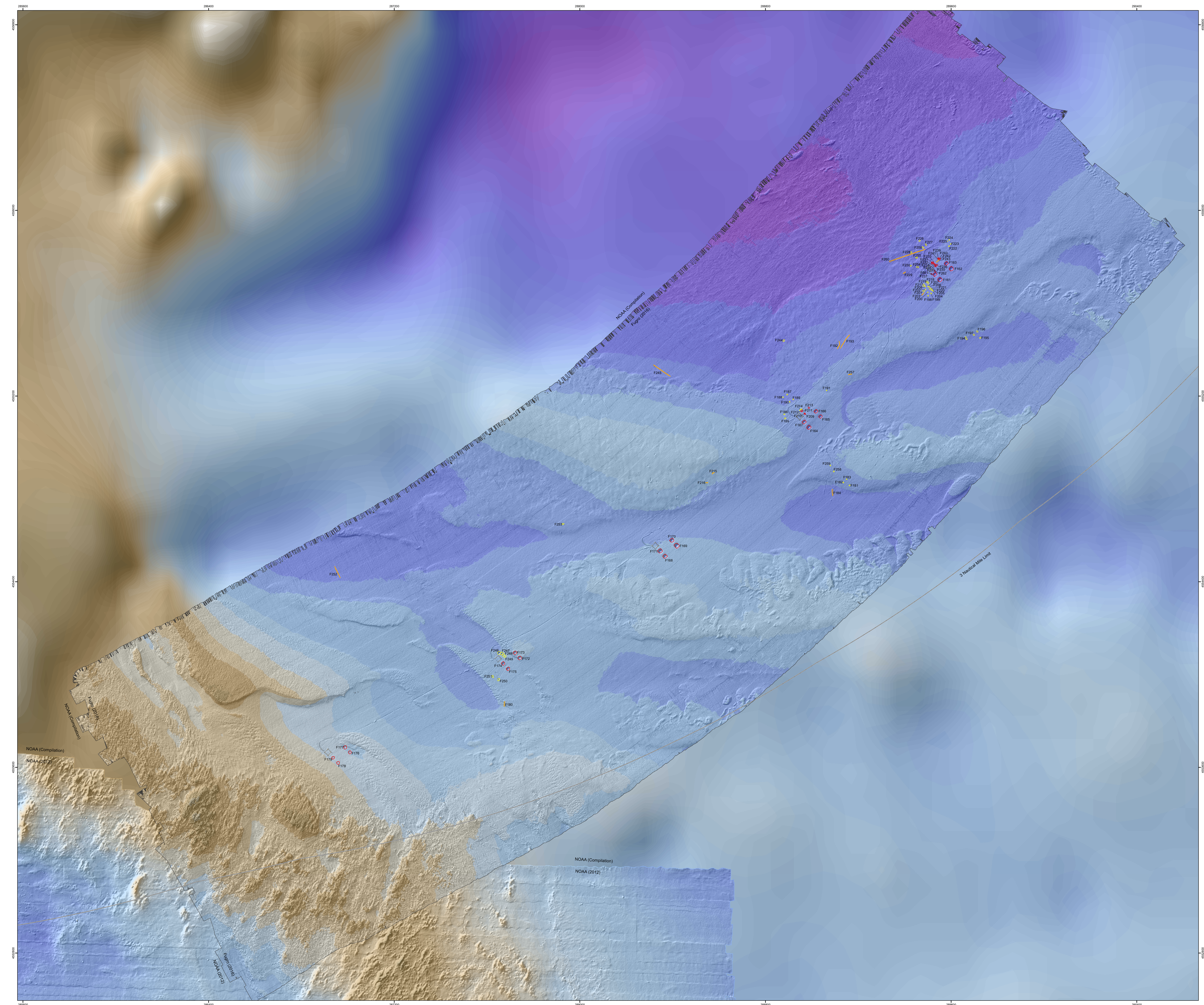
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 0.25 0.5 Kilometers

0 0.125 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2017	Survey 3 (May 2017) Report	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 CHART NO.: 3



LEGEND

3 Nautical Mile Limit

Bathymetry (Meters, MLLW)

-16.9 to -16	-24.9 to -24
-17.9 to -17	-25.9 to -25
-18.9 to -18	-26.9 to -26
-19.9 to -19	-27.9 to -27
-20.9 to -20	-28.9 to -28
-21.9 to -21	-29.9 to -29
-22.9 to -22	-30.8 to -30
-23.9 to -23	

Interpreted Seafloor Disturbance Features

- Spud Location
- Scour
- Linear Feature
- Other Seafloor Disturbance

Notes:

1. Fugro marine survey data were collected from October 02 through October 05, 2016 onboard the R/V Westerly using a high-resolution integrated multibeam bathymetric survey system.

2. Differential Global Positioning System (DGPS) corrections were obtained from Fugro's OmniStar GNSS in real-time via a G2 subscription.

3. Survey equipment utilized for data collection included the following systems:
-Reson SeaBat 7125 SV2 Multibeam Echosounder (MBES)
-Applanix POS MV 320 (v4) Motion Reference Unit & Positioning System
-Applied Microsystems Limited (AML) SmartProbe for Sound Velocity Profiles
-FPI's WinFrog (v3.10.49) navigation and data acquistion software

4. NOAA (2012) Multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

5. NOAA Compiled: Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

GEODETIC INFORMATION

SPHEROID:	GRS 1980
SEMI-MAJOR AXIS:	6,378,137.0000
SEMI-MINOR AXIS:	6,356,752.3141
INVERSE FLATTENING:	298.257222101
ECCENTRICITY^2:	0.006694380
PROJECTION:	UNIVERSAL TRANSVERSE MERCATOR
ZONE:	ZONE 19 NORTH
LONGITUDE OF ORIGIN:	0°
FALSE EASTING:	500,000
FALSE NORTHING:	0

N W E S

Coordinate Grid is UTM Zone 19N, NAD 1983, Meters

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Norfolk, Virginia 23510
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SEAFLOOR DISTURBANCE FEATURE CATALOGUE FROM SURVEY 2 (OCT. 2016)

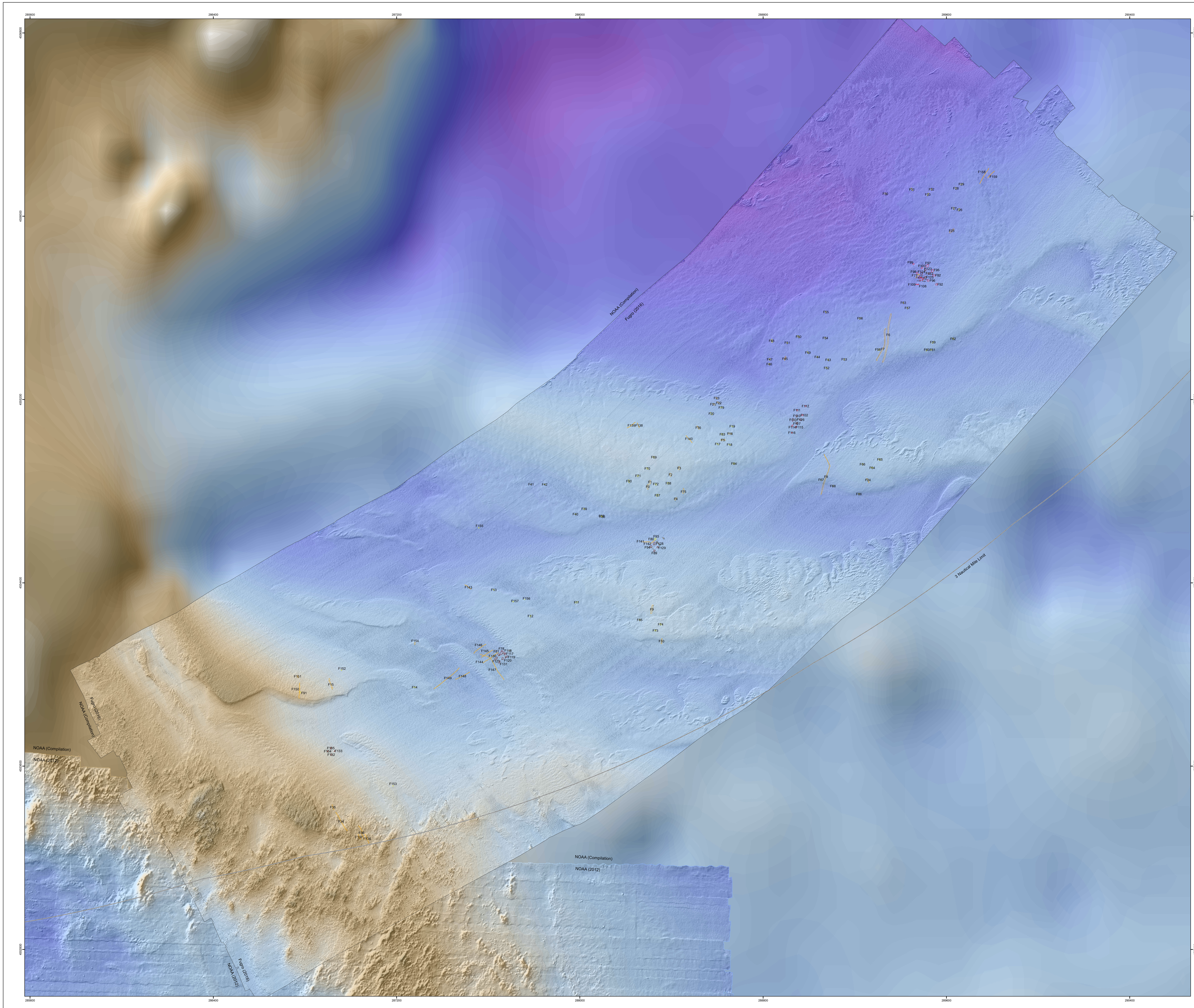
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 — 0.25 — 0.5 Kilometers

0 — 0.125 — 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	Feb. 2017	Survey 3 (May 2017) Report	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 CHART NO.: 4



LEGEND

3 Nautical Mile Limit

Bathymetry (Meters, MLLW)

-16.9 to -16	-24.9 to -24
-17.9 to -17	-25.9 to -25
-18.9 to -18	-26.9 to -26
-19.9 to -19	-27.9 to -27
-20.9 to -20	-28.9 to -28
-21.9 to -21	-29.9 to -29
-22.9 to -22	-30.8 to -30
-23.9 to -23	

Interpreted Seafloor Disturbance Features

- Spud Location
- Scour
- Linear Feature
- Other Seafloor Disturbance

Notes:

1. Fugro marine survey data were collected from May 11 through May 13, 2016 onboard the R/V Jamie Hanna using a high-resolution integrated multibeam bathymetric survey system.

2. Differential Global Positioning System (DGPS) corrections were obtained from Fugro's OmniStar GNSS in real-time via a G2 subscription.

3. Survey equipment utilized for data collection included the following systems:
-Reson SeaBat 7125 SV2 Multibeam Echosounder (MBES)
-Applanix POS MV 320 (v4) Motion Reference Unit & Positioning System
-Applied Microsystems Limited (AML) SmartProbe for Sound Velocity Profiles
-FPI's WinFrog (v3.10.49) navigation and data acquistion software

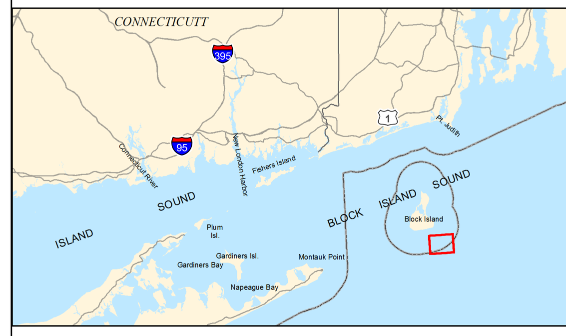
4. NOAA (2012) Multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

5. NOAA Compiled: Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

GEODETIC INFORMATION

SPHEROID:	GRS 1980
SEMI-MAJOR AXIS:	6,378,137.0000
SEMI-MINOR AXIS:	6,356,752.3141
INVERSE FLATTENING:	298.257222101
ECCENTRICITY^2:	0.006694380
PROJECTION:	UNIVERSAL TRANSVERSE MERCATOR
ZONE:	ZONE 19 NORTH
LONGITUDE OF ORIGIN:	0°
FALSE EASTING:	500,000
FALSE NORTHING:	0

Coordinate Grid is UTM Zone 19N, NAD 1983, Meters



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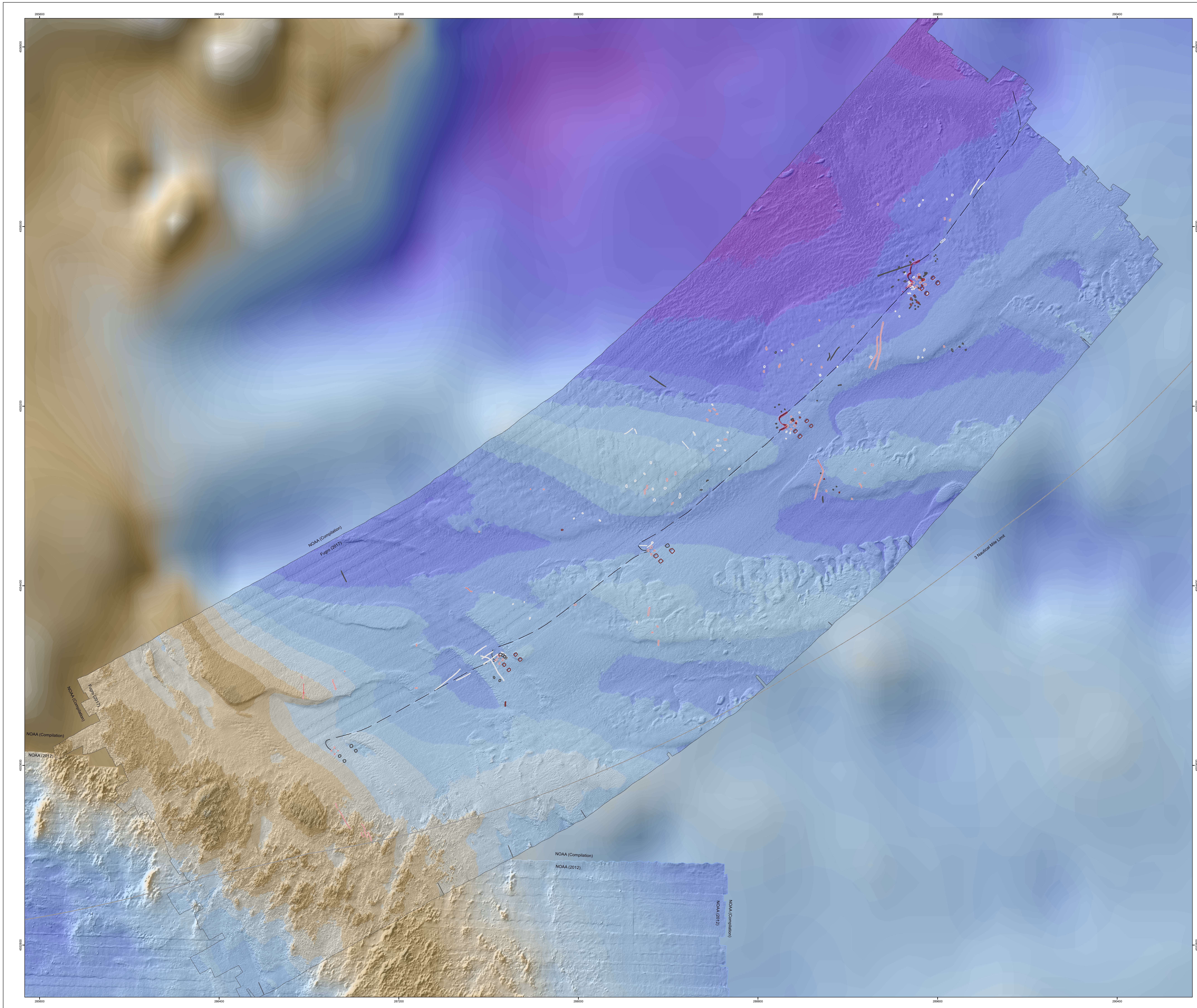
SEAFLOOR DISTURBANCE FEATURE CATALOGUE FROM SURVEY 1 (MAY 2016)

Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 — 0.25 — 0.5 Kilometers
0 — 0.125 — 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	Feb. 2017	Survey 3 (May 2017) Report	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 CHART NO.: 5



LEGEND

- - - Export Cable/Inter Array Cable

3 Nautical Mile Limit

Bathymetry (Meters, MLLW)

-16.9 to -16	-24.9 to -24
-17.9 to -17	-25.9 to -25
-18.9 to -18	-26.9 to -26
-19.9 to -19	-27.9 to -27
-20.9 to -20	-28.9 to -28
-21.9 to -21	-29.9 to -29
-22.9 to -22	-30.8 to -30
-23.9 to -23	

Interpreted Seafloor Disturbance Features

Construction Season 1 (Survey 1--May 2016)

Construction Season 2 (Survey 2--Oct. 2016)

Survey 3 (May 2017)

Notes:

1. Fugro marine survey data were collected on May 18 and 19, 2017 onboard the R/V Westerly using a high-resolution integrated multibeam bathymetric survey system.

2. Differential Global Positioning System (DGPS) corrections were obtained from Fugro's OmniStar GNSS in real-time via a G2 subscription.

3. Survey equipment utilized for data collection included the following systems:
-Reson SeaBat 7125 SV2 Multibeam Echosounder (MBES)
-Applanix POS MV 320 (v4) Motion Reference Unit & Positioning System
-Applied Microsystems Limited (AML) SmartProbe for Sound Velocity Profiles
-FPI's WinFrog (v3.10.49) navigation and data acquistion software

4. NOAA (2012) Multibeam bathymetric data is from the National Oceanic and Atmospheric Administration's (NOAA) hydrographic survey of Block Island Sound, New York. This survey was conducted August 25 through August 29, 2012.

5. NOAA Compiled: Bathymetric data is a compilation of NOAA sounding files in the area that were collected between 1938 to 1979.

GEODETIC INFORMATION

SPHEROID:	GRS 1980
SEMI-MAJOR AXIS:	6,378,137.0000
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INVERSE FLATTENING:	298.257222101
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PROJECTION:	UNIVERSAL TRANSVERSE MERCATOR
ZONE:	ZONE 19 NORTH
LONGITUDE OF ORIGIN:	0°
FALSE EASTING:	500,000
FALSE NORTHING:	0

N W E S

Coordinate Grid is UTM Zone 19N, NAD 1983, Meters

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N W E S

INTERPRETED SEAFLOOR DISTURBANCE FEATURES PER SURVEY

Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 0.25 0.5 Kilometers

0 0.125 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2017	Survey 3 (May 2017) Report	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001

CHART NO.: 6

A. BATHYMETRIC SURVEY VESSEL SPECIFICATIONS

A. SURVEY ACQUISITION AND PROCESSING

Fugro Marine GeoServices, Inc., Fugro, was contracted by HDR to perform a bathymetric survey of the Block Island Wind Farm and the corresponding cable route. Survey operations were carried out on May 18 – 19, 2017. Multibeam bathymetry was acquired to provide current sounding data for the area in the vicinity of the wind turbines and the cable route.

Data were acquired using a high-resolution integrated multibeam bathymetric survey system. The water depths surveyed ranged from approximately 20 to 32 meters in the wind farm area and 4 to 40 meters across the cable route, based on the charted datum of Mean Lower Low Water (MLLW).

A.1 DATA ACQUISITION

A.1.1 Vessel

The *R/V Westerly*, a 50-foot survey vessel, was used for the project. The vessel was equipped with the following primary equipment for execution of the survey:

- Reson SeaBat 7125 SV2 Dual Head Multibeam Echosounder (MBES)
- Applanix POS MV 320 (v4) Motion Reference Unit & Positioning System
- Applied Microsystems Limited (AML) SmartProbe, for Sound Velocity Profiles
- FPI's WinFrog (v3.10.49) navigation and data acquisition software.

A.1.2 GPS Vessel Positioning

Primary positioning data was provided by the POS MV 320 system. Position was determined in real time using a Trimble Zephyr L1/L2 GPS antenna, which was connected to a Trimble BD960 L1/L2 GPS card residing in the POS MV. An Inertial Measurement Unit (IMU) provided velocity values to the POS MV allowing it to compute an inertial position based on Differential GPS (DGPS), heading, and motion.

The POS MV was configured to accept differential corrections in the WGS84 (g1150) reference frame, received from Fugro's OmniStar GNSS subscription.

The POS MV controller software's real-time QC displays were monitored throughout the survey to ensure positional accuracies stayed within industry standards. These displays include, but are not limited to GPS Status, Position Accuracy, Receiver Status (which included HDOP), and Satellite Status.

WinFrog (v. 3.10.49) navigation software, running on a Windows 7-based PC, was used for vessel navigation. WinFrog presented vessel position data in graphical and tabular format for QC purposes. The following display windows were used:

- Graphics – the Graphics window showed an overview of navigation, including vessel position and orientation, survey lines, background plots, charts, and waypoints.
- Vehicle – the Vehicle window was configured to show tabular navigation information. This window displayed position, time, line name, heading, course over ground, speed, and data/event status.

A.1.3 Project Datum

All bathymetry was processed in WGS84 (g1150). The data were projected in Universal Transverse Mercator (UTM), zone 19 North.

TABLE 1 – PROJECT DATUM

Datum	WGS 1984 (g1150)
Ellipsoid/ Spheroid	WGS 1984
Semi-Major Axis	6378137.00 m
Semi-Minor Axis	6356752.314245179 m
Inverse Flattening (1/f)	298.257223563
Projection	UTM
Zone	19 North
Unit	Meters
Latitude of Origin	0.0º
Central Meridian (CM)	-69.0º
False Easting	500,000 m
False Northing	0 m
Scale Factor	0.9996

A.1.4 Vertical Datum

Bathymetric data were reduced to MLLW based on the National Oceanic and Atmospheric Administration (NOAA) VDatum model (http://vdatum.noaa.gov). This model provides separation values from the GNSS ellipsoid down to the chart datum of MLLW for the survey area.

A.1.5 Motion Sensor and Vessel Heading

A POS MV 320 motion sensor system measured the vessel's dynamic motion and orientation (heave, pitch, roll and heading). The system consists of an inertial motion unit (IMU), two GPS receivers, and a processing unit.

The IMU uses a series of linear accelerometers and angular rate sensors that work in tandem to determine vessel attitude solutions. The combined GPS solution of each antenna is used to calculate the orientation and heading of the vessel. Offsets for the IMU and GPS antenna are presented in the vessel offset diagram in Figure A-1.

Motion, heading, and position data were sent to WinFrog for navigation and data logging purposes during MBES acquisition.

A.1.6 Sound-Velocity Profiles

Sound-velocity profile (SVP) data were acquired using an Applied Microsystems Ltd. (AML) Smart Probe. The AML Smart probe measures at a maximum rate of 10 velocity and pressure observations per second. For each cast, the probe was held at the surface for approximately two minutes to reach temperature equilibrium. The probes were then manually lowered at the rate of about 1 m/s to the seafloor and raised to the surface at the same rate.

Sound-velocity casts were conducted regularly to ensure MBES data could be corrected for refraction. Casts were spaced geographically and temporally to create an accurate model of the sound velocity profile for the water column across the survey area.

A.1.7 Multibeam Echosounder

The *R/V Westerly* was equipped with an over-the-stern, pole-mounted dual-head Reson SeaBat 7125 SV2 MBES system, designed to operate between water depths of 0.5 m to 300 m. The two multibeam sonars were mounted with a 30-degree vertical offset between the port and starboard transducers. The MBES was used to collect bathymetry data over the entire area. Survey speed was kept between 4 to 7 knots to ensure low turbulence around the multibeam transducer pole.

Data received by the SeaBat sonar-processing unit was sent to WinFrog, where bathymetry quality was continually monitored during acquisition. Various windows displayed a 3D bathymetry profile, sonar beam amplitude measurements, and swath coverage to allow adjustments to sonar settings or vessel speed, when appropriate. A parameter window also displayed position, speed, heading, and attitude data that was received from the POS MV 320.

WinFrog was used to start and stop data logging in .S7K file format and to name lines. Power, gain, and range settings were controlled directly through the Reson user interface monitor and varied according to water depth and data quality. Settings were noted on the multibeam line logs, using FPI's MB Survey Tools software.

A.2 DATA PROCESSING

A.2.1 HORIZONTAL AND VERTICAL CONTROL

The real-time navigation and position data were used as the geodetic control, receiving Differential GNSS corrections in real-time via a G2 subscription to Fugro's OmniStar service.

All real-time positioning data were converted to WGS84 (g1150) in the Applanix POS MV. This real-time positioning was used to process the multibeam survey lines.

A.2.2 Vertical Control

The vertical datum for this project was the MLLW datum. The separation values form the GNSS ellipsoid to the MLLW datum were calculated using NOAA's VDatum software. These values were then applied to the bathymetry in CARIS HIPS' Compute GPS Tide routine.

A.2.3 Bathymetry

All soundings were processed using CARIS HIPS software on Windows 7 workstations. CARIS was used to process, clean, and produce Digital Terrain Models (DTM) and finalized XYZ ASCII files.

A.2.4 Corrections to Bathymetry Data

Within CARIS HIPS, Reson 7125 SV2 soundings were corrected for calibrated patch test results, vessel offsets, vessel motion, draft, sound velocity, and tide.

A.2.5 Vessel Offsets

Offsets established during the mobilization were used to correct bathymetry for differences between the transducer head and GPS antenna position. Offsets are detailed in Figure A-1. Offsets were entered in the Vessel Configuration File in CARIS HIPS to correct the bathymetry during processing.

A.2.6 Sound Velocity Profiles

Processed sound velocity profiles were used to correct bathymetry data for sound refraction, or ray bending.

SVP's were applied within CARIS. FPI's Multibeam Survey Tools v 3.1.30 software was used to process the SVP data set, generating a smooth interpolation curve that depicted the original profile at the finest resolution available in CARIS.

A.2.7 Static Draft

Static draft observations were measured at the over-the-stern mount of the *R/V Westerly.* The correction was then applied to bring soundings from the transducer level to the water level. The static draft value was entered into the HIPS Vessel File (HVF) within CARIS HIPS. It should be noted that draft is actually distance from the common reference point (CRP) to the water level; CARIS takes into account the distance from the CRP to the transducer head in its calculations.

A.2.8 Data Cleaning

The .S7K files were converted to CARIS HIPS format for bathymetry processing. Prior to each survey line being converted from .S7K to CARIS' HIPS format, the vessel offsets, patch test calibration values and static draft measurements were entered into the HVF. The SVP file was then loaded into each line, and the line was corrected for sound refraction. During SVP correction the bathymetry was also corrected for dynamic vessel heave, pitch and roll. The attitude, heading, navigation, and bathymetry data were examined for noise and gaps. Beam filters were used to reject data from the outer beams of the swaths. It should be noted that rejection does not mean deletion from the data set; soundings were simply flagged as 'rejected' and could be re-accepted if necessary.

After each individual line was examined and cleaned in CARIS' Swath Editor (Figure A2-1), the tide file was loaded, and the lines were merged. During merging, tide and draft corrections were applied. Subsets were then created in CARIS' Subset Editor mode (Figure A2-2 A2-2), and adjacent overlapping lines of corrected bathymetry data were examined to identify any tidal busts, sound velocity errors, motion errors, or data gaps. Any residual noise in the data set was manually rejected at this time.

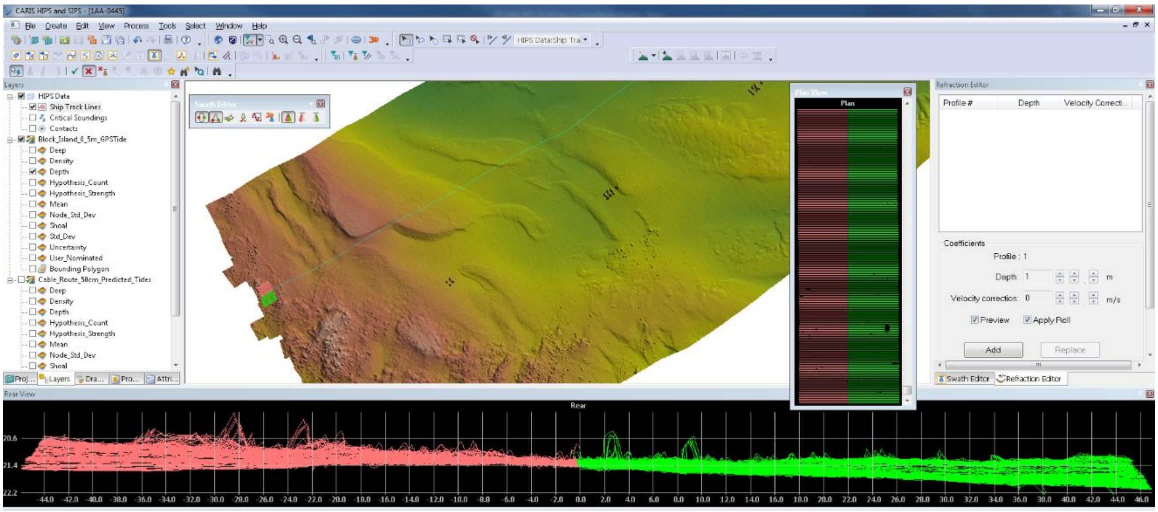


FIGURE A2-1 CARIS SWATH EDITOR

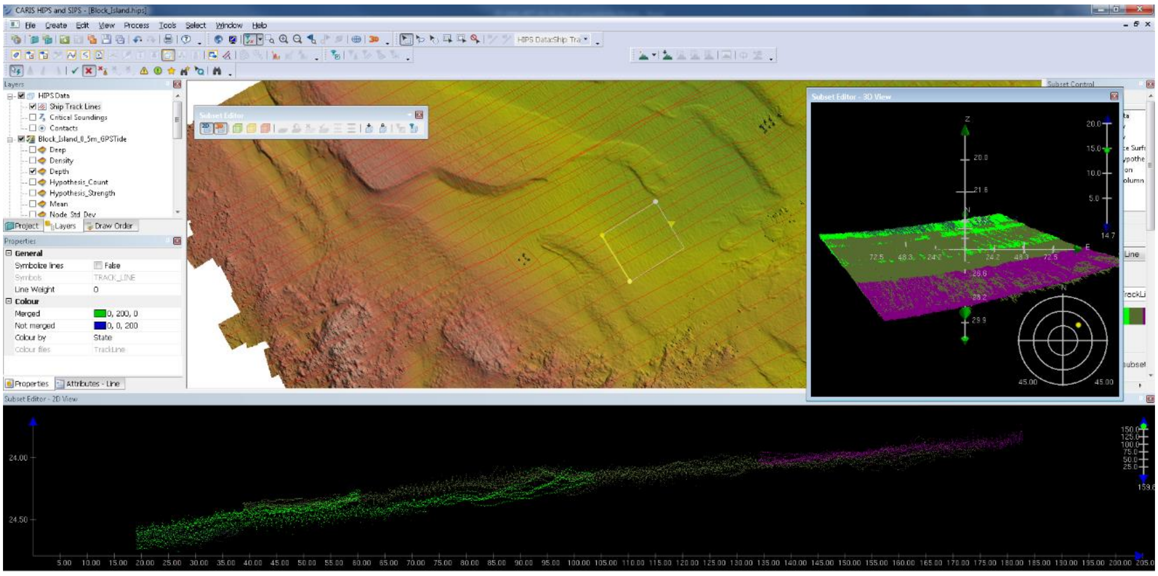


FIGURE A2-2 CARIS SUBSET EDITOR

A.2.9 DTM Generation

Once all cleaning and processing was completed, a DTM was generated with CARIS' CUBE surface routine, thus depicting a mean seafloor. Final DTM grid size was 0.5 m.

Sun-illuminated images of the DTM grids were created within CARIS using the image-manager. These images were then exported as GeoTiffs.

A.2.10 XYZ Generation

CARIS HIPS was used to export the CUBE surface model to an ASCII XYZ grid of Eastings, Northings, and Depth values in meters. The XYZ file was delivered with a grid spacing of 0.5 meters by 0.5 meters.

A.3 CALIBRATIONS AND QUALITY CONTROL

During both data acquisition and processing, various calibrations and quality control (QC) measures were performed to ensure the data met the project's accuracy specifications.

A.3.1 Vessel Offset Survey

During vessel mobilization, the offset values from the POS MV's IMU to the sonar and GNSS antennas were obtained using total station.

A.3.2 MBES Patch Test Calibration

An MBES patch test calibration was carried out on October 05, 2016 to verify the mounting offsets between the sonar heads and motion reference unit. Each sonar head of the dual-head system was calibrated independently. A patch test uses seafloor topology to bring swaths run at varying speeds, headings, and overlaps into coincidence. Patch tests are employed to correct the data for navigation timing, pitch, roll, and azimuth offsets, which may exist between the MBES transducers and the IMU.

Patch Test values were obtained in CARIS HIPS calibration mode within the Subset Editor routine. Calculated values were then entered in the HVF to ensure all survey data would be corrected for these offsets during processing (Table 2).

TABLE 2 – PATCH TEST CALIBRATION

Calibration Offset	Correction
Navigation Timing Error	0.00 s
Pitch Offset	-1.000º
Roll Offset	-0.100º
Azimuth (Yaw) Offset	-0.300º

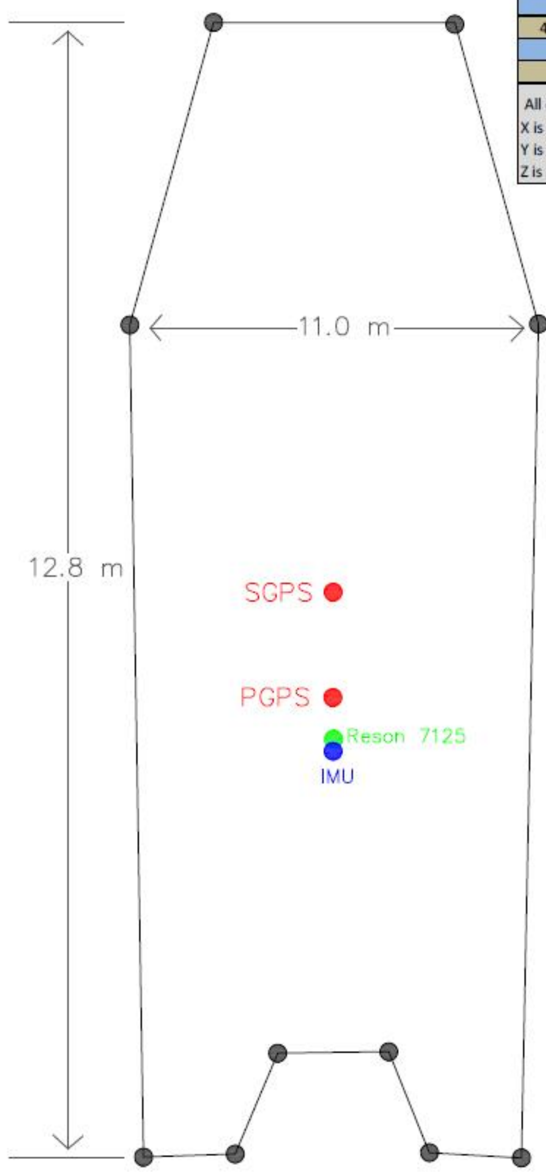
A.3.3 MBES Crosslines

Due to time constraints, crosslines were not acquired during acquisition on this phase of the project. However, quality control was easily performed by comparing this current bathymetry to the previous bathymetry in rocky areas. The peaks of rocks should always align, as the rocks are not shifting on the seafloor. Similar types of testing is less reliable over sandy seafloors due to sediment transfer causing erosion or deposition.

R/V Westerly Vessel Offsets

Sensor	X	Y	Z
IMU (CRP)	0.000	0.000	0.000
7125 Sonar Acoustic Center (for 7004 records) Port	0.000	0.142	0.675
7125 Transmit Acoustic Center (for 7027 records) Port	0.000	0.142	0.651
400 kHz Receiver Acoustic Center (for 7027 records) Port	0.000	0.321	0.675
PGPS (Phase Center - Trimble)	0.010	0.610	-4.770
SGPS (Phase Center - Trimble)	-0.014	1.791	-4.511

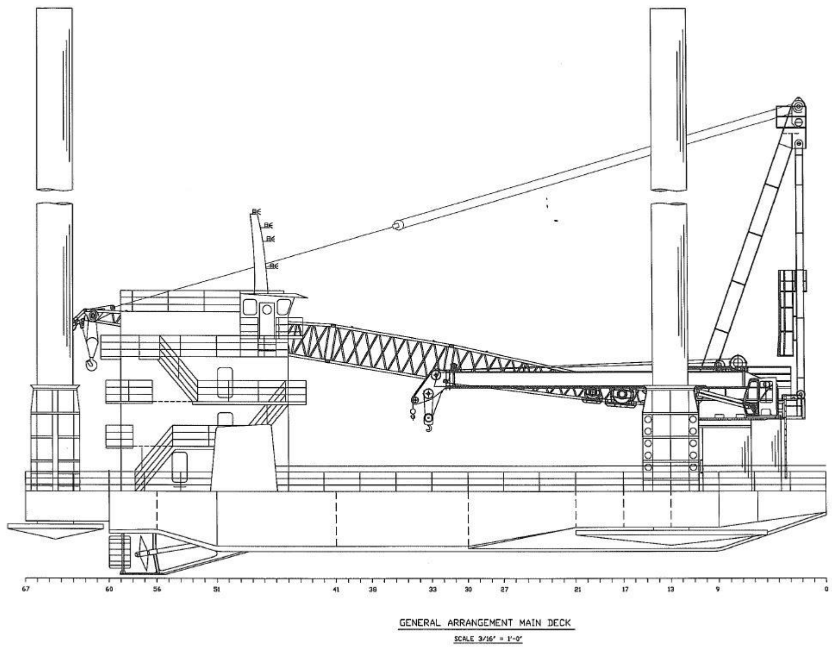
All coordinates are on the IMU reference Frame.
X is positive to Stbd
Y is positive towards Bow
Z is positive Up

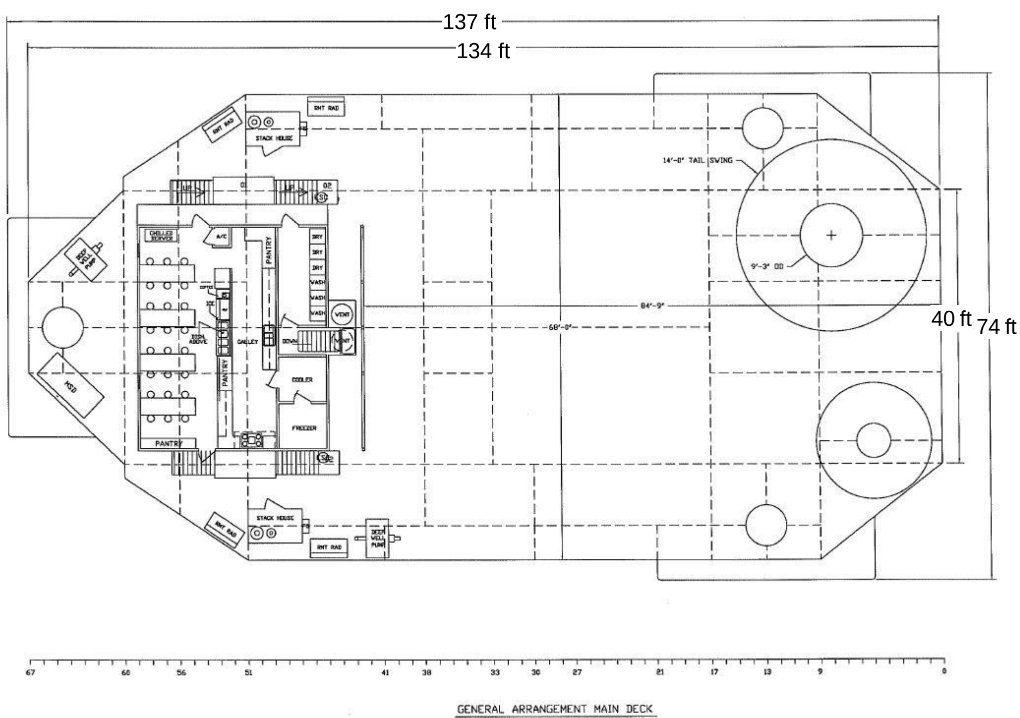


VESSEL OFFSET DIAGRAM FOR THE R/V *WESTERLY*
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE A-3

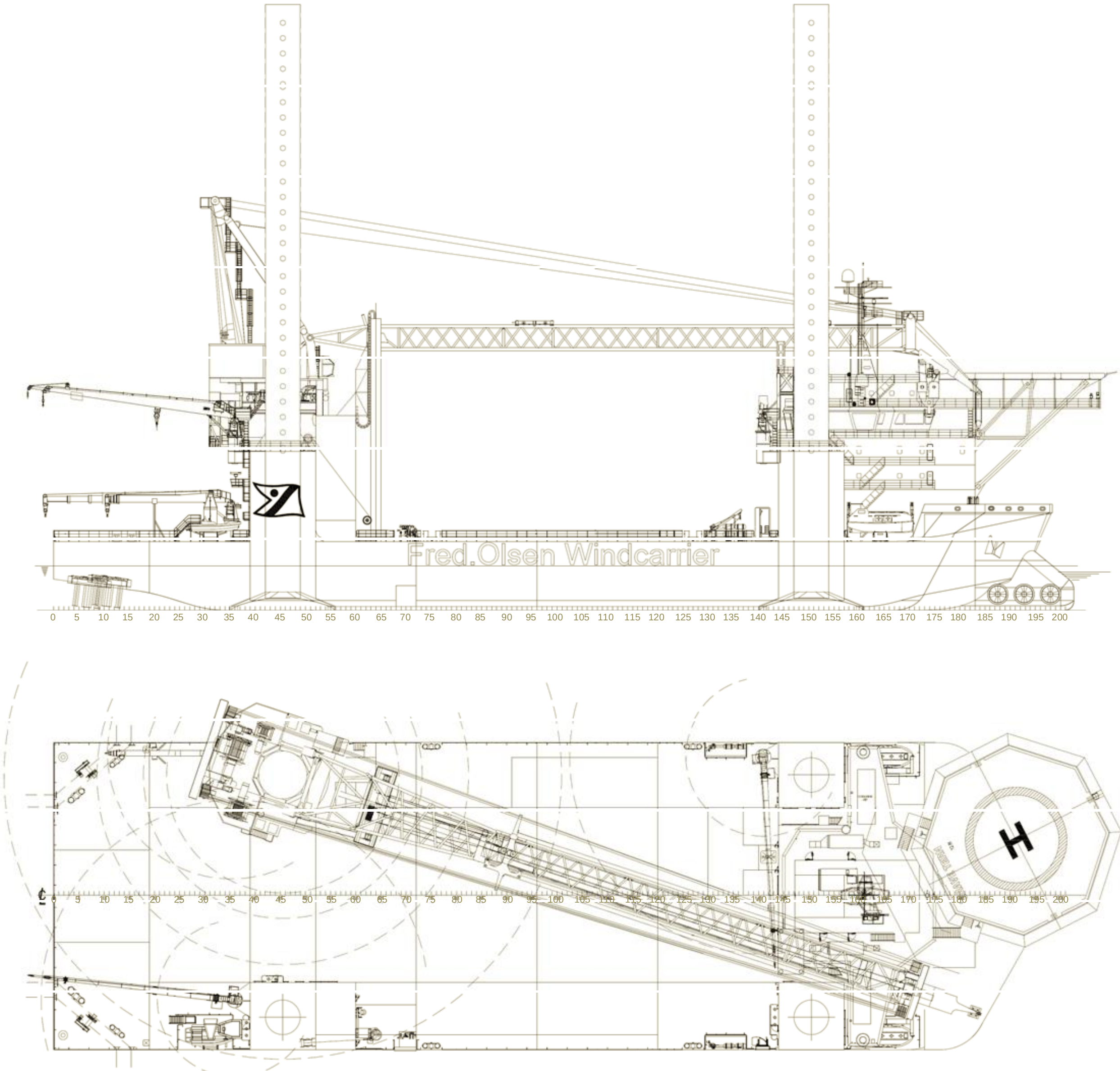
B. INSTALLATION VESSEL SPECIFICATIONS





VESSEL SPECIFICATIONS FOR THE *L/B MICHAEL EYMARD*
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE B-1



VESSEL SPECIFICATIONS FOR THE L/B *BRAVE TERN*

Seafloor Monitoring Study

Block Island Wind Farm and Transmission Project

Offshore Rhode Island

FIGURE B-2

C. CATALOG OF SEAFLOOR DISTURBANCE FEATURES

Table C-1. Seafloor Disturbance Features (Survey 3-May 2017)

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F0	4554820	288297	-25.0	54	120	0.17	Drag Mark	Unknown	1	Some Change[3]
F1	4554840	288306	-25.0	39	82	0.16	Drag Mark	Unknown	1	Some Change[3]
F2	4554870	288395	-24.8	36	72	0.14	Drag Mark	Unknown	1	Some Change[3]
F3	4554900	288433	-24.8	37	76	0.22	Drag Mark	Unknown	1	Some Change[3]
F4	4554770	288418	-25.4	33	59	0.17	Drag Mark	Unknown	1	Some Change[3]
F5	4555020	288625	-25.4	49	108	0.13	Drag Mark	Unknown	1	Mostly Healed
F6	4555470	289343	-27.0	441	983	0.12	Drag Mark	Unknown	1	Some Change[3]
F7	4555440	289322	-26.9	310	603	0.11	Drag Mark	Unknown	1	Some Change[3]
F8	4554860	289072	-26.2	380	595	0.15	Drag Mark	Unknown	1	Some Change[3]
F9	4554290	288314	-24.4	86	205	0.13	Drag Mark	Unknown	1	Some Change[3]
F10	4554150	288357	-25.1	54	97	0.11	Drag Mark	Unknown	1	Some Change[3]

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F11	4554320	287986	-25.6	30	59	0.25	Circular Depression	Unknown	1	Some Change[3]
F12	4554260	287784	-25.7	25	38	0.13	Circular Depression	Unknown	1	Mostly Healed
F13	4554370	287624	-26.2	19	24	0.09	Circular Depression	Unknown	1	Mostly Healed
F14	4553940	287279	-25.4	23	34	0.13	Circular Depression	Unknown	1	Some Change[3]
F15	4553960	286913	-23.5	95	155	0.12	Drag Mark	Unknown	1	Some Change[3]
F16	4555050	288655	-25.7	35	74	0.2	Drag Mark	Unknown	1	Some Change[3]
F17	4555010	288601	-25.3	26	42	0.15	Circular Depression	Unknown	1	Some Change[3]
F18	4555000	288653	-25.4	23	34	0.09	Circular Depression	Unknown	1	Mostly Healed
F19	4555080	288665	-25.9	22	35	0.07	Circular Depression	Unknown	1	Mostly Healed
F20	4555140	288574	-26.3	33	69	0.14	Circular Depression	Unknown	1	Some Change[3]
F21	4555180	288585	-26.7	30	48	0.18	Drag Mark	Unknown	1	Some Change[3]
F22	4555190	288606	-26.7	37	56	0.12	Drag Mark	Unknown	1	Some Change[3]

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Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F23	4555210	288597	-27.0	24	31	0.13	Drag Mark	Unknown	1	Mostly Healed
F24	4554850	289258	-26.0	50	73	0.16	Drag Mark	Unknown	1	Some Change[3]
F25	4555940	289623	-28.0	60	151	0.09	Drag Mark	Unknown	1	Mostly Healed
F26	4556030	289655	-28.1	29	51	0.08	Circular Depression	Unknown	1	Some Change[3]
F27	4556030	289632	-28.1	30	53	0.08	Circular Depression	Unknown	1	Some Change[3]
F28	4556120	289641	-28.2	26	41	0.1	Circular Depression	Unknown	1	Mostly Healed
F29	4556140	289665	-28.3	28	54	0.19	Circular Depression	Unknown	1	Mostly Healed
F30	4556100	289334	-29.6	27	51	0.07	Circular Depression	Unknown	1	Some Change[3]
F31	4556120	289449	-29.0	35	74	0.11	Circular Depression	Unknown	1	Some Change[3]
F32	4556120	289535	-28.8	19	26	0.05	Circular Depression	Unknown	1	Mostly Healed
F33	4556100	289519	-28.7	31	56	0.1	Circular Depression	Unknown	1	Mostly Healed
F34	4553360	286958	-22.0	195	247	0.2	Drag Mark	Unknown	1	Some Change[3]

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F35	4553420	286922	-21.8	52	70	0.1	Drag Mark	Unknown	1	Some Change[3]
F36	4553310	287048	-21.7	146	222	0.16	Drag Mark	Unknown	1	Some Change[3]
F37	4554690	288094	-26.3	18	22	0.1	Circular Depression	Unknown	1	Mostly Healed
F38	4554690	288098	-26.3	15	14	0.06	Circular Depression	Unknown	1	Mostly Healed
F39	4554720	288019	-26.4	20	28	0.14	Circular Depression	Unknown	1	Mostly Healed
F40	4554700	287980	-26.4	19	24	0.06	Circular Depression	Unknown	1	Mostly Healed
F41	4554830	287787	-26.8	12	11	0.1	Circular Depression	Unknown	1	Some Change[3]
F42	4554830	287846	-26.6	18	23	0.14	Circular Depression	Unknown	1	Some Change[3]
F43	4555370	289084	-27.2	25	44	0.09	Circular Depression	Unknown	1	Some Change[3]
F44	4555390	289036	-27.5	21	32	0.07	Circular Depression	Unknown	1	Some Change[3]
F45	4555380	288895	-28.0	52	80	0.13	Drag Mark	Unknown	1	Some Change[3]
F46	4555350	288826	-28.1	25	43	0.08	Circular Depression	Unknown	1	Some Change[3]

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F47	4555380	288829	-28.2	26	50	0.06	Circular Depression	Unknown	1	Mostly Healed
F48	4555460	288838	-28.5	37	76	0.07	Circular Depression	Unknown	1	Some Change[3]
F49	4555410	288995	-27.7	28	46	0.08	Circular Depression	Unknown	1	Little Change
F50	4555470	288954	-28.0	32	59	0.1	Circular Depression	Unknown	1	Some Change[3]
F51	4555450	288905	-28.2	18	22	0.05	Circular Depression	Unknown	1	Mostly Healed
F52	4555340	289077	-27.2	33	49	0.08	Circular Depression	Unknown	1	Mostly Healed
F53	4555380	289154	-27.1	18	24	0.06	Circular Depression	Unknown	1	Mostly Healed
F54	4555470	289071	-27.8	25	43	0.09	Circular Depression	Unknown	1	Mostly Healed
F55	4555580	289074	-28.4	21	26	0.09	Circular Depression	Unknown	1	Some Change[3]
F56	4555560	289223	-27.8	32	67	0.18	Circular Depression	Unknown	1	Some Change[3]
F57	4555600	289430	-27.9	22	34	0.12	Circular Depression	Unknown	1	Mostly Healed
F58	4555420	289304	-26.8	32	76	0.17	Circular Depression	Unknown	1	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F59	4555450	289541	-26.5	28	52	0.13	Circular Depression	Unknown	1	Mostly Healed
F60	4555420	289514	-26.5	29	47	0.08	Circular Depression	Unknown	1	Mostly Healed
F61	4555420	289533	-26.5	17	21	0.03	Circular Depression	Unknown	1	Mostly Healed
F62	4555470	289629	-26.5	25	44	0.08	Circular Depression	Unknown	1	Some Change[3]
F63	4555620	289412	-28.1	15	16	0.06	Circular Depression	Unknown	1	Mostly Healed
F64	4554900	289275	-25.7	27	46	0.11	Circular Depression	Unknown	1	Some Change[3]
F65	4554940	289309	-25.6	33	78	0.09	Circular Depression	Unknown	1	Some Change[3]
F66	4554920	289234	-25.7	23	38	0.06	Circular Depression	Unknown	1	Some Change[3]
F67	4554850	289053	-26.4	23	37	0.14	Circular Depression	Unknown	1	Some Change[3]
F68	4554820	289105	-27.0	24	38	0.2	Circular Depression	Unknown	1	Some Change[3]
F69	4554950	288323	-24.3	28	57	0.1	Circular Depression	Unknown	1	Mostly Healed
F70	4554900	288294	-24.4	24	35	0.1	Circular Depression	Unknown	1	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F71	4554870	288253	-24.6	25	42	0.06	Circular Depression	Unknown	1	Mostly Healed
F72	4554830	288332	-25.0	27	51	0.11	Circular Depression	Unknown	1	Mostly Healed
F73	4554190	288330	-24.6	21	31	0.07	Circular Depression	Unknown	1	Some Change[3]
F74	4554220	288352	-24.4	24	41	0.05	Circular Depression	Unknown	1	Some Change[3]
F75	4554800	288452	-25.4	43	106	0.09	Drag Mark	Unknown	1	Mostly Healed
F76	4555080	288517	-25.6	41	64	0.25	Drag Mark	Unknown	1	Mostly Healed
F77	4555740	289474	-28.1	64	89	0.07	Drag Mark	Unknown	1	Mostly Healed
F78	4554100	287659	-26.2	70	135	0.22	Scour	Unknown	1	Mostly Healed
F79	4555170	288618	-26.6	24	38	0.08	Circular Depression	Unknown	1	Some Change[3]
F80	4554590	288327	-26.2	17	19	0.07	Circular Depression	Unknown	1	Mostly Healed
F81	4554090	287646	-26.0	36	79	0.08	Scour	Unknown	1	Little Change
F82	4555740	289545	-27.8	33	80	0.1	Spud	L/B Robert	1	Some Change[3]

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F83	4555050	288622	-25.7	27	51	0.05	Circular Depression	Unknown	1	Mostly Healed
F84	4554920	288672	-25.6	25	45	0.05	Circular Depression	Unknown	1	Mostly Healed
F85	4554240	288261	-24.9	24	36	0.06	Circular Depression	Unknown	1	Mostly Healed
F86	4554790	289218	-26.7	22	32	0.08	Circular Depression	Unknown	1	Some Change[3]
F87	4554780	288338	-25.3	33	82	0.09	Circular Depression	Unknown	1	Mostly Healed
F88	4554830	288386	-24.8	31	68	0.05	Circular Depression	Unknown	1	Mostly Healed
F89	4554540	288325	-23.8	27	53	0.08	Scour	Unknown	1	Little Change
F90	4554840	288214	-25.0	33	69	0.08	Circular Depression	Unknown	1	Mostly Healed
F91	4553920	286779	-22.0	23	39	0.12	Circular Depression	Unknown	1	Some Change[3]
F92	4555700	289557	-27.5	25	47	0.12	Spud	L/B Robert	1	Some Change[3]
F93	4554590	288330	-26.3	22	32	0.07	Circular Depression	Unknown	1	Mostly Healed
F94	4554560	288311	-26.1	31	71	0.06	Scour	Unknown	1	Little Change

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F95	4555760	289539	-27.8	37	99	0.13	Spud	L/B Robert	1	Some Change[3]
F96	4555720	289520	-27.9	28	56	0.16	Spud	L/B Robert	1	Some Change[3]
F97	4555780	289517	-28.0	36	94	0.16	Spud	L/B Robert	1	Some Change[3]
F98	4555750	289472	-28.2	24	43	0.15	Spud	L/B Robert	1	Mostly Healed
F99	4555790	289456	-28.4	21	32	0.19	Spud	L/B Robert	1	Mostly Healed
F100	4555770	289493	-28.2	27	51	0.11	Spud	L/B Robert	1	Mostly Healed
F101	4555730	289481	-28.3	32	62	0.38	Spud	L/B Michael Eymard	1	Mostly Healed
F102	4555130	288971	-26.8	21	30	0.1	Spud	L/B Robert	1	Some Change[3]
F103	4555720	289486	-28.1	17	19	0.15	Spud	L/B Michael Eymard	1	Mostly Healed
F104	4555720	289495	-28.2	18	19	0.33	Spud	L/B Michael Eymard	1	Mostly Healed
F105	4555730	289499	-28.1	17	17	0.20	Spud	L/B Michael Eymard	1	Some Change[3]
F106	4555730	289491	-28.3	14	12	0.20	Spud	L/B Michael Eymard	1	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F107	4555730	289488	-28.2	19	21	0.20	Spud	L/B Michael Eymard	1	Mostly Healed
F108	4555700	289477	-28.0	19	21	0.14	Spud	L/B Michael Eymard	1	Mostly Healed
F109	4555700	289470	-28.1	19	19	0.15	Spud	L/B Michael Eymard	1	Mostly Healed
F110	4555130	288947	-26.7	28	55	0.06	Scour	Unknown	1	Some Change[5]
F111	4555150	288948	-26.8	21	34	0.1	Spud	L/B Robert	1	Some Change[3]
F112	4555170	288984	-26.9	21	34	0.07	Spud	L/B Robert	1	Mostly Healed
F113	4555110	288930	-26.6	40	99	0.11	Scour	Unknown	1	Some Change[4]
F114	4555090	288927	-26.5	23	35	0.13	Spud	L/B Michael Eymard	1	Mostly Healed
F115	4555080	288943	-26.5	22	32	0.12	Spud	L/B Michael Eymard	1	Mostly Healed
F116	4555060	288925	-26.4	15	15	0.12	Spud	L/B Michael Eymard	1	Mostly Healed
F117	4554090	287674	-25.9	30	45	0.08	Scour	Unknown	1	Mostly Healed
F118	4554090	287670	-25.9	20	20	0.06	Scour	Unknown	1	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F119	4554080	287682	-25.9	24	32	0.06	Scour	Unknown	1	Mostly Healed
F120	4554070	287663	-26.0	33	75	0.04	Scour	Unknown	1	Little Change
F121	4554060	287630	-26.0	12	11	0.12	Scour	Unknown	1	Little Change
F122	4555750	289524	-23.7	31	66	0.1	Scour	Unknown	1	Little Change
F123	4555770	289508	-28.0	32	78	0.06	Scour	Unknown	1	Little Change
F124	4555750	289491	-25.4	36	99	0.07	Scour	Unknown	1	Little Change
F125	4555730	289508	-28.0	33	65	0.08	Scour	Unknown	1	Little Change
F126	4555110	288964	-26.6	30	62	0.02	Scour	Unknown	1	Little Change
F127	4555100	288947	-18.7	25	47	0.03	Scour	Unknown	1	Little Change
F128	4554570	288324	-13.8	37	98	0.06	Scour	Unknown	1	Little Change
F129	4554560	288339	-26.0	25	42	0.03	Scour	Unknown	1	Little Change
F130	4554070	287634	-17.7	43	90	0.12	Scour	Unknown	1	Some Change[4]

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F131	4554050	287648	-26.0	32	52	0.05	Scour	Unknown	1	Little Change
F132	4553650	286914	-18.9	21	32	0.05	Scour	Unknown	1	Little Change
F133	4553670	286929	-23.6	16	18	0.09	Scour	Unknown	1	Little Change
F134	4553670	286899	-23.3	19	22	0.1	Scour	Unknown	1	Little Change
F135	4553680	286913	-19.2	24	38	0.02	Scour	Unknown	1	Little Change
F136	4553280	287071	-21.7	93	155	0.05	Drag Mark	Unknown	1	Some Change[3]
F137	4553290	287037	-21.1	58	65	0.1	Drag Mark	Unknown	1	Some Change[3]
F138	4555090	288255	-25.3	48	40	0.09	Drag Mark	Unknown	1	Mostly Healed
F139	4555090	288225	-25.1	91	60	0.06	Drag Mark	Unknown	1	Mostly Healed
F140	4555030	288476	-25.1	86	34	0.06	Drag Mark	Unknown	1	Mostly Healed
F141	4554580	288290	-26.1	68	30	0.03	Drag Mark	Unknown	1	Mostly Healed
F142	4554580	288317	-26.2	53	19	0.06	Drag Mark	Unknown	1	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F143	4554380	287514	-26.3	76	69	0.11	Drag Mark	Unknown	1	Some Change[3]
F144	4554070	287607	-26.0	164	176	0.02	Drag Mark	Unknown	1	Mostly Healed
F145	4554090	287595	-26.1	146	131	0.02	Drag Mark	Unknown	1	Mostly Healed
F146	4554120	287565	-26.1	112	109	0.02	Drag Mark	Unknown	1	Mostly Healed
F147	4554050	287615	-26.0	272	292	0.03	Drag Mark	Unknown	1	Mostly Healed
F148	4553990	287487	-26.3	142	121	0.02	Drag Mark	Unknown	1	Mostly Healed
F149	4553990	287423	-26.1	291	225	0.05	Drag Mark	Unknown	1	Mostly Healed
F150	4553930	286775	-22.1	141	151	0.08	Drag Mark	Unknown	1	Some Change[3]
F151	4553990	286768	-22.9	29	39	0.21	Drag Mark	Unknown	1	Some Change[3]
F152	4554020	286959	-24.2	13	12	0.15	Circular Depression	Unknown	1	Some Change[3]
F153	4553510	287184	-23.3	10	7	0.12	Circular Depression	Unknown	1	Mostly Healed
F154	4554140	287279	-25.8	28	41	0.07	Drag Mark	Unknown	1	Some Change[3]

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
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[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F155	4554640	287558	-27.0	16	18	0.12	Circular Depression	Unknown	1	Some Change[3]
F156	4554330	287759	-26.1	12	9	0.20	Circular Depression	Unknown	1	Mostly Healed
F157	4554320	287709	-26.0	16	18	0.10	Circular Depression	Unknown	1	Mostly Healed
F158	4556180	289764	-28.0	161	129	0.02	Drag Mark	Unknown	1	Mostly Healed
F159	4556180	289793	-28.0	90	63	0.03	Drag Mark	Unknown	1	Mostly Healed
F160	4555720	289530	-28.4	54	196	0.60	Spud	L/B *Brave Tern*	2	Some Change[3]
F161	4555700	289552	-28.6	58	246	1.2	Spud	L/B *Brave Tern*	2	Some Change[3]
F162	4555750	289601	-28.3	58	245	0.90	Spud	L/B *Brave Tern*	2	Some Change[3]
F163	4555770	289579	-28.5	52	187	0.87	Spud	L/B *Brave Tern*	2	Some Change[3]
F164	4555070	288987	-27.5	56	214	0.90	Spud	L/B *Brave Tern*	2	Some Change[3]
F165	4555110	289037	-27.3	46	148	0.60	Spud	L/B *Brave Tern*	2	Some Change[3]
F166	4555130	289017	-27.4	50	170	0.85	Spud	L/B *Brave Tern*	2	Some Change[3]

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
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[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F167	4555090	288966	-27.3	51	185	0.86	Spud	L/B *Brave Tern*	2	Some Change[3]
F168	4554510	288367	-26.4	57	222	0.85	Spud	L/B *Brave Tern*	2	Some Change[3]
F169	4554560	288417	-27.0	67	313	1.27	Spud	L/B *Brave Tern*	2	Some Change[3]
F170	4554580	288397	-26.8	54	213	0.75	Spud	L/B *Brave Tern*	2	Mostly Healed
F171	4554530	288345	-26.8	59	255	1.16	Spud	L/B *Brave Tern*	2	Some Change[3]
F172	4554070	287741	-25.8	50	191	0.62	Spud	L/B *Brave Tern*	2	Some Change[3]
F173	4554090	287720	-25.7	49	174	0.75	Spud	L/B *Brave Tern*	2	Some Change[3]
F174	4554050	287669	-26.5	48	160	0.75	Spud	L/B *Brave Tern*	2	Some Change[3]
F175	4554030	287690	-26.4	48	164	0.75	Spud	L/B *Brave Tern*	2	Some Change[3]
F176	4553670	287009	-24.2	41	124	0.14	Spud	L/B *Brave Tern*	2	Mostly Healed
F177	4553690	286988	-24.3	45	150	0.30	Spud	L/B *Brave Tern*	2	Mostly Healed
F178	4553620	286958	-23.2	41	124	0.06	Spud	L/B *Brave Tern*	2	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
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[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F179	4553640	286937	-23.4	38	110	0.09	Spud	L/B *Brave Tern*	2	Mostly Healed
F180	4553870	287675	-25.5	47	68	0.10	Drag Mark	Unknown	2	Some Change[3]
F181	4554820	289162	-26.7	16	19	0.12	Circular Depression	Unknown	2	Some Change[3]
F182	4554830	289135	-26.6	15	15	0.10	Circular Depression	Unknown	2	Mostly Healed
F183	4554840	289150	-26.4	12	10	0.07	Circular Depression	Unknown	2	Mostly Healed
F184	4554790	289089	-27.2	59	84	0.08	Drag Mark	Unknown	2	Mostly Healed
F185	4555100	288885	-26.6	21	30	0.08	Circular Depression	Unknown	2	Mostly Healed
F186	4555120	288881	-26.7	17	19	0.09	Circular Depression	Unknown	2	Mostly Healed
F187	4555210	288894	-27.4	16	19	0.09	Circular Depression	Unknown	2	Mostly Healed
F188	4555200	288876	-27.3	13	13	0.03	Circular Depression	Unknown	2	Mostly Healed
F189	4555190	288919	-27.1	14	14	0.05	Circular Depression	Unknown	2	Mostly Healed
F190	4555180	288904	-27.1	15	15	0.07	Circular Depression	Unknown	2	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F191	4555220	289063	-27.0	12	9	0.09	Circular Depression	Unknown	2	Mostly Healed
F192	4555420	289116	-27.3	76	61	0.06	Drag Mark	Unknown	2	Mostly Healed
F193	4555440	289142	-27.4	145	107	0.06	Drag Mark	Unknown	2	Mostly Healed
F194	4555450	289665	-27.1	35	69	0.08	Circular Depression	Unknown	2	Mostly Healed
F195	4555450	289725	-27.2	21	28	0.06	Circular Depression	Unknown	2	Mostly Healed
F196	4555480	289713	-27.1	21	30	0.06	Circular Depression	Unknown	2	Mostly Healed
F197	4555460	289698	-27.1	21	33	0.06	Circular Depression	Unknown	2	Mostly Healed
F198	4555630	289501	-27.5	15	16	0.11	Circular Depression	Unknown	2	Mostly Healed
F199	4555640	289514	-27.4	16	18	0.13	Circular Depression	Unknown	2	Mostly Healed
F200	4555650	289499	-27.5	11	8	0.06	Circular Depression	Unknown	2	Mostly Healed
F201	4555650	289482	-27.8	27	49	0.16	Circular Depression	Unknown	2	Some Change[3]
F202	4555660	289489	-27.6	13	10	0.06	Circular Depression	Unknown	2	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F203	4555640	289477	-27.6	27	25	0.07	Drag Mark	Unknown	2	Mostly Healed
F204	4555650	289522	-27.4	9	6	0.05	Circular Depression	Unknown	2	Mostly Healed
F205	4555660	289519	-27.4	10	7	0.07	Circular Depression	Unknown	2	Mostly Healed
F206	4555670	289505	-27.6	11	8	0.07	Circular Depression	Unknown	2	Mostly Healed
F207	4555670	289500	-27.6	11	8	0.06	Circular Depression	Unknown	2	Mostly Healed
F208	4555670	289487	-27.8	16	18	0.11	Circular Depression	Unknown	2	Mostly Healed
F209	4555120	288971	-26.7	15	15	0.04	Spud	L/B *Michael Eymard*	2	Some Change[3]
F210	4555130	288968	-26.7	15	15	0.09	Spud	L/B *Michael Eymard*	2	Some Change[3]
F211	4555130	288958	-26.8	18	22	0.10	Spud	L/B *Michael Eymard*	2	Some Change[3]
F212	4555140	288954	-26.9	25	44	0.17	Spud	L/B *Michael Eymard*	2	Some Change[3]
F213	4555150	288987	-26.8	21	33	0.07	Spud	L/B *Michael Eymard*	2	Mostly Healed
F214	4555140	288952	-26.8	31	37	0.05	Circular Depression	Unknown	2	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F215	4554870	288574	-25.6	27	28	0.08	Drag Mark	Unknown	2	Mostly Healed
F216	4554830	288547	-25.9	24	19	0.06	Drag Mark	Unknown	2	Mostly Healed
F217	4555680	289482	-27.8	33	62	0.13	Circular Depression	Unknown	2	Some Change[3]
F218	4555690	289501	-27.7	22	37	0.13	Circular Depression	Unknown	2	Mostly Healed
F219	4555690	289497	-27.8	31	43	0.10	Circular Depression	Unknown	2	Some Change[3]
F220	4555660	289515	-27.5	20	28	0.14	Circular Depression	Unknown	2	Mostly Healed
F221	4555660	289509	-27.6	24	41	0.15	Circular Depression	Unknown	2	Some Change[3]
F222	4555850	289591	-27.8	17	14	0.11	Circular Depression	Unknown	2	Mostly Healed
F223	4555860	289598	-27.8	11	9	0.09	Circular Depression	Unknown	2	Mostly Healed
F224	4555870	289592	-27.9	12	10	0.06	Circular Depression	Unknown	2	Mostly Healed
F225	4555870	289585	-27.9	7	3	0.03	Circular Depression	Unknown	2	Mostly Healed
F226	4555870	289464	-28.6	20	27	0.10	Circular Depression	Unknown	2	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F227	4555850	289491	-28.5	21	26	0.16	Circular Depression	Unknown	2	Mostly Healed
F228	4555820	289428	-28.7	20	23	0.15	Circular Depression	Unknown	2	Mostly Healed
F229	4555730	289398	-28.4	28	30	0.05	Drag Mark	Unknown	2	Mostly Healed
F230	4555760	289426	-28.4	17	20	0.08	Circular Depression	Unknown	2	Mostly Healed
F231	4555780	289517	-28.0	17	18	0.12	Spud	L/B *Michael Eymard*	2	Some Change[3]
F232	4555770	289518	-28.0	17	22	0.07	Spud	L/B *Michael Eymard*	2	Some Change[3]
F233	4555780	289523	-28.0	14	13	0.05	Spud	L/B *Michael Eymard*	2	Mostly Healed
F234	4555770	289523	-27.9	16	17	0.04	Spud	L/B *Michael Eymard*	2	Mostly Healed
F235	4555760	289532	-27.8	16	17	0.09	Spud	L/B *Michael Eymard*	2	Some Change[3]
F236	4555760	289538	-27.9	25	44	0.11	Spud	L/B *Michael Eymard*	2	Some Change[3]
F237	4555770	289532	-27.9	19	24	0.11	Spud	L/B *Michael Eymard*	2	Some Change[3]
F238	4555770	289528	-27.8	15	16	0.04	Spud	L/B *Michael Eymard*	2	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F239	4555790	289544	-27.9	12	10	0.05	Spud	L/B *Michael Eymard*	2	Mostly Healed
F240	4555790	289551	-27.9	19	23	0.12	Spud	L/B *Michael Eymard*	2	Mostly Healed
F241	4555790	289545	-27.9	16	17	0.06	Spud	L/B *Michael Eymard*	2	Mostly Healed
F242	4555790	289550	-27.9	14	14	0.05	Spud	L/B *Michael Eymard*	2	Mostly Healed
F243	4555780	289543	-27.9	37	48	0.08	Drag Mark	Unknown	2	Mostly Healed
F244	4555440	288879	-28.2	24	41	0.08	Circular Depression	Unknown	2	Mostly Healed
F245	4555310	288352	-27.6	178	169	0.08	Drag Mark	Unknown	2	Mostly Healed
F246	4554090	287652	-26.4	44	145	0.41	Circular Depression	Unknown	2	Mostly Healed
F247	4554090	287663	-26.3	37	100	0.41	Circular Depression	Unknown	2	Mostly Healed
F248	4554080	287671	-26.1	35	82	0.11	Circular Depression	Unknown	2	Mostly Healed
F249	4554080	287678	-25.9	30	63	0.10	Circular Depression	Unknown	2	Mostly Healed
F250	4553980	287650	-25.9	32	72	0.17	Circular Depression	Unknown	2	Mostly Healed

Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season	Relative Change
F251	4553990	287625	-25.8	27	51	0.25	Circular Depression	Unknown	2	Mostly Healed
F252	4554440	286955	-27.4	112	80	0.13	Drag Mark	Unknown	2	Mostly Healed
F253	4554650	287927	-26.3	25	39	0.07	Circular Depression	Unknown	2	Some Change[3]
F254	4555760	289455	-28.3	28	50	0.13	Circular Depression	Unknown	2	Mostly Healed
F255	4555800	289452	-28.4	25	32	0.13	Circular Depression	Unknown	2	Mostly Healed
F256	4555840	289479	-28.4	26	36	0.08	Circular Depression	Unknown	2	Mostly Healed
F257	4555290	289165	-26.8	34	36	0.04	Drag Mark	Unknown	2	Mostly Healed
F258	4554880	289095	-26.2	15	16	0.08	Circular Depression	Unknown	2	Some Change[3]
F259	4554900	289079	-26.2	13	13	0.06	Circular Depression	Unknown	2	Mostly Healed
F260	455800	289404	-28.6	333	376	0.27	Drag Mark	Unknown	2	Mostly Healed
F261	4555730	289515	-27.9	19	20	0.09	Scour	Unknown	2	Mostly Healed
F262	4555740	289531	-27.8	24	31	0.12	Scour	Unknown	2	Some Change[3]

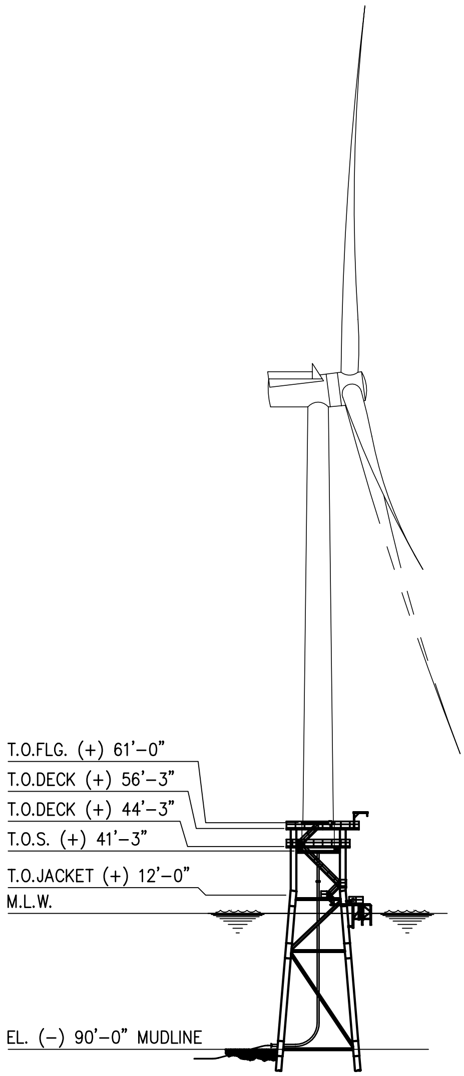
Notes: See Charts 3 and 4 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature.
[3] Change was infilling of feature.
[4] Change was due to overprint of new features.
[5] Change was due to widening of feature.

Table C-2. Seafloor Disturbance Features (Survey 3-May 2017)

Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel	Construction Season
F263	4555840	289507	-28.3	60	55	0.13	Scour	N/A	Post-Construction
F264	4555820	289487	-28.3	222	219	0.20	Scour	N/A	Post-Construction
F265	4555740	289475	-28.1	122	112	0.19	Scour	N/A	Post-Construction
F266	4555790	289475	-28.1	33	21	0.09	Scour	N/A	Post-Construction
F267	4555760	289483	-28.2	30	25	0.10	Scour	N/A	Post-Construction
F268	4555740	289482	-28.2	47	30	0.10	Scour	N/A	Post-Construction
F269	4555710	289445	-28.2	13	11	0.08	Scour	N/A	Post-Construction
F270	4555150	288908	-26.9	199	154	0.20	Scour	N/A	Post-Construction
F271	4555160	288915	-27.0	84	53	0.07	Scour	N/A	Post-Construction
F272	4555120	288920	-26.7	33	29	0.14	Scour	N/A	Post-Construction
F273	4555100	288911	-26.6	81	86	0.17	Scour	N/A	Post-Construction
F274	4555100	288918	-26.6	60	50	0.15	Scour	N/A	Post-Construction

Notes: See Chart 3 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the feature

D. TYPICAL CONSTRUCTION DRAWINGS



ELEVATION

Upstream Engineering LLC
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HOUSTON, TEXAS www.upstreamengineering.com (281) 531–0047

Registration No.: F-2752

No.	DATE	REVISION	BY	APP.
B	03/15/12	REVISED ISSUED FOR PERMITTING	JR	RS
A	01/24/12	ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA
SCALE: 1/128"=1'–0"
DRAWN BY: J. RHAME
DATE: 01/11/12

DEEPWATERWIND®

ASSEMBLY ELEVATION
TURBINE & PLATFORM

PROJ. No.: P12–002
FILENAME: 9001.dwg

Figure 1

REV. No.: B

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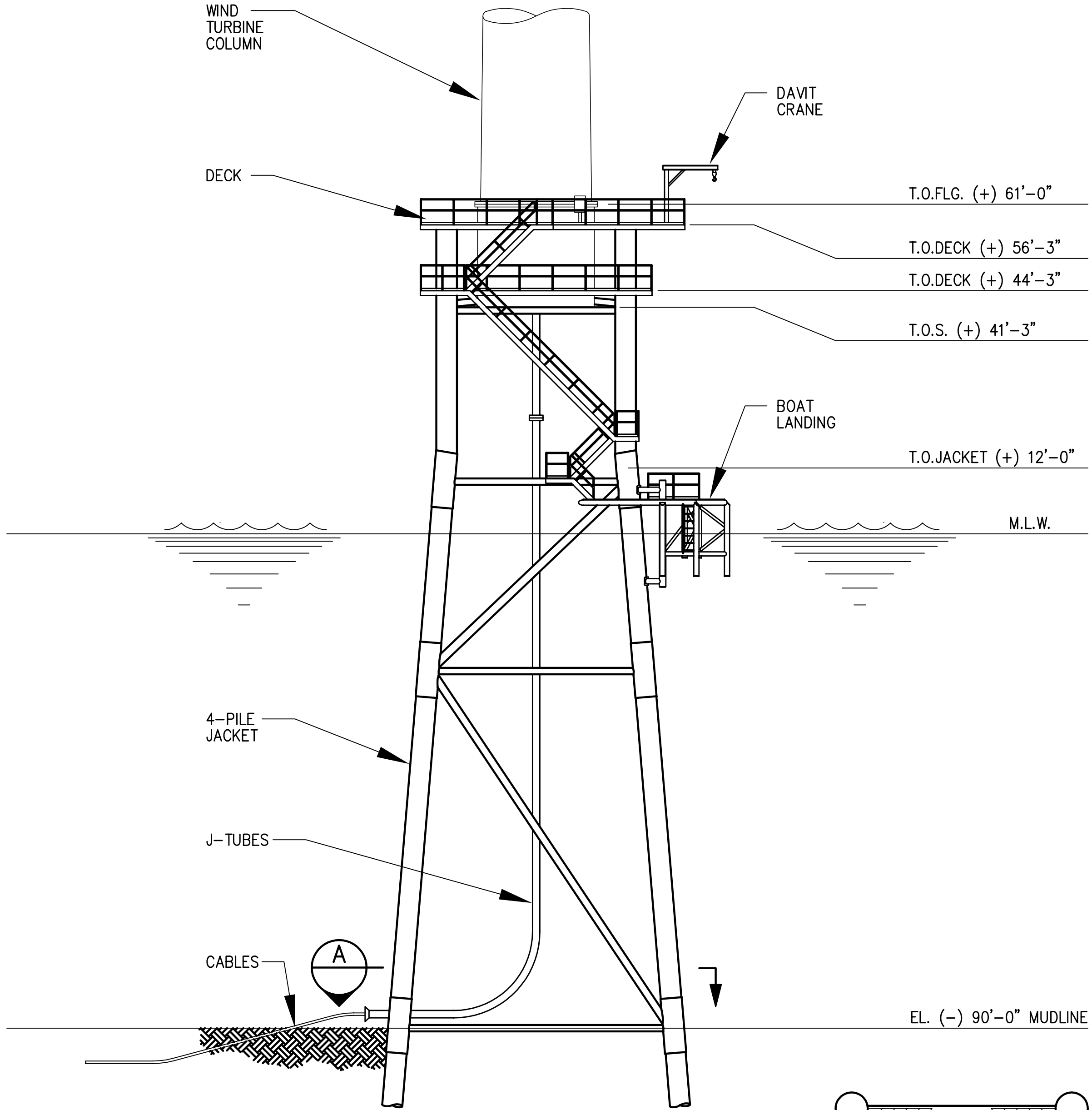

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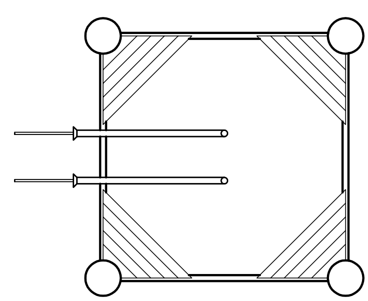

SECTION A
SCALE — 1"=40'–0"

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B	03/15/12	REVISED ISSUED FOR PERMITTING	JR	RS

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DRAWN BY: J. RHAME	DATE: 01/11/12

DEEPWATERWIND®

4–PILE JACKET w/DECK STRUCTURE

PROJ. No.: P12–002 FILENAME: 9002.dwg	Figure 2	REV. No.: C

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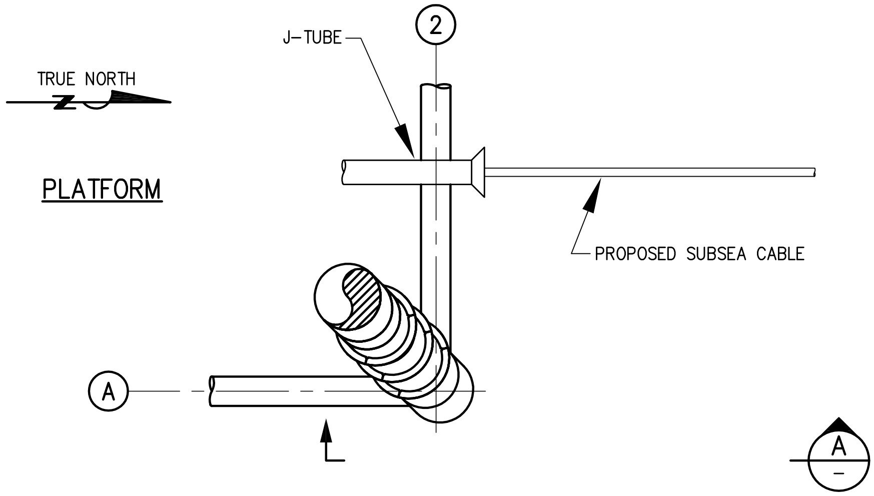

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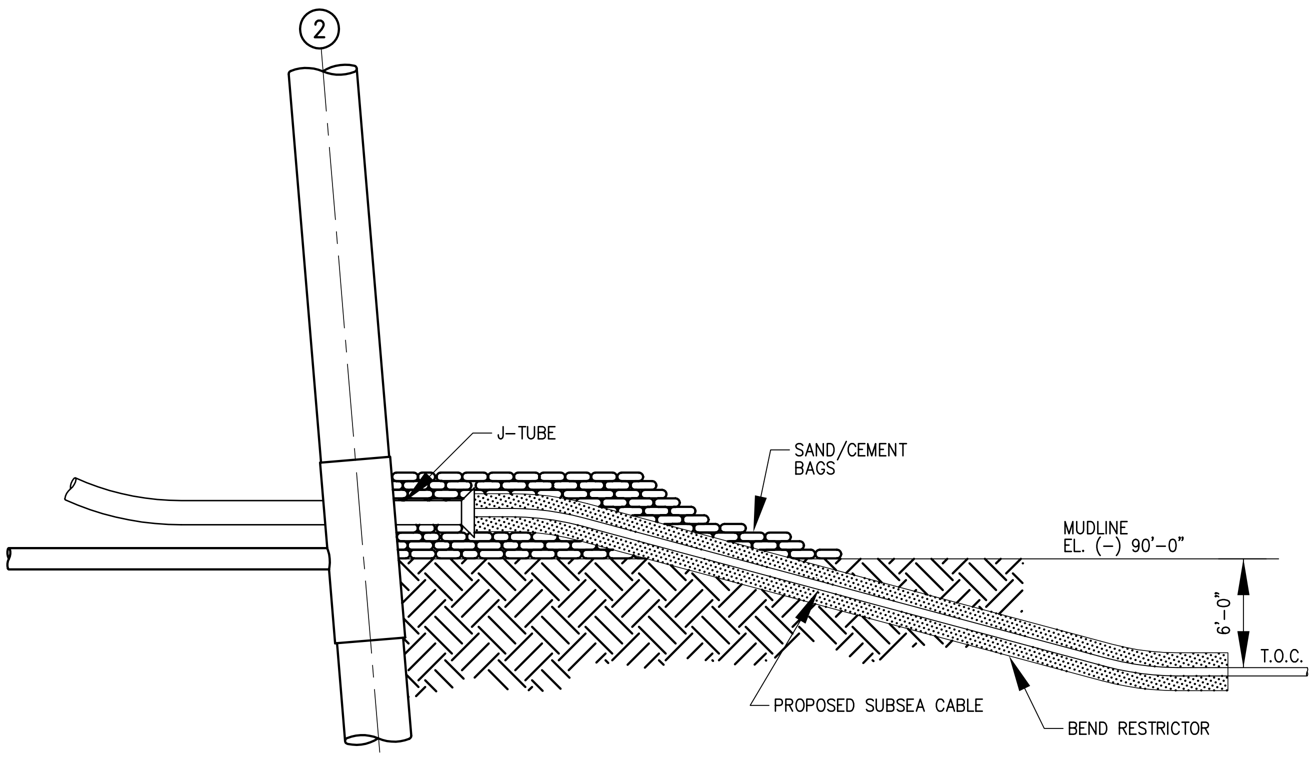

ELEVATION A
SCALE —— 3/16"=1'-0"

Upstream Engineering LLC
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Registration No.: F-2752

No.	DATE	REVISION	BY	APP.
B	03/15/12	REVISED ISSUED FOR PERMITTING	JR	RS
A	01/24/12	ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA
SCALE: AS NOTED
DRAWN BY: J. RHAME
DATE: 01/11/12

DEEPWATERWIND®

CABLE AT J-TUBE

PROJ. No.: P12-002
FILENAME: 9009.dwg

Figure 3

REV. No.: B

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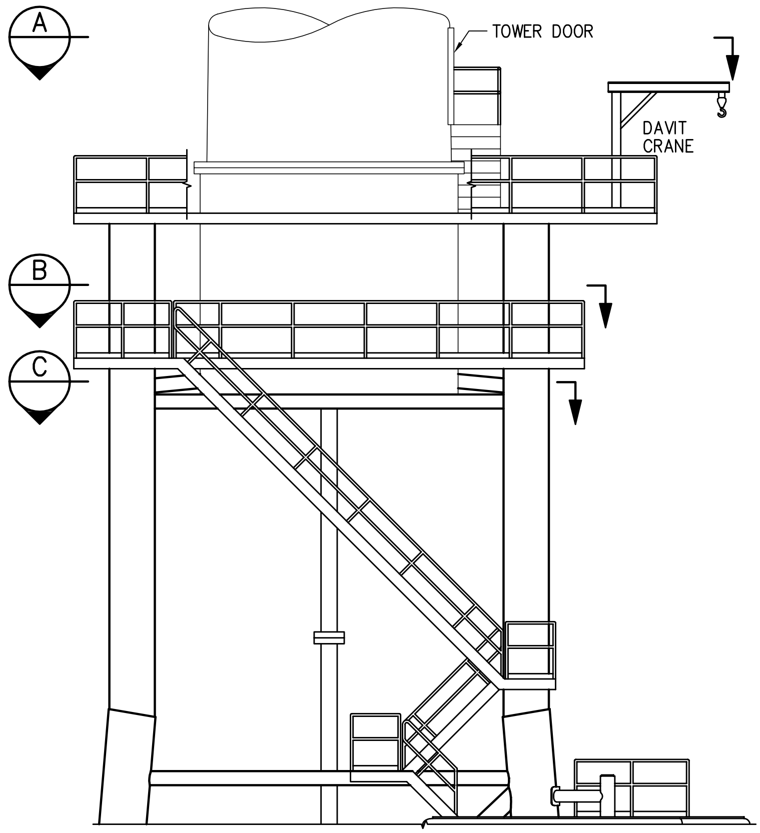

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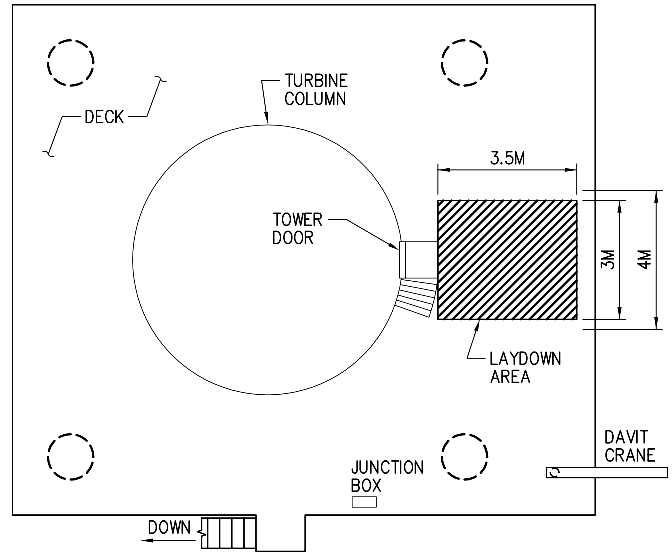

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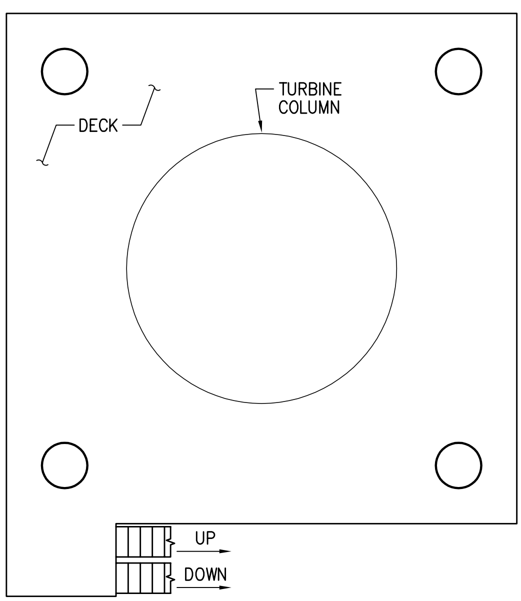

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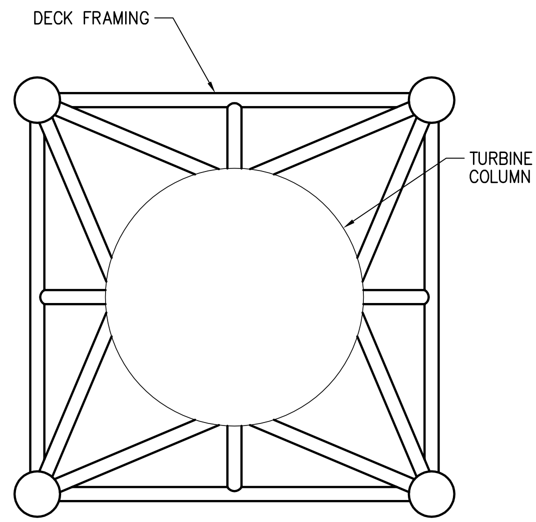

SECTION C
SCALE —— 1/16"=1'-0"

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Registration No.: F-2752

No.	DATE	REVISION	BY	APP.
B		REVISED ISSUED FOR PERMITTING	JR	
A	03/15/12	ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA
SCALE: 1/16"=1'-0"
DRAWN BY: J. RHAME
DATE: 03/08/12

DEEPWATERWIND®

DETAILS AND SECTIONS

PROJ. No.: P12-002
FILENAME: 9010.dwg

Figure 4

REV. No.: B

jim.rhame, F:\Projects\2012\P12-002 Deepwater Wind Permit Dwgs\Drafting\PLD\9010.dwg, PAPERSPACE, 04/20/2012 - 09:21am

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A	ISSUED FOR REVIEW	2/09/12	MT	CMD	CMD	
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD

LEGEND

1 - CONDUCTOR

2 - FILLING COMPOUND

3 - CONDUCTOR SCREEN

4 - INSULATION

5 - INSULATION SCREEN

6 - **LEAD ALLOY SHEATH**

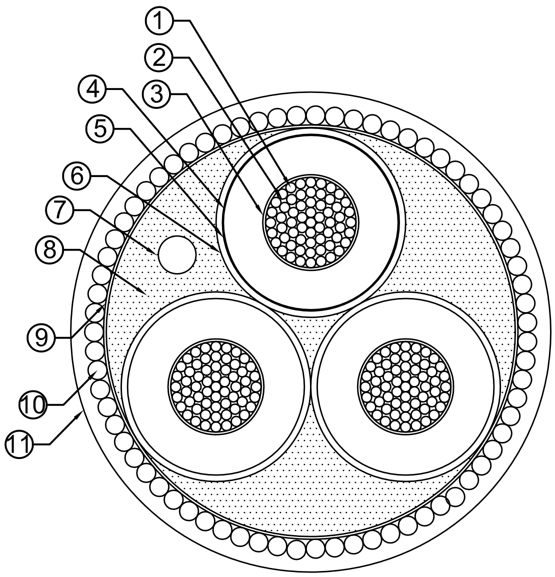
7 - INTERSTITIAL FIBER OPTIC

8 - YARN FILLERS

9 - BINDER TAPES

10 - ARMOUR WIRES

11 - YARN AND BITUMEN



35KV 3-CORE SUBMARINE CABLE

SUBMARINE CABLE DETAIL.dwg

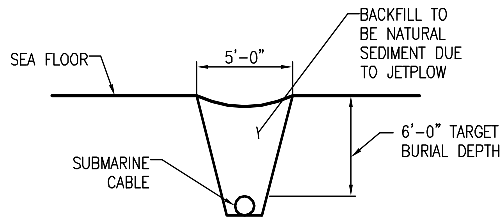
DEEPWATERWIND

		DSGN	CMD	02/09/2012
		DRN	MT	02/09/2012
		CKD	CMD	02/09/2012
		SCALE:	N.T.S	
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY		

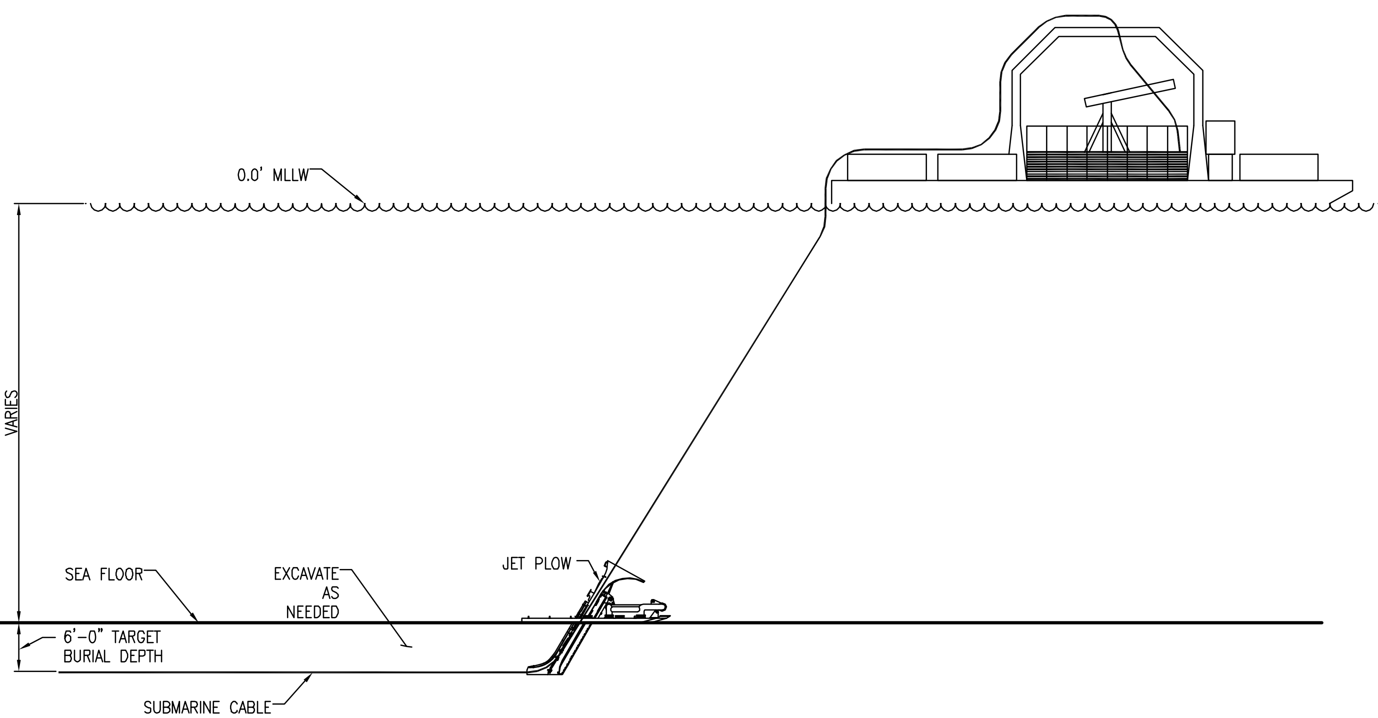
Mott MacDonald

DEEPWATER WIND	JOB NUMBER	REV
BLOCK ISLAND TRANSMISSION PROJECT	276847	A
TYPICAL 3-CORE SUBMARINE CABLE	Figure 5	

D	ISSUED FOR REVIEW	02/14/2012	JJS	JJS	DEJ	
C	ISSUED FOR REVIEW	02/03/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	01/30/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	01/17/2012	JJS	JJS	DEJ	
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD



SECTION
SCALE N.T.S.



ELEVATION VIEW
SCALE N.T.S.

DEEPWATERWIND

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		DRN	JJS	1/17/2012	
		CKD	DEJ	1/17/2012	
		SCALE:	N.T.S.		
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY			

POWER ENGINEERS

DEEPWATER WIND	JOB NUMBER	REV
BLOCK ISLAND TRANSMISSION PROJECT	119630	D
SUBMARINE DETAIL	Figure 6	

Submarine Detail.dwg

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REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
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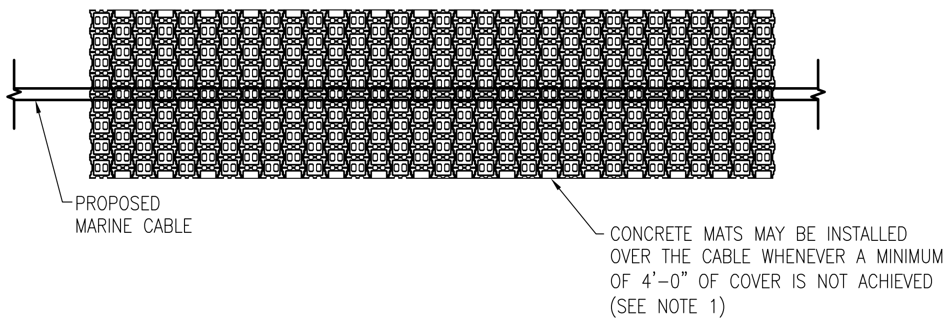
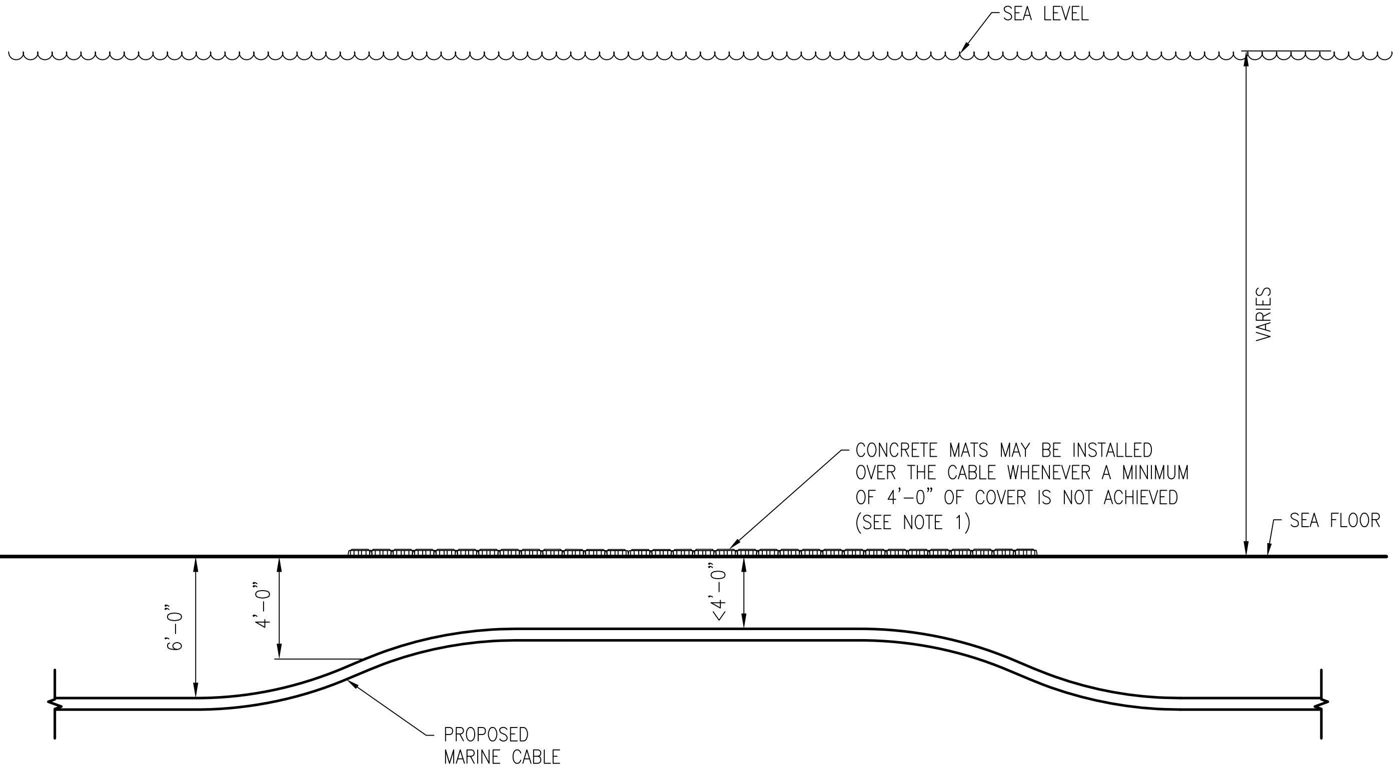
A	ISSUED FOR REVIEW	04/13/2012	JJS	JJS	DEJ	



PLAN VIEW



PROFILE VIEW

NOTES:
1. ROCK DROPPING WITH SIMILAR PROFILE MAY BE USED IN LIEU OF CONCRETE MATS WHERE TARGER DEPTH WAS NOT ACHIEVED.

SHALLOW PENETRATION DETAIL

SCALE N.T.S.

AECOM

DEEPWATERWIND®

DSGN	JJS	04/13/2012	POWER ENGINEERS	DEEPWATER WIND	JOB NUMBER: 119630
DRN	JJS	04/13/2012		BLOCK ISLAND TRANSMISSION PROJECT	REV: B
CKD	DEJ	04/13/2012		SHALLOW PENETRATION DETAIL	Figure 7
SCALE:	N.T.S.				
FOR 8.5x11 DWG ONLY					

REFERENCE DRAWINGS

SHALLOW PENETRATION.dwg

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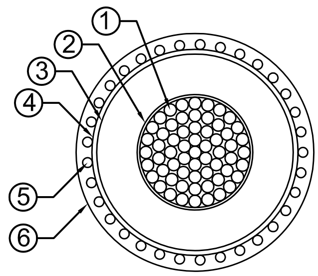
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
A	ISSUED FOR REVIEW	2/09/12	MT	CMD	CMD	



35KV URD CABLE

LEGEND

1 - CONDUCTOR

2 - CONDUCTOR SCREEN

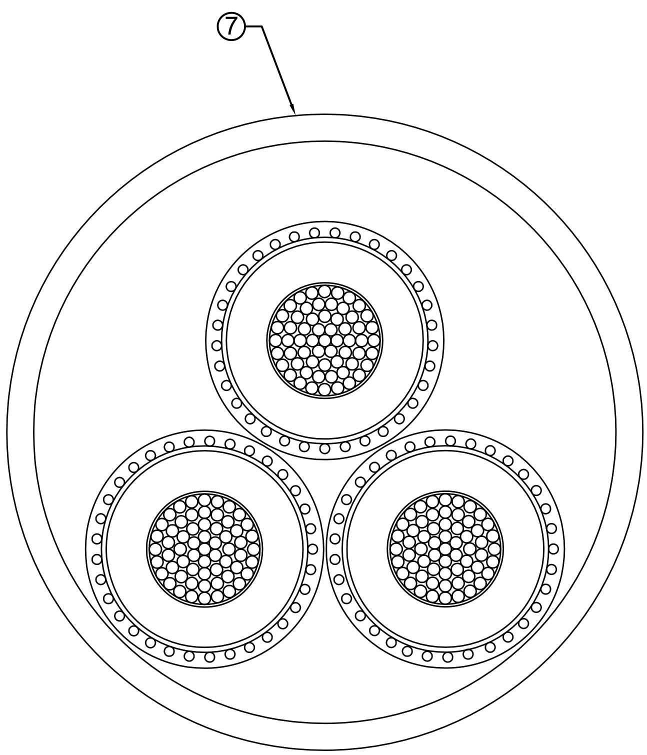
3 - INSULATION

4 - INSULATION SCREEN

5 - CONCENTRIC CONDUCTOR

6 - JACKET

7 - CONDUIT



35KV CABLE TREFOIL IN CONDUIT

UPLAND CABLE DETAIL.dwg

DEEPWATERWIND

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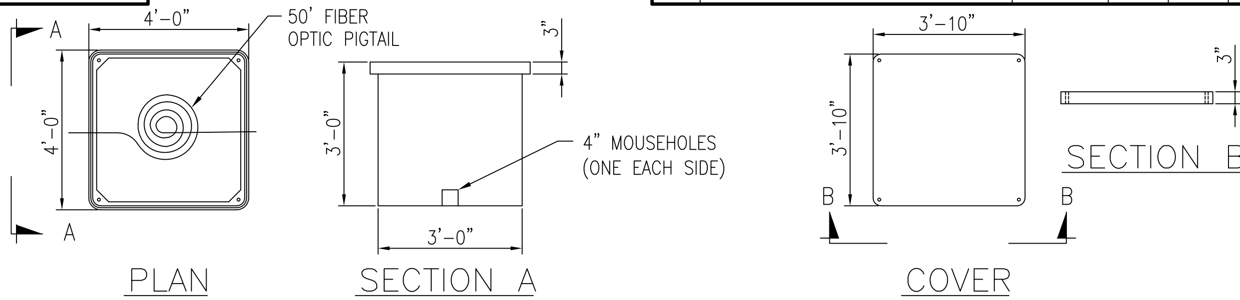
		DRN	MT	02/09/2012	
		CKD	CMD	02/09/2012	
		SCALE:	N.T.S		
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY			

Mott MacDonald

DEEPWATER WIND	JOB NUMBER	REV
BLOCK ISLAND TRANSMISSION PROJECT	276847	A
TYPICAL UPLAND CABLE	Figure 8	

REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
C	ISSUED FOR REVIEW	02/14/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	02/03/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	12/01/2011	JJS	JJS	DEJ	

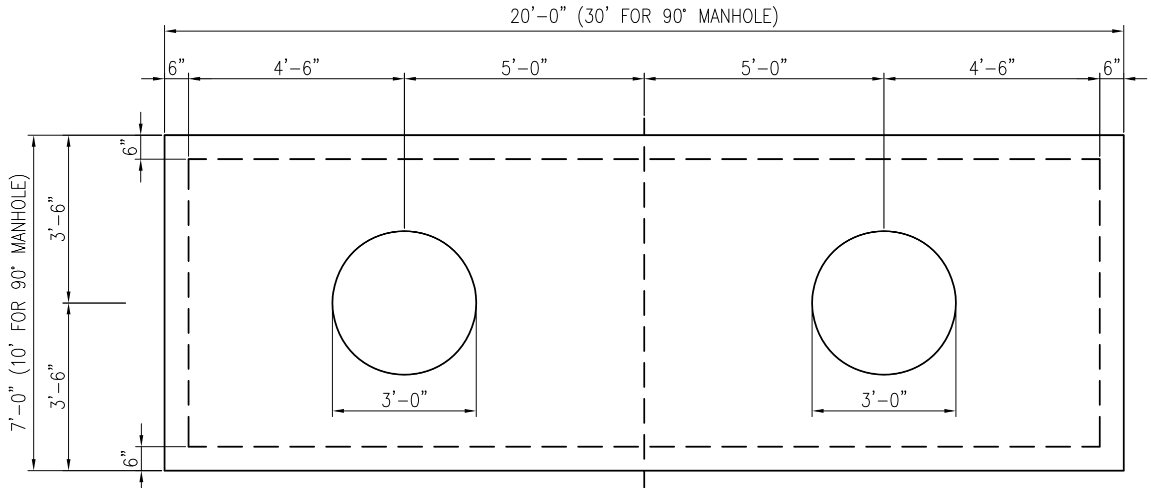


FIBER OPTIC HAND HOLE

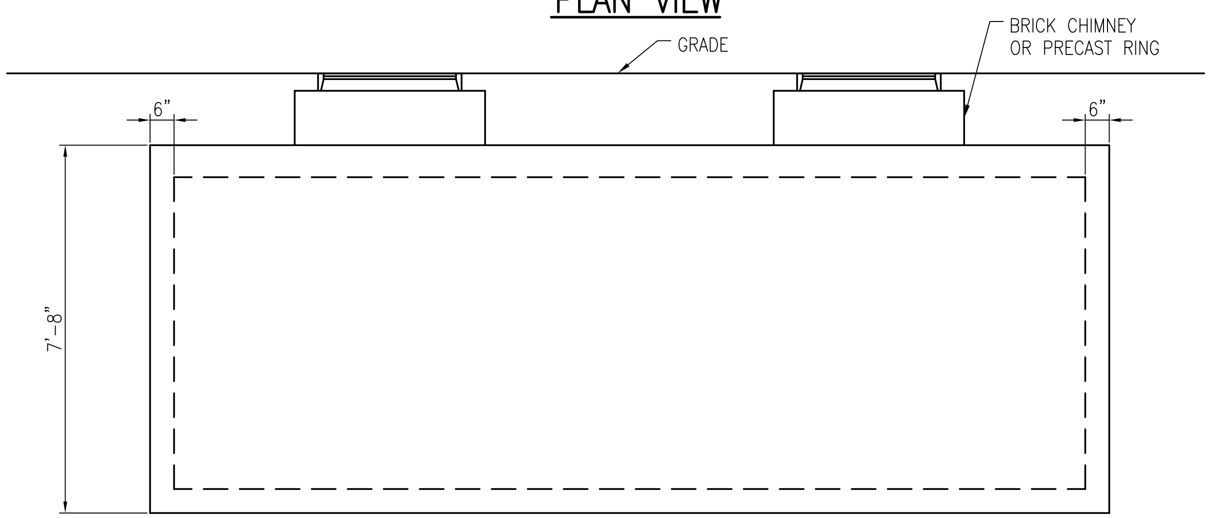
SCALE N.T.S.

NOTE

QUAZITE 48"x48" PG COVER AND BOX MADE FROM POLYMER CONCRETE.



PLAN VIEW



MANHOLE SECTION VIEW

"TYPICAL" NOT FOR CONSTRUCTION

SCALE N.T.S.

DEEPWATERWIND

		DSGN	JJS	12/01/2011	DEEPWATER WIND
		DRN	JJS	12/01/2011	BLOCK ISLAND TRANSMISSION PROJECT
		CKD	DEJ	12/01/2011	TYPICAL MANHOLE DETAIL
		SCALE:	N.T.S.		
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY			

POWER ENGINEERS

JOB NUMBER	REV
119630	C

Figure 9

Manhole Detail.dwg

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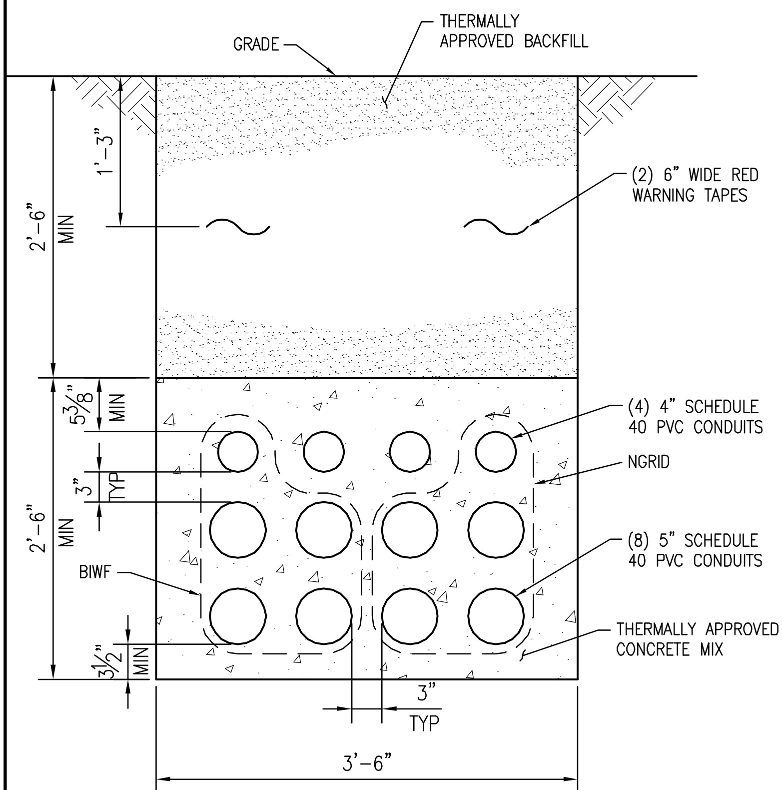
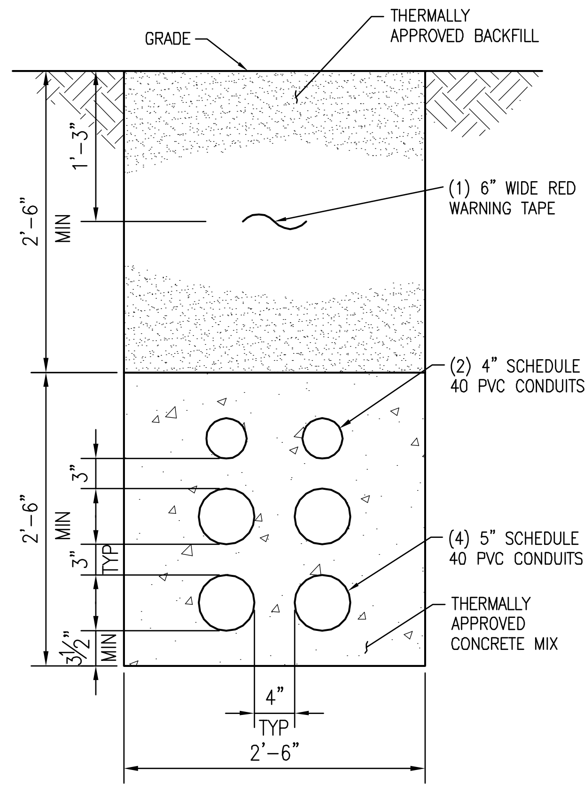
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
C	ISSUED FOR REVIEW	02/03/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	01/30/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	01/12/2012	JJS	JJS	DEJ	



DOUBLE CIRCUIT SECTION
"TYPICAL" NOT FOR CONSTRUCTION
SCALE N.T.S.



SINGLE CIRCUIT SECTION
"TYPICAL" NOT FOR CONSTRUCTION
SCALE N.T.S.

DEEPWATERWIND

DSGN	JJS	01/12/2012	DEEPWATER WIND	JOB NUMBER 119630
DRN	JJS	01/12/2012	BLOCK ISLAND TRANSMISSION PROJECT	REV C
CKD	DEJ	01/12/2012	TRENCH DETAIL (ALUMINUM)	Figure 10
SCALE:	N.T.S.			

REFERENCE DRAWINGS

FOR 8.5x11 DWG ONLY

POWER ENGINEERS

TRENCH DETAIL ALUMINUM.dwg

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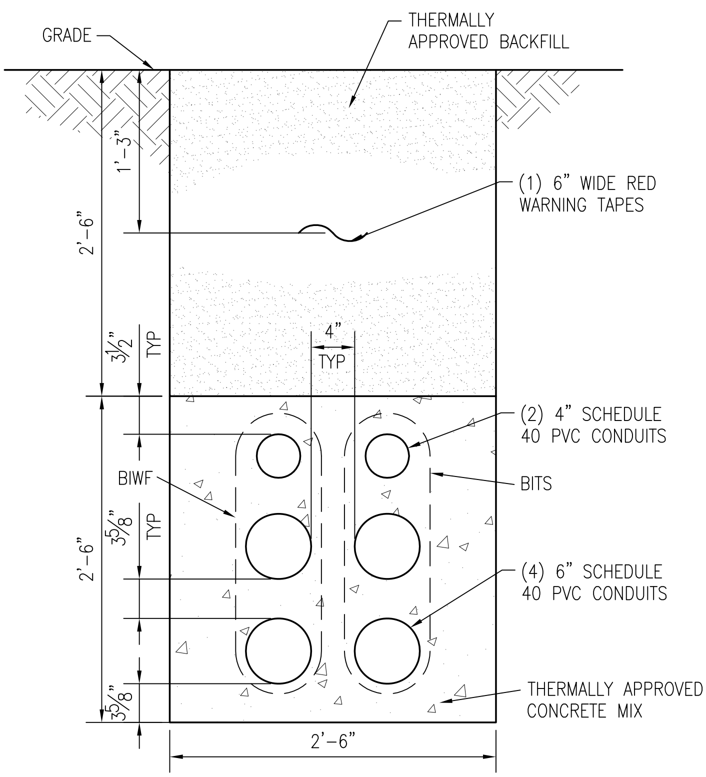
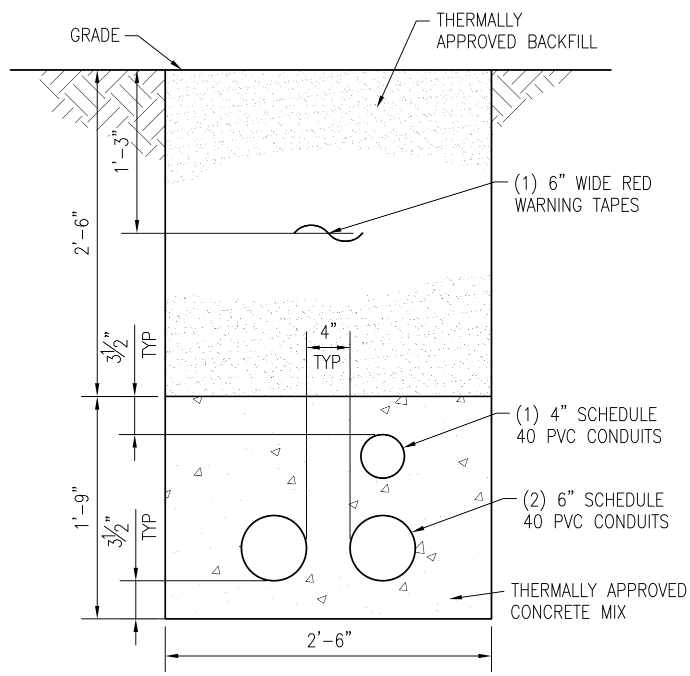
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
C	ISSUED FOR REVIEW	02/03/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	01/30/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	12/01/2011	JJS	JJS	DEJ	



TRENCH DETAIL
"TYPICAL" NOT FOR CONSTRUCTION
SCALE N.T.S.



TRENCH DETAIL
"TYPICAL" NOT FOR CONSTRUCTION
SCALE N.T.S.

TRENCH DETAIL COPPER.dwg

REFERENCE DRAWINGS	DSGN JJS 12/01/2011	POWER ENGINEERS	DEEPWATER WIND	JOB NUMBER 119630
	DRN JJS 12/01/2011		BLOCK ISLAND TRANSMISSION PROJECT	REV C
	CKD DEJ 12/01/2011		TRENCH DETAIL (COPPER)	Figure 11
	SCALE: N.T.S.			
	FOR 8.5x11 DWG ONLY			

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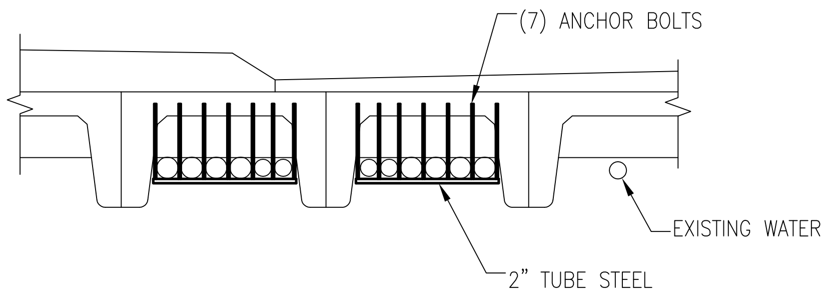
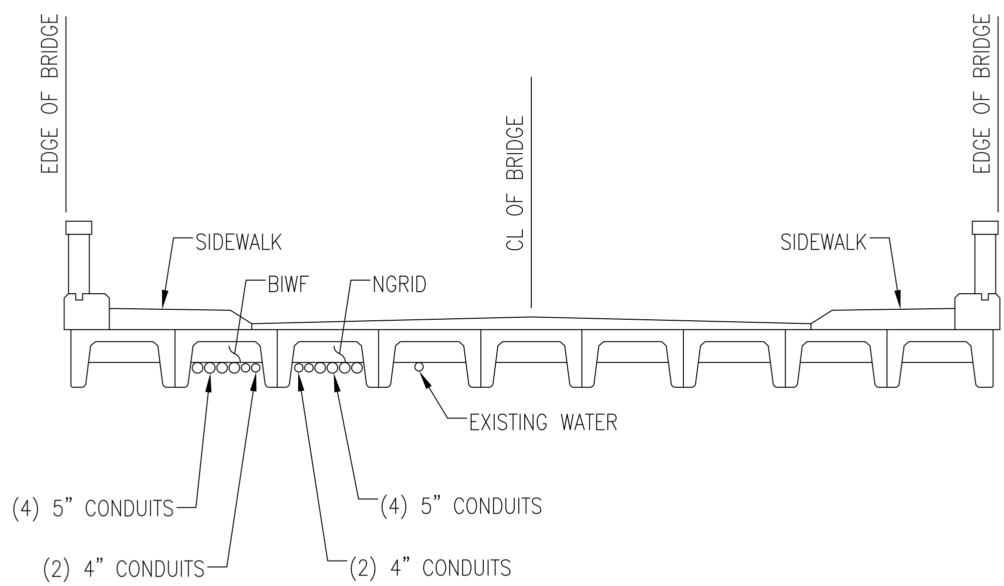
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
C	ISSUED FOR REVIEW	02/14/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	01/30/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	01/19/2012	JJS	JJS	DEJ	



CONDUIT SUPPORTS



BRIDGE CROSS SECTION

LOOKING EAST

DEEPWATERWIND

		DSGN	JJS	1/19/2012	POWER ENGINEERS	DEEPWATER WIND	JOB NUMBER 119630
		DRN	JJS	1/19/2012		BLOCK ISLAND TRANSMISSION PROJECT	REV C
		CKD	DEJ	1/19/2012		BRIDGE DETAIL	Figure 12
		SCALE:	N.T.S.				
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY					

Bridge Detail.dwg

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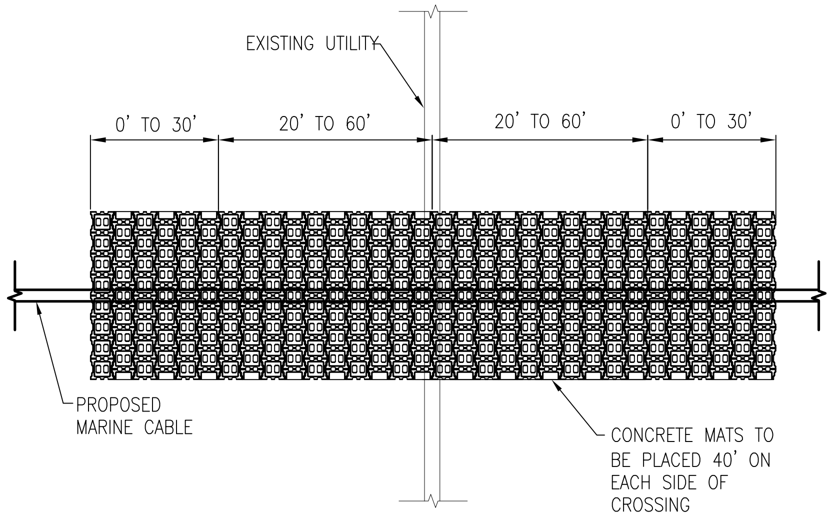
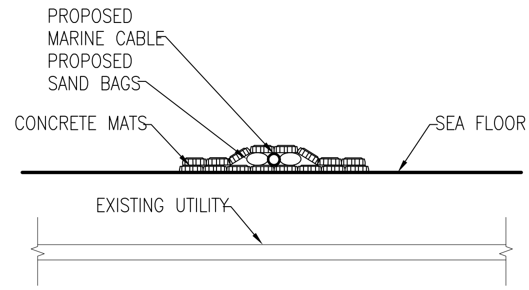
D	ISSUED FOR REVIEW	02/14/2012	JJS	JJS	DEJ	
C	ISSUED FOR REVIEW	02/03/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	01/30/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	12/30/2011	JJS	JJS	DEJ	
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD



PLAN VIEW

EXISTING UTILITY CROSSING

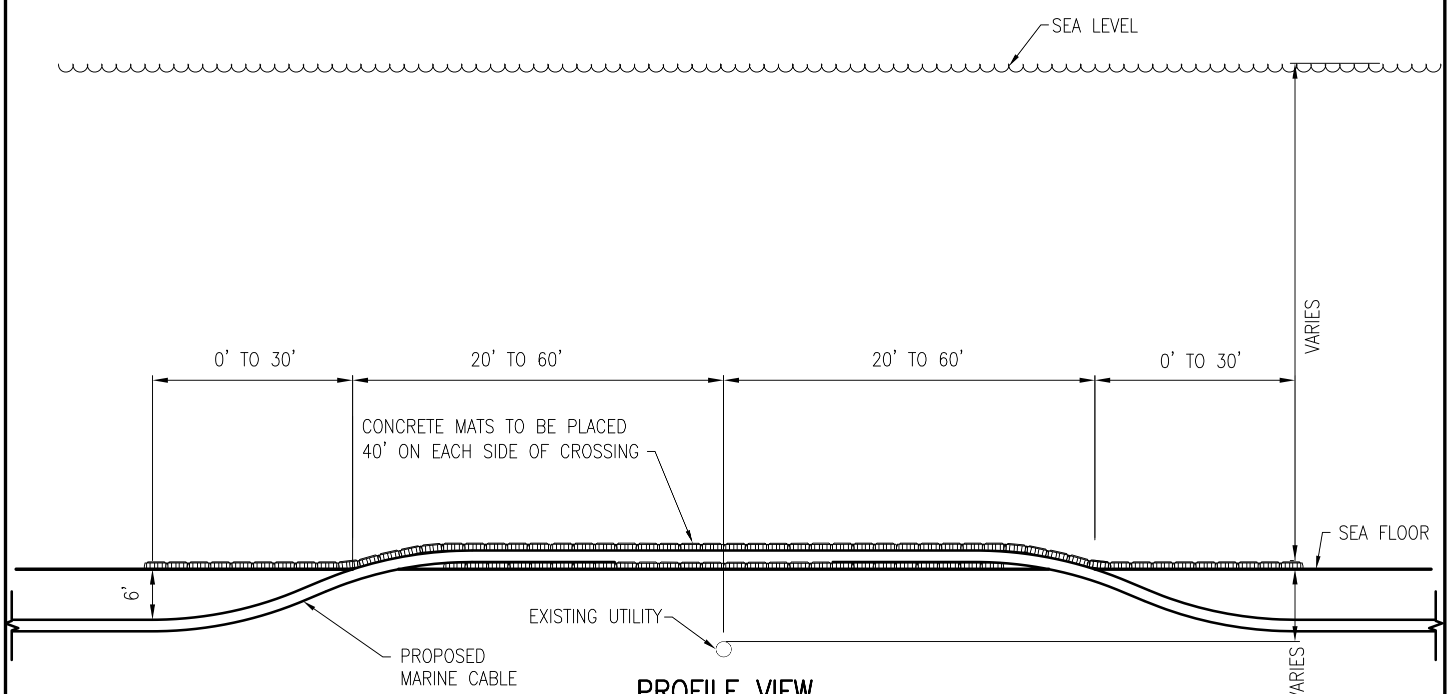
SCALE N.T.S.



CROSS SECTION

EXISTING UTILITY CROSSING

SCALE N.T.S.



PROFILE VIEW

EXISTING UTILITY CROSSING

SCALE N.T.S.

DEEPWATERWIND

		DSGN	JJS	12/30/2011	DEEPWATER WIND	JOB NUMBER 119630
		DRN	JJS	12/30/2011	BLOCK ISLAND TRANSMISSION PROJECT	REV D
		CKD	DEJ	12/30/2011		
		SCALE:	N.T.S.		TYPICAL OCEAN UTILITY CROSSING DETAIL	Figure 13
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY				

POWER ENGINEERS

UTILITY CROSSING.dwg

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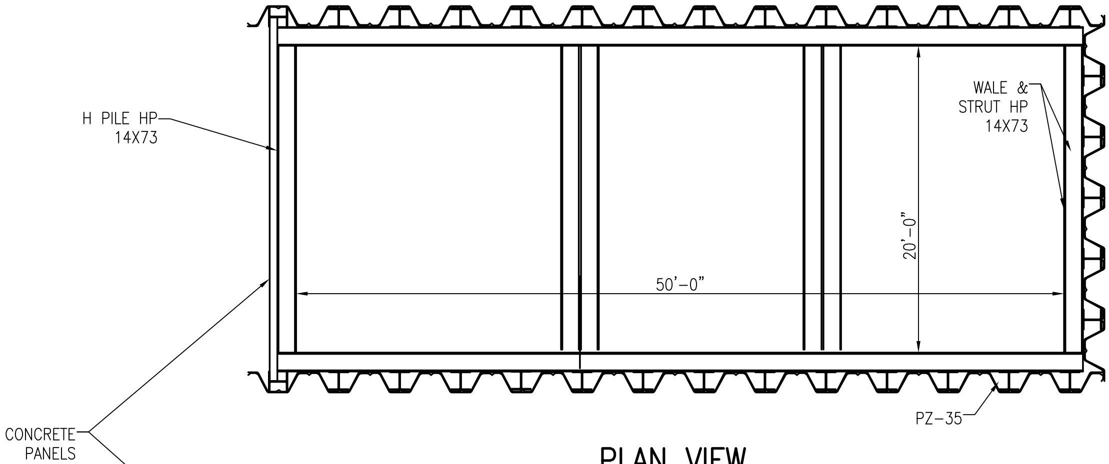
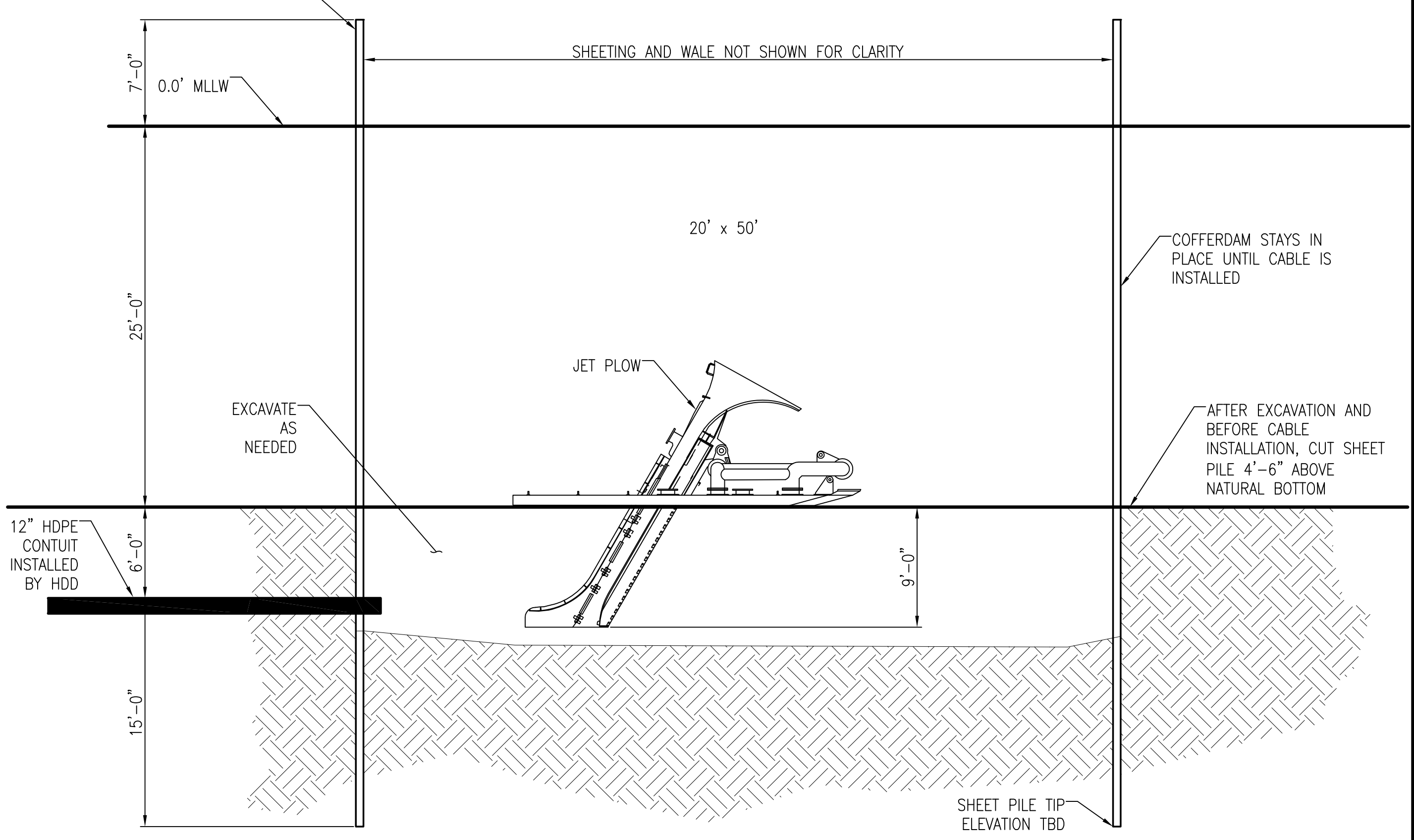
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
D	ISSUED FOR REVIEW	02/14/2012	JJS	JJS	DEJ	
C	ISSUED FOR REVIEW	02/03/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	01/30/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	01/12/2012	JJS	JJS	DEJ	



PLAN VIEW

SCALE N.T.S.



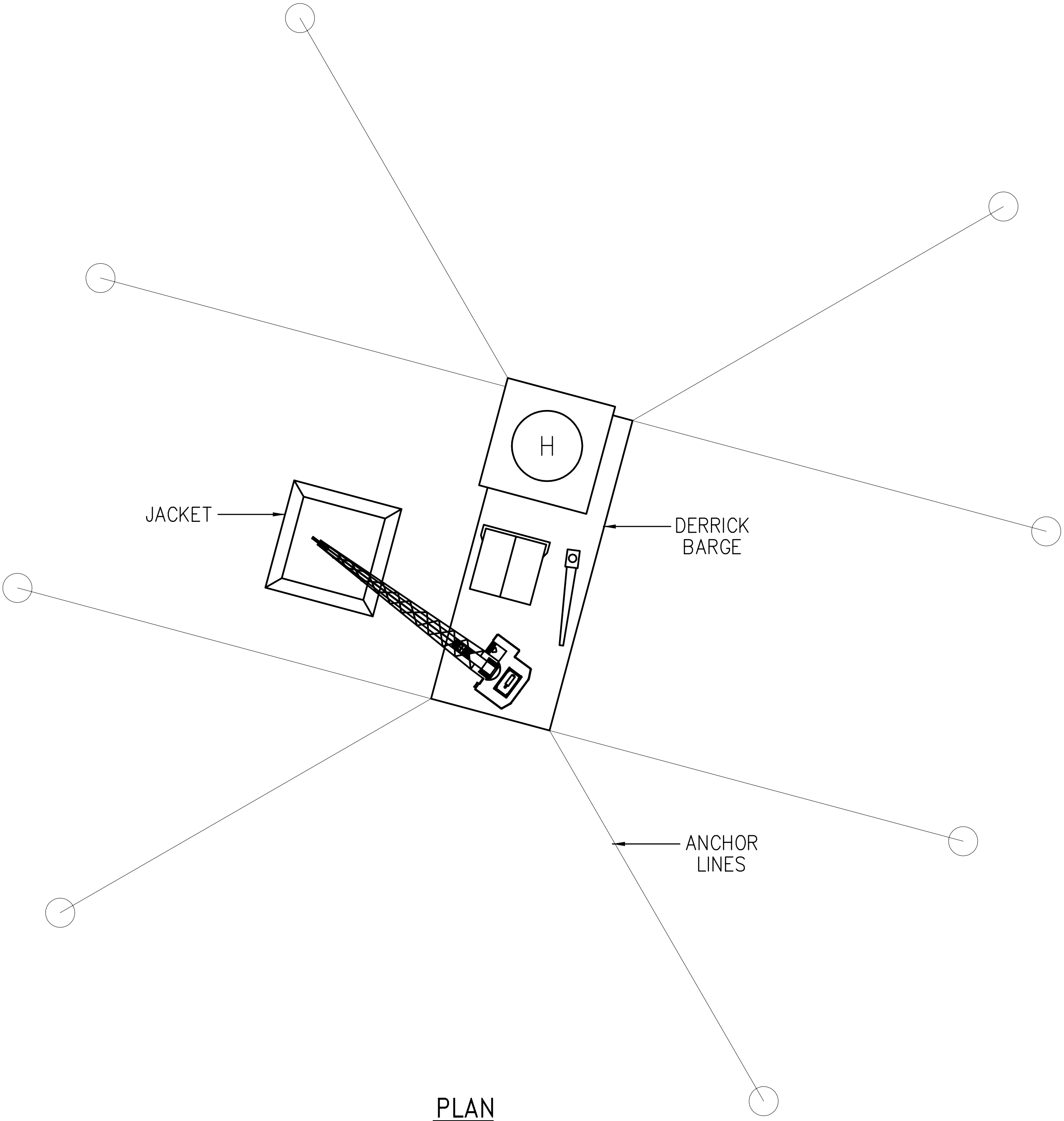
ELEVATION VIEW

SCALE N.T.S.

DEEPWATERWIND

	DSGN	JJS	1/12/2012	DEEPWATER WIND	JOB NUMBER 119630
	DRN	JJS	1/12/2012	BLOCK ISLAND TRANSMISSION PROJECT	REV D
	CKD	DEJ	1/12/2012		
	SCALE:	N.T.S.		COFFER DAM DETAIL	Figure 14
REFERENCE DRAWINGS	FOR 8.5x11 DWG ONLY			POWER ENGINEERS	

Coffer Dam Detail.dwg



PLAN

Upstream Engineering LLC

"Providing Value Added Engineering Services"

HOUSTON, TEXAS www.upstreamengineering.com (281) 531-0047

Registration No.: F-2752

DEEPWATERWIND®

JACKET INSTALLATION
w/DERRICK BARGE

No.	DATE	REVISION	BY	APP.
B	03/15/12	REVISED ISSUED FOR PERMITTING	JR	RS
A	01/24/12	ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA	SCALE: N.T.S.
DRAWN BY: J. RHAME	DATE: 01/11/12

PROJ. No.: P12-002 FILENAME: 9004.dwg	Figure 15	REV. No.: B

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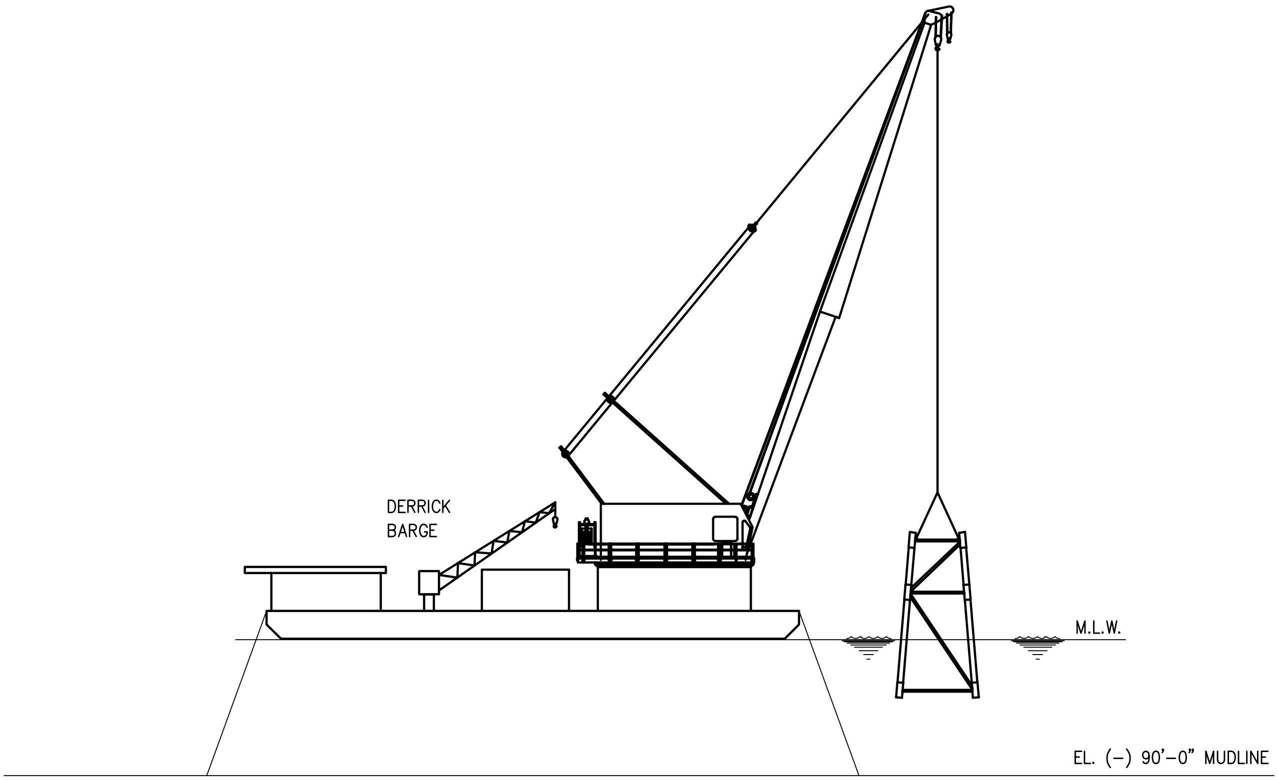

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No.	DATE	REVISION	BY	APP.
C	03/15/12	REVISED ISSUED FOR PERMITTING	JR	RS
B	01/26/12	REVISED ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA

SCALE: 1/128"=1'-0"

DRAWN BY: J. RHAME

DATE: 01/11/12

DEEPWATERWIND®

JACKET INSTALLATION
w/DERRICK BARGE

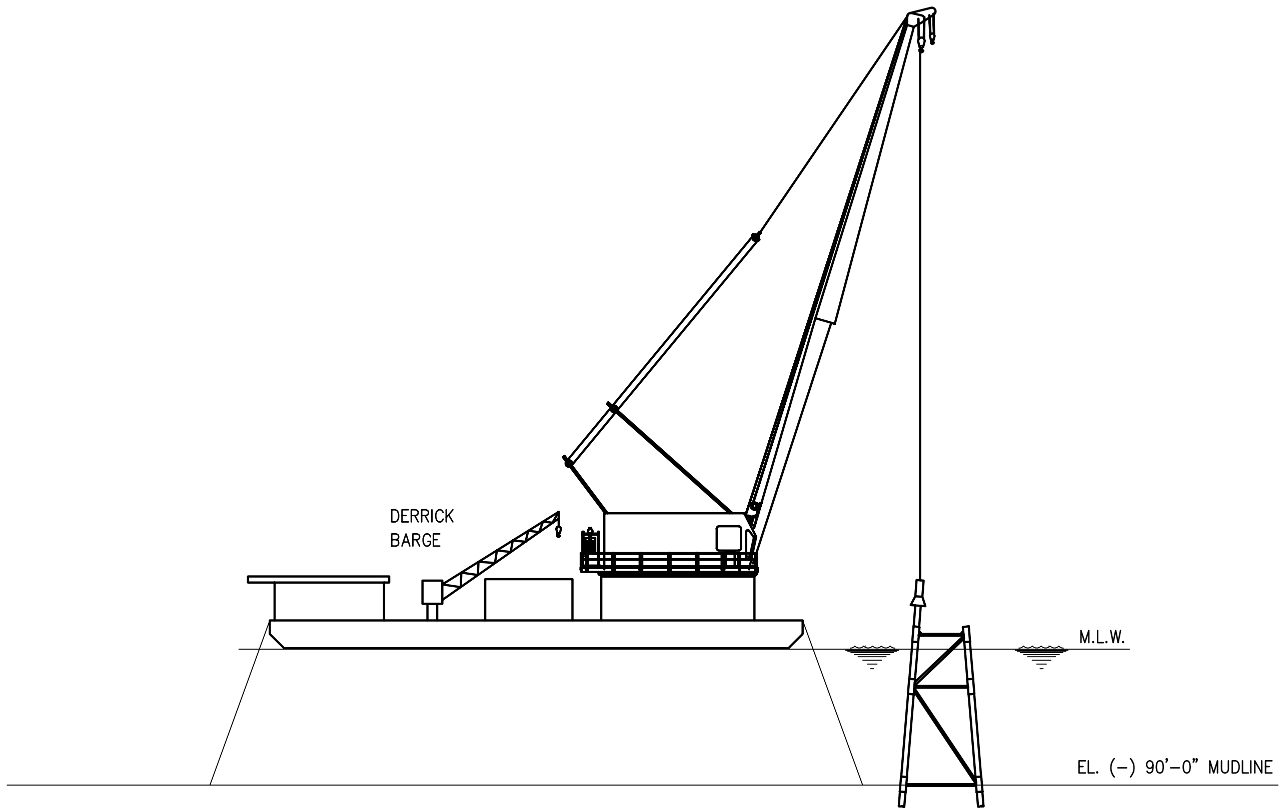
PROJ. No.: P12-002

FILENAME: 9005.dwg

Figure 16

REV. No.: C

jim.rhame, F:\Projects\2012\P12-002 Deepwater Wind Permit Dwgs\Drafting\PLD\9005.dwg, PAPERSPACE, 04/20/2012 – 09:20am



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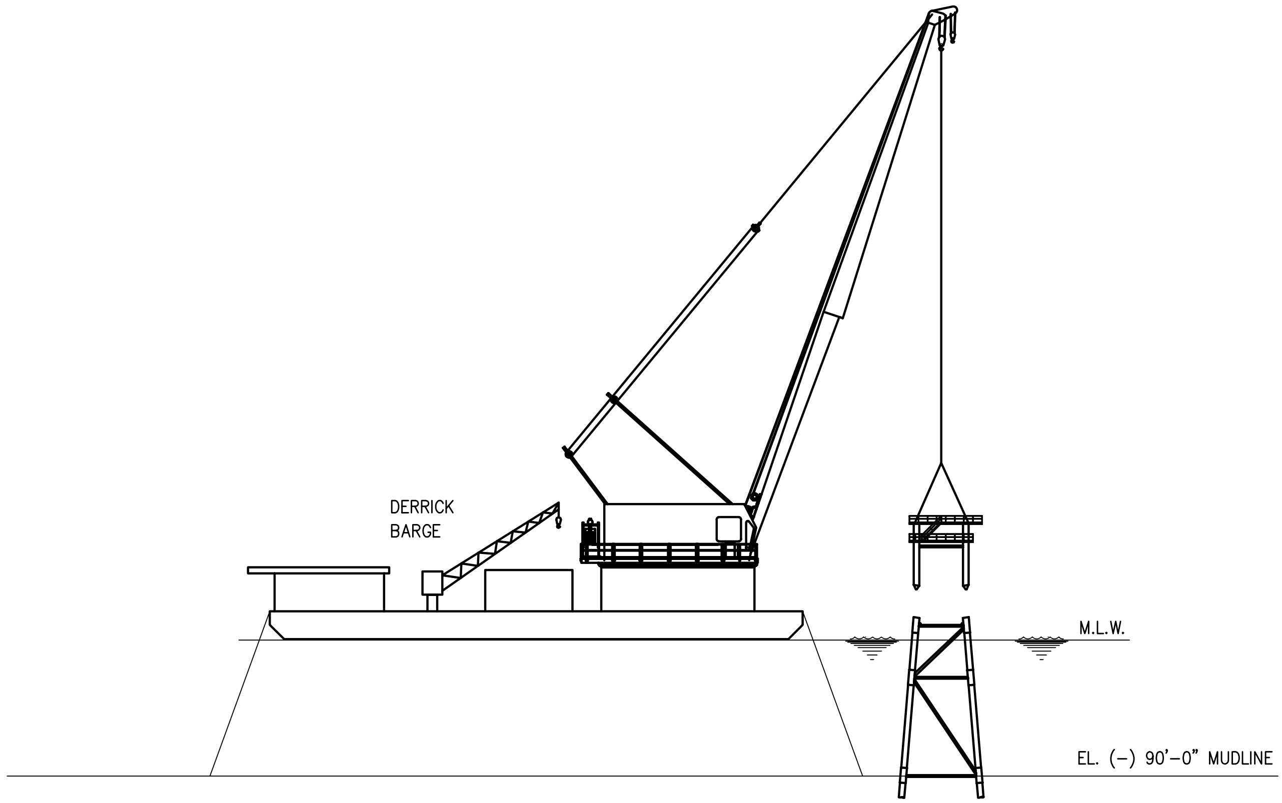
No.	DATE	REVISION	BY	APP.
C	03/15/12	REVISED ISSUED FOR PERMITTING	JR	RS
B	01/26/12	REVISED ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA	SCALE: 1/128"=1'–0"
DRAWN BY: J. RHAME	DATE: 01/11/12

DEEPWATERWIND®

PILE DRIVING
w/DERRICK BARGE

PROJ. No.: P12–002	Figure 17	REV. No.: C
FILENAME: 9006.dwg		



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A	01/24/12	ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA
SCALE: 1/128"=1'–0"
DRAWN BY: J. RHAME
DATE: 02/02/12

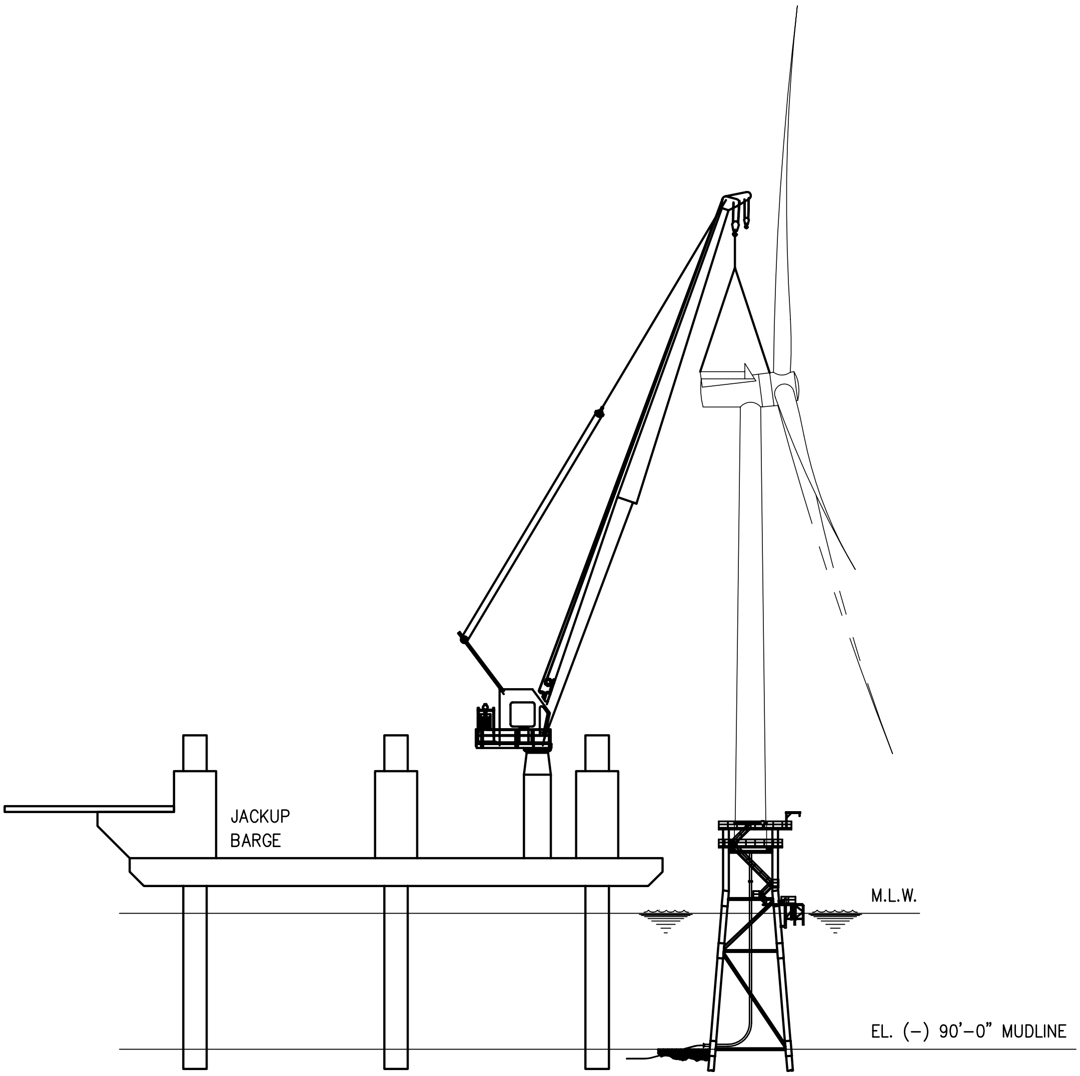
DEEPWATERWIND

DECK INSTALLATION
w/DERRICK BARGE

PROJ. No.: P12–002
FILENAME: 9007.dwg

Figure 18

REV. No.: B



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B	03/15/12	REVISED ISSUED FOR PERMITTING	JR	RS
A	01/24/12	ISSUED FOR PERMITTING	JR	RS

DESIGNED BY: D. YBARRA
SCALE: 1/128"=1'–0"
DRAWN BY: J. RHAME
DATE: 01/11/12

DEEPWATERWIND®

TURBINE INSTALLATION
w/JACKUP BARGE

PROJ. No.: P12–002
FILENAME: 9008.dwg

Figure 19

REV. No.: B

jim.rhame, F:\Projects\2012\P12–002 Deepwater Wind Permit Dwgs\Drafting\PLD\9008.dwg, PAPERSPACE, 04/20/2012 – 09:20am