OCS Study
BOEM 2018-029

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

Appendix E2: Seafloor Monitoring Survey 2 Report

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

OCS Study
BOEM 2018-029

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

Appendix E2: Seafloor Monitoring Survey 2 Report

May 2018

Authors (in alphabetical order):
Jennifer L. Amaral, Robin Beard, R.J. Barham, A.G. Collett, James Elliot, Adam S. Frankel, Dennis Gallien, Carl Hager, Anwar A. Khan, Ying-Tsong Lin, Timothy Mason, James H. Miller, Arthur E. Newhall, Gopu R. Potty, Kevin Smith, and Kathleen J. Vigness-Raposa

Prepared under BOEM Award
Contract No. M15PC00002,
Task Order No. M16PD00031
By
HDR
9781 S Meridian Boulevard, Suite 400
Englewood, CO 80112

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

FUGRO

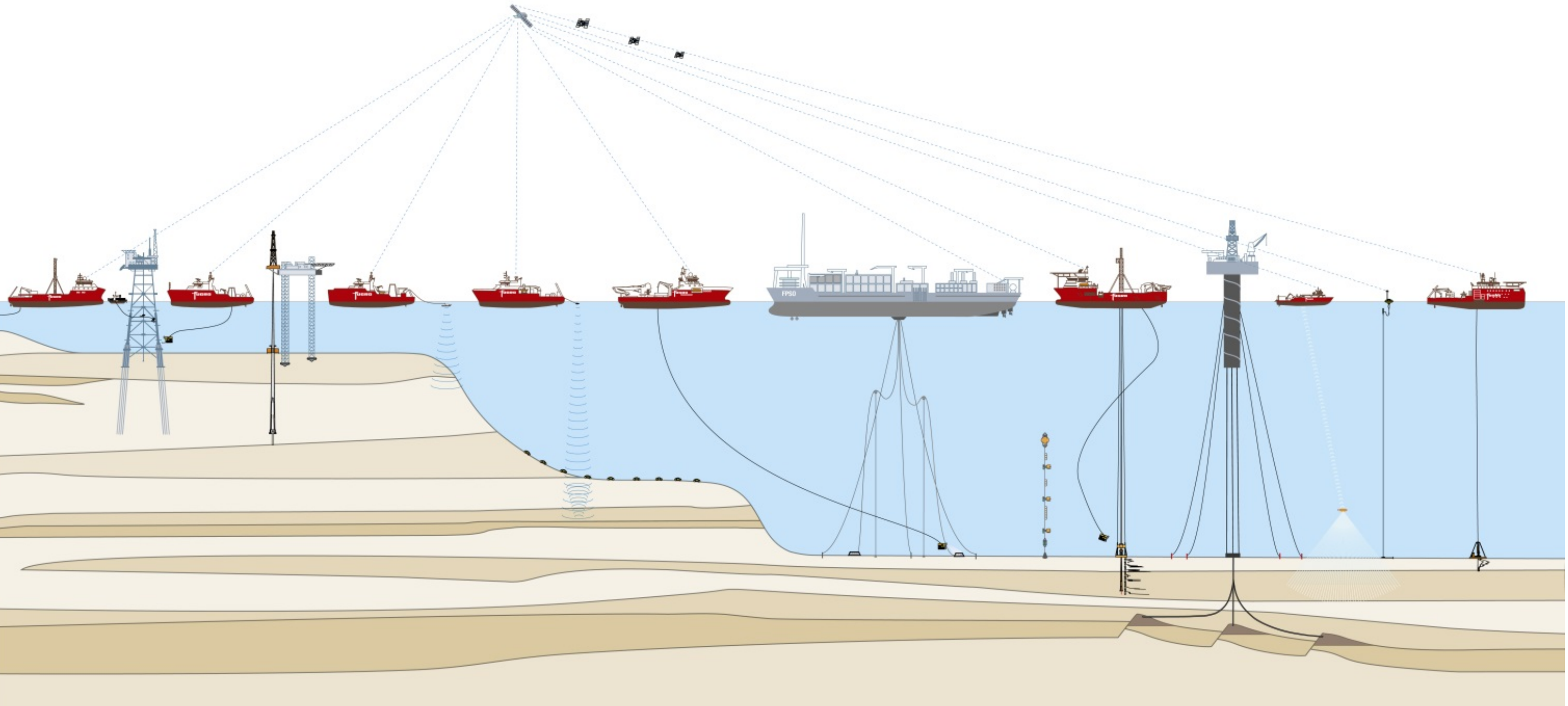
Seafloor Disturbance and Recovery Monitoring Program Survey No. 2 October 2016

Block Island Wind Farm, USA

Fugro Job No.: 04.81150001
Task Order No. 3, 0000023102

June 8, 2017
HDR Environmental, Operations and Construction, Inc.

Document Number: 04.81150001-3



Seafloor Disturbance and Recovery Monitoring Program Survey No. 2 October 2016

Block Island Wind Farm

June 8, 2017

Fugro Job No.: 04.81150001
Task Order No.: 3, 0000023102

Prepared for: HDR
300 North Madison Street
Athens, Alabama 35611
USA

01	Draft	Matt Greenwood	Dean Gresham	Kevin Smith	June 8, 2017
Issue	**Report Status**	**Prepared**	**Checked**	**Approved**	**Date**

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF CHARTS

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 ddisturbances. 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 9 and 10, 2016	Survey No. 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 No. 2 (current report; Construction Season 2 Baseline Survey)

This report presents the findings of the second bathymetric survey conducted by Fugro at the BIWF from October 2 to 5, 2016. The multibeam data from a previous bathymetry survey of the area (conducted by Fugro on May 11 and 12, 2016) were compared to the October 2016 data to:

- Identify seafloor disturbance features that were created during the 2016 Construction Season (Table 1.1), and
- Evaluate seafloor recovery from disturbances created during the 2015 Construction Season.

Interpreted seafloor disturbances observed in Survey No. 1 conducted in May 2015 after the first construction season are described in a separate report (catalogued in Fugro Report No. 160215-2). This report includes an assessment of the recovery of those features identified in the Survey No. 1 report.

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 October 2 to 5, 2016, Fugro conducted the second hydrographic survey (Survey No. 2) of the Work Area surrounding the five existing Block Island wind turbines. Figure 1 and Chart 1 show the extent of the hydrographic survey. Survey No. 2 encompassed the same area that was surveyed during Survey No. 1 on May 11 and 12, 2016. Both 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 details 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 No. 1 report. The May 2016 hydrographic survey was conducted using the chartered vessel R/V *Jamie Hanna.* The R/V *Jamie Hanna* is a 55-foot long purpose-built survey vessel. This report describes the Construction Season 2 (2016) baseline survey which was conducted in October 2016 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). Both survey vessels were equipped with pole mounted echosounder transducers. Both 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 both 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 both 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 both 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

Variability and repeatability of vertical measurements were evaluated by analyzing a subset of data from Surveys No. 1 and 2. Subsets of data were selected from an area that was interpreted to undergo no significant seafloor change between two 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 / October 2016 Comparison
Analysis area size (square meters)	16,940
Minimum Difference (meters)	-0.17
Maximum Difference (meters)	0.18
Mean Difference (meters)	0.01
Standard Deviation (meters)	±0.05

An average systematic bias of 0.01 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 (±0.05 meters) reflects the uncertainty of vertical difference calculated for the two 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 (±0.10 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 two 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.

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 second survey which:

- Identifies new disturbance features created during Construction Season 2 (2016), and
- Evaluates the recovery from disturbances that were created in Construction Season 1 (2015).

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 interpreting seafloor disturbances. Seafloor disturbance features were interpreted and 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 a wind turbine tower, blades, or nacelles.
- 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.

Figure 2b and Chart 2 presents the locations and classifications of the seafloor disturbance features interpreted from Survey No. 2. The features shown on Figure 2b and Chart 2 include disturbances created during Construction Seasons 1 and 2. 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 associated Construction Season (includes the footprint of the feature from the baseline survey).

This report presents the results from the second survey which represents the baseline condition survey for Construction Season 2 (2016). New seafloor disturbance features inferred to be from Construction Season 2 were concentrated around each of the five WTG locations and along the inter-array cable route (Figure 2b and Charts 2 and 3). We interpreted 103 new disturbance features that comprise an area of approximately 6,876 m^2. Circular depressions comprise the largest number of features, however, spud impressions comprise the largest total area of the three different categories of features. Table 3.1 summarizes the number, area, and relative percentage of the Work Area that each category of feature comprised for both Construction Season 1 (2015) and Construction Season 2 (2016).

Baseline conditions from Construction Season 1 (2015) were described in our Survey No. 1 report and are also summarized in Table 3.1. The following sections describe the seafloor disturbances that are related to Construction Season 2 (2016). Table 3.1 also provides a summary of the disturbances identified from the baseline survey for Construction Season 2.

Table 3.1: Seafloor Disturbance Baseline Condition Summary of Construction Seasons 1 (2015) and 2 (2016)

	Construction Season 1 (2015) Seafloor Disturbances (based on Survey No. 1 [May 2016])			Construction Season 2 (2016) Seafloor Disturbances (based on Survey No. 2 [Oct 2016])			Total (Construction Seasons 1 and 2)		
Area and Interpreted Features	**Area (m^2)**	**Percentage of Work Area**	**Number of Features**	**Area (m^2)**	**Percentage of Work Area**	**Number of Features**	**Area (m^2)**	**Percentage of Work Area**	**Number of Features**
Work Area	7,277,390	--	--	7,277,390	--	--	7,277,390	--	--
Spud	1,102	0.02%	26	4,152	0.06%	37	5,254	0.07%	63
Circular Depressions	2,803	0.04%	69	1,595	0.02%	51	4,398	0.06%	120
Drag Marks	6,414	0.09%	44	1,129	0.02%	13	7,543	0.10%	57
Total Disturbed Area	**11,570**	**0.16%**	**160**	**6,876**	**0.09%**	**101**	**18,446**	**0.25%**	**261**

Note: Baseline conditions for Construction Season 1 are based on Survey No. 1 (May 2016) and baseline conditions for Construction Season 2 are based on Survey No. 2 (October 2016).

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 feature extents are outlined from both surveys (May and October 2016) to aid in discerning if changes in their size or position has occurred (Figure 3c).

Construction Season 2 Features: Several new spud depressions that are associated with two construction vessels are located in the immediate vicinity of the WTG foundation (Figure 3b and 3c, Chart 3, and Table C-2). Features F160–F163 are associated with the L/B *Brave Tern*, while features F231–F242 are associated with the L/B *Michael Eymard*. In addition, numerous circular depressions (F198–F202, F204–F228, F230, and F254–F256) and four new drag marks (F203, F229, F243, and

F260) are located near WTG 1. The largest spud leg depressions (attributed to the L/B *Brave Tern)* range in depth from approximately 0.6 to 1.2 meters; each covers an area about 15 meters long and ten meters wide (Figure 3b, Chart 3, and Table C-2). The most prominent drag mark near WTG 1 (F260) is approximately 160 m long and 3 m wide and appears to be the result of a jet trencher associated with the installation of the inter-array cable, rather than a vessel leg or anchor being dragged due to its position and orientation. Concrete mats placed to provide burial cable protection where the cable enters the turbine WTG 1 appear as positive relief of approximately 0.2 m above the adjacent seafloor.

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 a variety of 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 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 feature extents are outlined from both surveys (May and October 2016) to aid in discerning if any changes in their size or position has occurred (Figure 4c).

<u>Construction Season 2 Features</u>: Several new spud depressions that were created by two construction vessels (the L/B *Brave Tern* and the L/B *Michael Eymard*) are located in the immediate vicinity of the WTG foundation (Figure 4b and 4c and Chart 3). Features F164–F167 are associated with the L/B *Brave Tern*, while features F209–F213 are associated with the L/B *Michael Eymard*. In addition, numerous circular depressions (F185–F191) are located to the immediate north and west of WTG 2. The largest spud leg depressions (attributed to the L/B *Brave Tern*) range in depth from approximately 0.6 to 0.9 meters; each covers an area about 15 meters long and ten meters wide (Figure 4b and 4c, Chart 3, and Table C-2). Spud depressions at this location associated with the L/B *Michael Eymard* range from approximately seven to 17 centimeters deep; each are about 6.5 meters long by three meters wide (Figure 4b and 4c, Chart 3, and Table C-2). Concrete mats placed to provide burial cable protection where the cable enters the turbine WTG 2 appear as positive relief of approximately 0.2 m above the adjacent seafloor.

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 apparent. 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 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 feature extents are outlined from both surveys (May and October 2016) to aid in discerning if any changes in their size or position has occurred (Figure 5c).

<u>Construction Season 2 Features</u>: Four new spud depressions (Features F168–F171) that are associated with the L/B *Brave Tern* are located in the immediate vicinity of the WTG foundation (Figure 5b and 5c and Chart 3). These depressions range in depth from approximately 0.7 to 1.3 meters; each

covers an area about 15 meters long and ten meters wide (Figure 5b and 5c, Chart 3, and Table C-2). Concrete mats placed to provide burial cable protection where the cable enters the turbine WTG 3 appear as positive relief of approximately 0.2 m above the adjacent seafloor.

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. Figures 6a, 6b, 6c, and Chart 2 display the local bathymetry and the interpreted seafloor disturbances that 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 feature extents are outlined from both surveys (May and October 2016) to aid in discerning if any changes in their size or position has occurred (Figure 6c).

Construction Season 2 Features: Four new spud depressions (Features F172–F175) that are associated with the L/B *Brave Tern* are located in the immediate vicinity of the WTG foundation (Figure 6b and 6c and Chart 3). These depressions range in depth from approximately 0.6 to 0.8 meters; each covers an area about 12 meters long and nine meters wide (Figure 6b and 6c, Chart 3, and Table C-2). The size and depth of these depressions are somewhat smaller and shallower than the impressions that were left by the same construction vessel at WTGs 1–3, indicating either less initial penetration, significant sediment infilling and/or depression collapse since the retraction of the vessel's spud legs, or both. Possible sediment infilling is likely due in part to the geotechnical properties of the soils (which may be more sand-prone/less consolidated), and intense hydrodynamic flow conditions at this location.

In addition to the new spud impressions, six circular depressions (F246–F251) were delineated just to the northeast and south of WTG 4 that are exclusive to the October 2016 bathymetry data. These features average five meters in diameter and range from 0.1 to 0.4 meters in depth. Concrete mats placed to provide burial cable protection where the cable enters the turbine WTG 2 appear as positive relief of approximately 0.2 m above the adjacent seafloor.

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 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 7c. Construction Season 1 feature extents are outlined from both surveys (May and October 2016) to see if any changes in their size or position has occurred (Figure 7c). Linear data artifacts are also observable in these renderings.

Construction Season 2 Features: Four new L/B *Brave Tern* spud depressions (Features F176–F179) were identified adjacent to the WTG foundation (Figure 7b and 7c and Chart 3). Those depressions range in depth from approximately 0.1 to 0.3 meters; each covers an area about eight meters long and six meters wide (Figure 7b and 7c, Chart 3, and Table C-2). The size and depth of those depressions are somewhat smaller and shallower than the impressions that were left by the same construction vessel at WTGs 1 through 4. WTG 5 is located at a water depth of 23 meters, which is the shallowest of the five locations.

Concrete mats placed to provide burial cable protection where the cable enters the turbine WTG 5 appear as positive relief of approximately 0.2 m above the adjacent seafloor.

3.1.6 Seafloor Disturbance Elsewhere in the Work Area

In addition to the disturbance features identified near the WTG foundations as described in Sections 3.1.1 through 3.1.5, more than 100 additional anthropogenic seafloor disturbance features were identified elsewhere in the Work Area. This section describes seafloor disturbances identified away from the immediate proximity to the WTG foundations.

Construction Season 2 Features: Several new seafloor disturbances were created during the Construction Season 2 (2016) at various locations in the Work Area (Chart 3 and Table C-2). Those disturbances are characterized as circular depressions and drag scars. The circular depressions sizes range from approximately three to 14 meters in diameter and approximately nine centimeters deep. The drag scars are approximately 11 to 88 meters long. During the Construction Season 2, the inter-array cable was installed and cable trench is readily observable. The cable trench is approximately 3 meters wide and between 5 and 20 cm deep. As previously described, concrete mats were placed on the cables section near each turbine. We understand that after the inter-array cable was installed use jet trenching, a section was left unburied at each turbine to allow the cable to be pulled into the J-tube. After the cable pull into the turbine, divers place concrete mats on the unburied sections of the cable near each turbine entry point.

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 bottom flow conditions at a site). Seafloor features identified in Survey No. 1 (May 11 and 12, 2016) and Survey No. 2 (October 2 through 5, 2016) represent baseline conditions from Construction Season 1 (2015) and Construction Season 2 (2016), respectively.

The second survey data were also compared to the first survey data to evaluate what changes (e.g. recovery), if any, had occurred to seafloor disturbance features created during Construction Season 1 (2015). Figures 3c, 4c, 5c, 6c, and 7c symbolize the features based on the construction season they were created. Also, Construction Season 1 baseline footprints are shown as light gray outlines on the Survey No. 2 renderings in Figures 3c, 4c, 5c, 6c, and 7c to compare how those features changed between the surveys.

Of the 160 seafloor disturbance features (F0 to F160) that were originally mapped and catalogued from Survey No. 1 (May 2016), 15 (F76, F80, F93, F138–F142, F144–F149, and F153) were observed in the Survey No. 2 (October 2016) data to be either mostly or completely infilled with sediment (“healed”). The former locations of those healed features are outline in light gray as shown in Figures 3c, 5c, and 6c. Eleven of the 15 features that were completely healed are located in areas where sediments have been described as predominantly fine-grained sand. Elsewhere, much of the area is described as medium- to coarse-grained sand.

Table C-1 (Appendix C) and Chart 4 list and display the features that were originally catalogued from Survey No. 1 and the relative changes that were interpreted to have occurred between May and October 2016. Table C-2 (Appendix C) and Chart 3 list and display all new seafloor features associated with Construction Season 2 that were observed (exclusively in the October 2016 data). Table 3.2 provides a summary of recovery of the Construction Season 1 disturbance features. The summary lists the number of features partially healed, completely healed, disturbed area completed healed and the percentage of the disturbed area that has completely healed.

Table 3.2: Summary of Seafloor Recovery

	Construction Season 1 (2015) Disturbances					
	Construction Season 1 (2015) Features		Recovery Since Baseline			
Interpreted Features	Number of Features	Area (m^2)	Partially Healed Features	Completely Healed Features	Completely Healed Area (m^2)	Recovery of Disturbed Area (%)
Spud	26	1,102	19	0	0	0
Circular Depressions	69	2,803	0	3	58	2
Drag Marks	44	6,414	1	12	1,300	20
Total	160	11,570	20	15	1,358	13

Note: Only Construction Season 1 features are listed above and their recovery is based on a comparison with Survey 2 (October 2016). Construction Season 2 features and their recovery will be evaluated using subsequent surveys. 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.

3.2.1 Wind Turbine Generator 1

<u>Construction Season 1 Features</u>: Five (F97–F100 and 108) of the 21 seafloor disturbances Construction Season 1 displayed no significant change in the Survey No. 2 (October 2016) bathymetric data (Table C-1). However, some change (between approximately two and ten centimeters) associated with sediment infilling was noted in Features F77, F82, F96, F101, F103–F107, and F109 (Chart 4 and Table C-1). In addition, features F92 and F95 displayed some change associated with overprint of new spud leg footprints.

3.2.2 Wind Turbine Generator 2

<u>Construction Season 1 Features</u>: Four of the ten seafloor disturbances (Features F110, F113, F126 and F127) that existed in this area prior to the May 2016 survey displayed no significant change in the October 2016 bathymetry data (Table C-1). However, some change (between two and nine centimeters) associated with sediment infilling was noted in the remaining six disturbances (Features F102, F111, F112, and F114–F116).

3.2.3 Wind Turbine Generator 3

<u>Construction Season 1 Features</u>: Five of the eight disturbances (F142, F89, F94, F129, and F128) that existed in this area prior to the May 2016 survey displayed no significant change in the October 2016 bathymetry data (Table C-1). The remaining three features (F80, F93, and F141) appear to have been completely healed and are not observable in the October 2016 bathymetry data. This area may

experience higher bottom current speeds and significant seafloor reworking, which could be the reason that Construction Season 1 seafloor disturbances from installation vessels aren't as apparent at this location. In addition, this theory could help explain the complete seafloor recovery associated with Features F80, F93, and F141. A more detailed discussion about sediment mobility and recovery is presented in Section 3.2 of this report.

3.2.4 Wind Turbine Generator 4

Construction Season 1 Features: Five of the thirteen disturbances (F120, F131, F121, F130, and F144) that existed in this area prior to the May 2016 survey displayed no significant change in the October 2016 bathymetry data (Table C-1). Four of the thirteen disturbances (F78 and F117–F119) experienced some change (between five and 11 centimeters) associated with sediment infilling from May 2016 to October 2016. The remainder of the features (F144–F147) appear to have been completely healed and are not observable in the October 2016 bathymetry data. WTG 4 is located within an area of active sediment reworking, as evidenced from an extensive wave ripple field that was observed to change bedform azimuth and height between May and October 2016 (Figure 8). Section 3.2 of this report discusses sediment mobility and recovery in further detail.

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 October 2016 bathymetry data (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 No. 2 data, the majority of the disturbances showed no significant change since Survey No. 1 (Table C-1). In addition, Features F53 and F159 displayed some change associated with overprint of new impressions. Seven features (F76, F138–140, F148, F149, and F153) appear to have been completely healed and are not observable in the Survey No. 2 bathymetry data. Those features are primarily concentrated between WTG 2 and WTG 3 and to the south of WTG 4 (within a field of actively migrating sand ripples). One feature (Feature F154) appeared to deepen by approximately 8 cm.

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 No. 1 and 2 data also indicate that the orientations and locations of individual bedforms and the extents of ripple and dune fields have changed between the surveys. Areas where the bedforms appear to have changed more notably have been associated with areas where seafloor disturbances have already partially or completely healed.

In the region between WTG 3 and 4, dune-scale bedforms were inferred to have migrated 8 to 15 meters between a survey conducted by DW in 2012 and our Survey No. 1 conducted in May 2016 (refer to Fugro Survey No. 1 report for description). However, those same dune-scale bedforms displayed little to no discernable movement between our Surveys No. 1 and 2.

We identified several large ripple fields that either changed in spatial extent or the ripples changed in orientation (Figure 10). Orientations of ripples in a large ripple field located between WTG 3 and 5 changed between Surveys No. 1 and 2 (Figures 8 and 10). During Survey No. 1 ripple crestlines were primarily east-west oriented but during Survey No. 2 there are primarily northeast-southwest oriented (refer to inset images in Figure 8 that depict the ripple orientations). The extent of the ripple field that exhibited change in their orientation is delineated on Figure 10 with black hachured lines. We also note that the ripples were approximately 10 cm tall in during Survey No. 1 but were only about 5 cm tall in Survey No. 2. Survey No 1. was conducted at the end of winter and Survey No. 2 was conducted at the end of summer. The differences in ripple heights may reflect seasonal differences.

Extents of the ripple fields also changed between the surveys. Dark green shading in Figure 10 highlights areas where ripples were present in Survey No. 1 but are not present in Survey No. 2. This represents an approximately 65 percent reduction in the extent of the ripple fields.

3.2.7.2 Zonation based on Morphology

Based on these observations of bedform migration and those in the Survey No. 1 Report (Fugro Report No. 160215-2), the seafloor was classified into zones based on bedform morphology and changes inferred from evaluation of the various survey data. Some inferences were made as to the grain size of the surficial material in each zone. The interpretive boundaries have been updated for this report (based on the October 2016 survey data). Figure 9 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 2012 and May 2016 bathymetric data sets, but not between the May and October 2016 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. Some sediment reworking (smoothing and slight shifting) was noticed between the May and October 2016 surveys
- Zone 2: Moderate mobility areas which are interpreted to be comprised of medium to coarse sand-size particles. These areas were identified in both the May and October 2016 surveys; however due to the fact that they are relatively featureless, the boundaries were difficult to notice change.
  - Zone 2a: Ripple fields which are moderately mobile and are comprised of medium to coarse sand particles. These wave ripple fields can be seen in both the May and October 2016 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 both the May and October 2016 datasets and was not observed to shift between the two.

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 No. 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 No. 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 No. 2 was conducted at the end of Construction Season 2 in October 2016 and represents the baseline survey for Construction Season 2 disturbance monitoring. This report describes Survey No. 2 and the interim results from the survey. After completion of the monitoring program, a final report will be prepared that provides of summary of the full program.

Survey No. 1, identified 160 disturbance features that comprise an area of 11,570 m^2 inferred to be created during Construction Season 1 as described in the Survey No. 1 Report. Survey No. 2 revealed that 20 of those features had partially healed and 15 have completely healed. The completely healed features comprise an area of 1,358 m^2 or indicates that approximately 13 percent of the disturbed area has completely healed. Eleven of the 15 features that have completely healed were in areas comprised predominantly of fine-grained sand. The other four features were in areas comprised of predominantly medium- to coarse-grained sand.

Survey No. 2 was used to identify 103 new disturbance features inferred to be created during Construction Season 2. The disturbance features comprise an area of approximately 6,876 m^2. Survey No. 2 also revealed the cable trench scar and concrete mats that were placed on the unburied sections of the cables new the turbines.

We compared Surveys No. 1 and 2 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. Ripples were two times taller in Survey No. 1 (conducted at the end of winter) than observed in Survey No. 2 (conducted at the end of summer). Also, the ripple field located between WTG 3 and 5 was approximately 65 percent smaller in Survey No. 2 than in Survey No. 1. 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 (Zone 1–Zone 3) and two subzones (Zone 1a and Zone 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. 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 fifteen disturbance features noted to have completely "healed", 11 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

Allen, J.R. (1982) Sedimentary Structures: Their Character and Physical Basis. Elsevier, New York, NY.

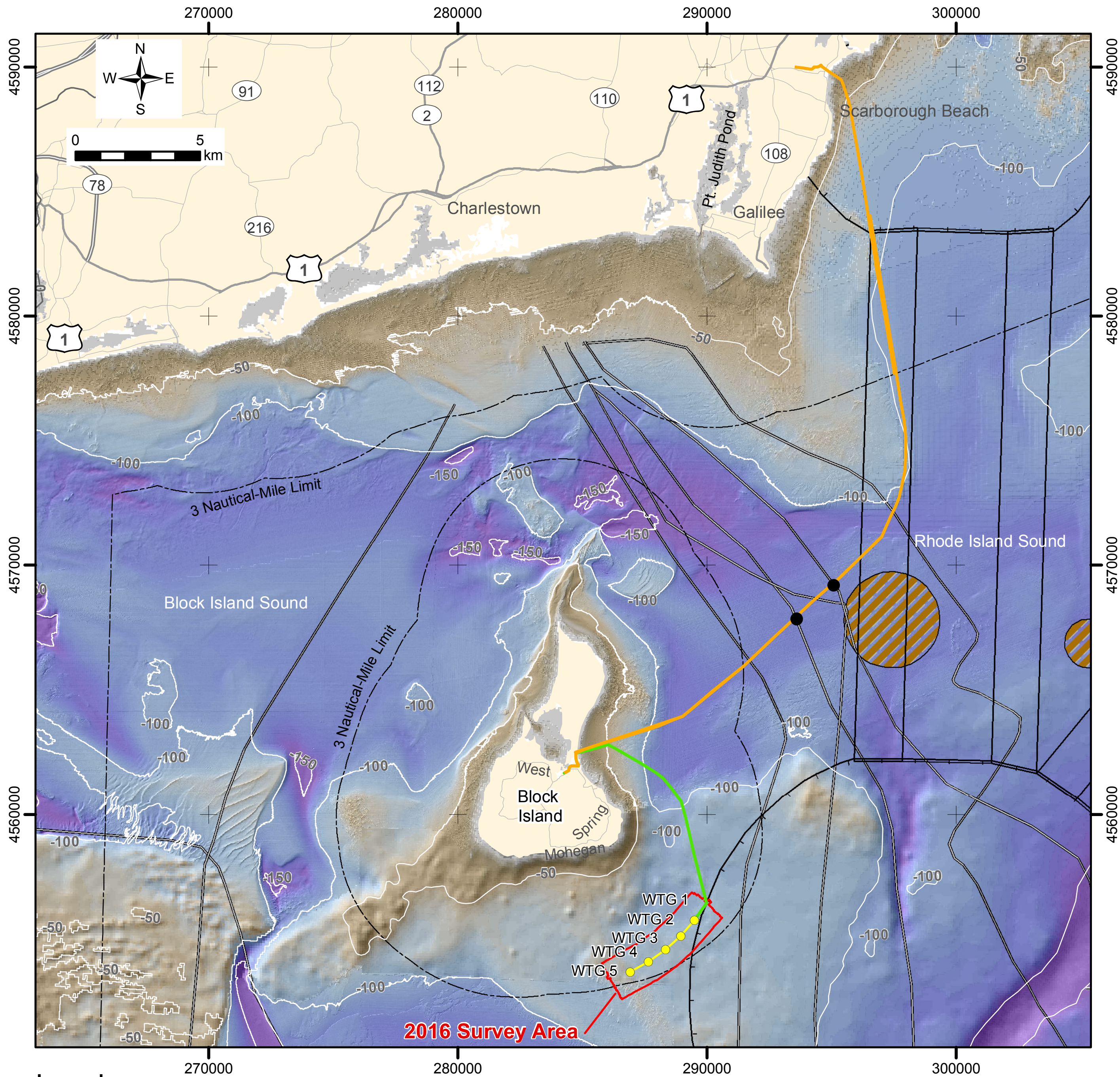
Ashley, G.M. (1990), "Classification of Large-Scale Subaqueous Bedforms: A New Look at an Old Problem," Journal of Sedimentary Petrology, Vol. 60, pp. 363-396.

Fugro (2106) Seafloor Disturbance and Recovery Monitoring Program, Survey No. 1, May 2016, Block Island Wind Farm. Report prepared for HDR Environmental, Operations and Construction, Inc.

Stow, Dorrik A.V., Hernández-Molina, Javier, Llave, Estefania, Sayago-Gil, Miriam, del Río, Victor Díaz, and Branson, Adam (2009), "Bedform-velocity matrix: The estimation of bottom current velocity from bedform observations," Geology, v.37, no. 4, p.327-330.

Van Rijn, L.C. (1993) Principle of Fluid Flow and Surface Waves in Rivers, Estuaries, Seas, and Ocean. Aqua, Amsterdam, The Netherlands.

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

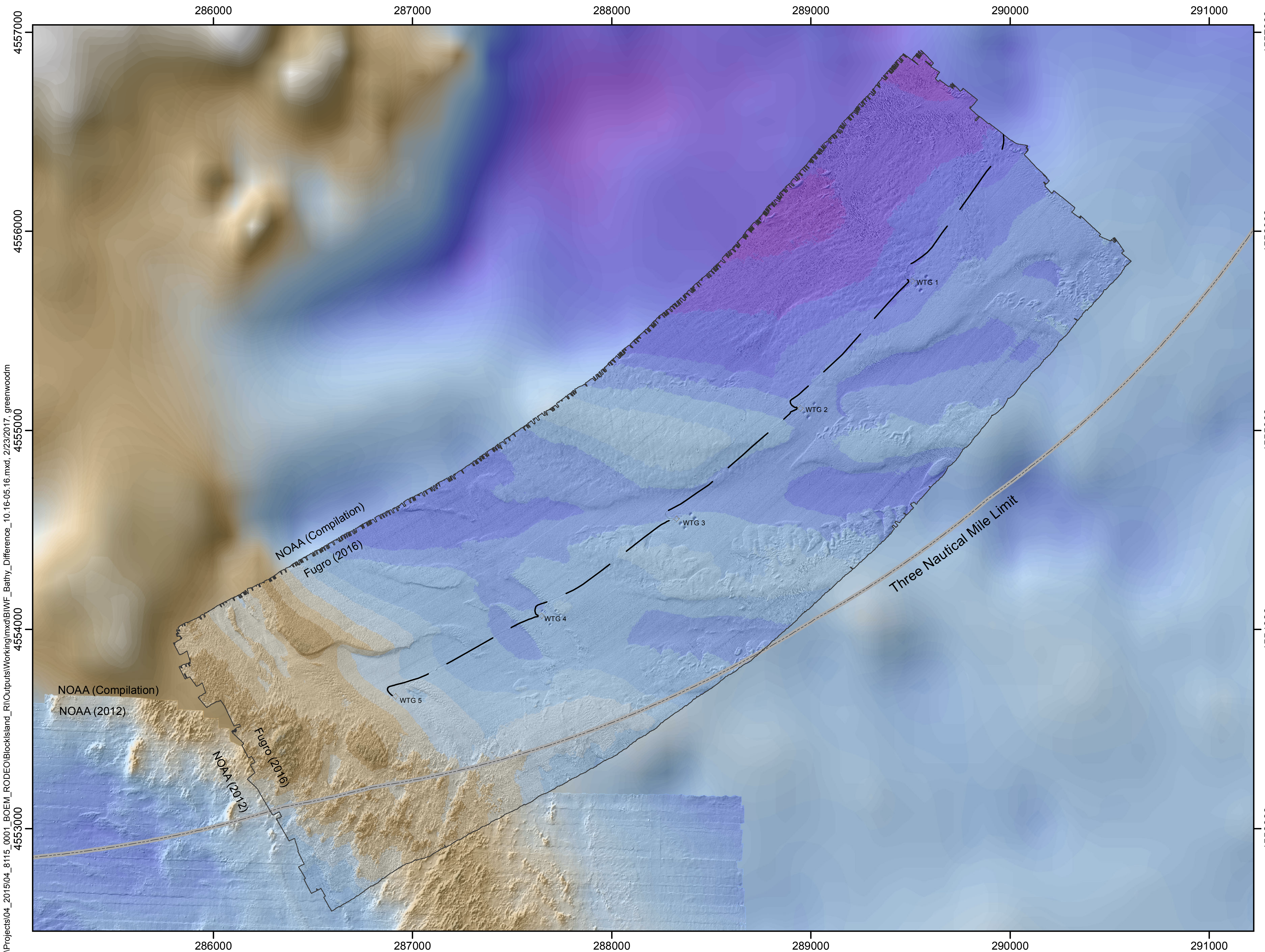
Base Map

- 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_2\MXD\Fig-1_Study_Area.mxd, 2/27/2017, greenwoodm



N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Working\mxd\BIWF_Bathy_Difference_10.16-05.16.mxd, 2/23/2017, greenwoodm

Legend

Export Cable/Inter Array Cable

Three Nautical Mile State Limit

Bathymetry (Meter, MLLW)

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

Notes:

1. Fugro 2016 multibeam bathymetry was collected on October 02 through 05, 2016.

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.

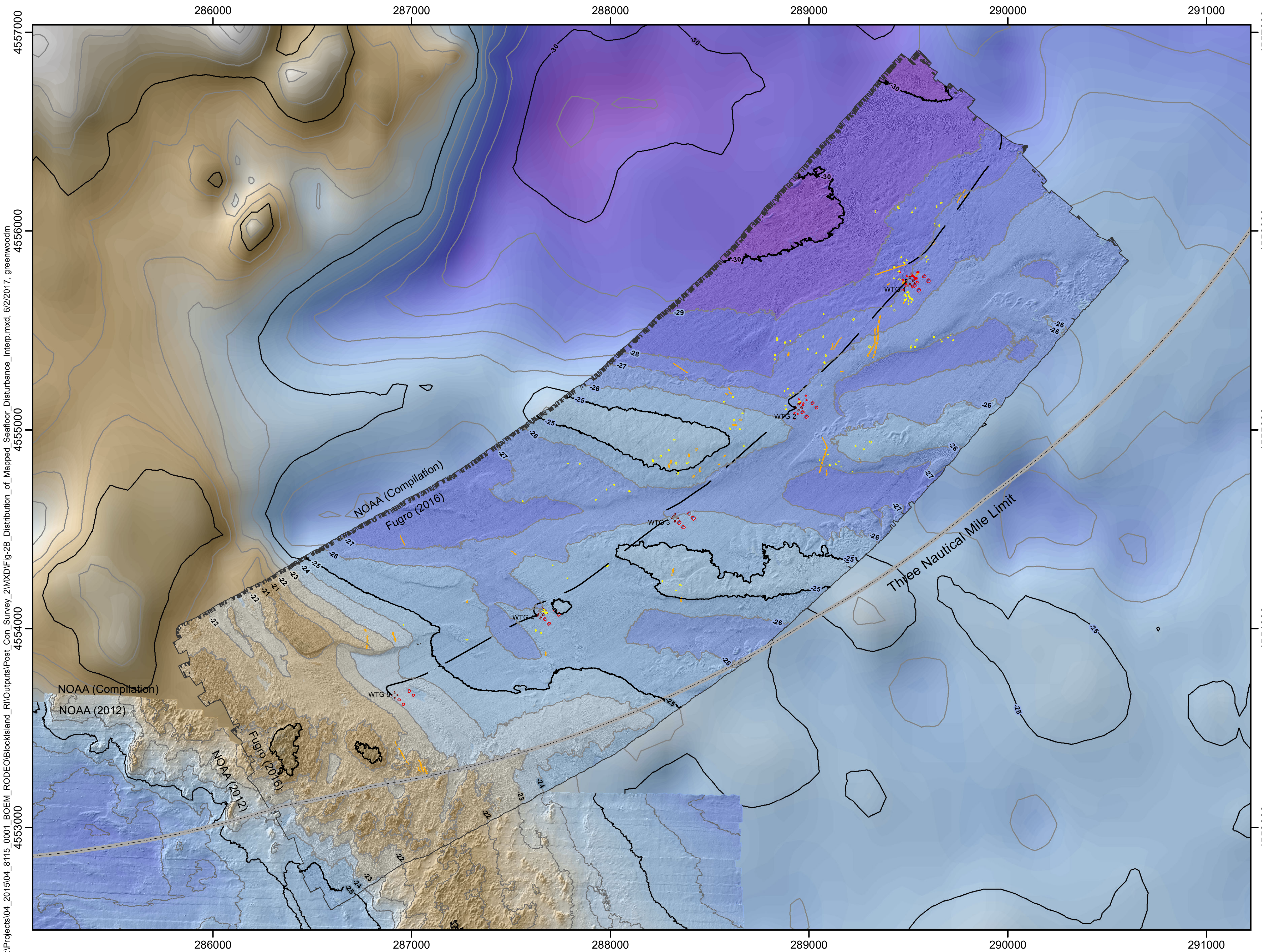
N
W E
S

0 200 400 800
Meters

Coordinate System: UTM 19N, NAD83, Meter

FUGRO 2016 BATHYMETRY
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 2a



N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-2B_Distribution_of_Mapped_Seafloor_Disturbance_Interp.mxd, 6/2/2017, greenwoodm

Legend

Export Cable/Inter Array Cable

Three Nautical Mile State Limit

Bathymetry (Meter, MLLW)

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

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 2016 multibeam bathymetry was collected on October 02 through 05, 2016.

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

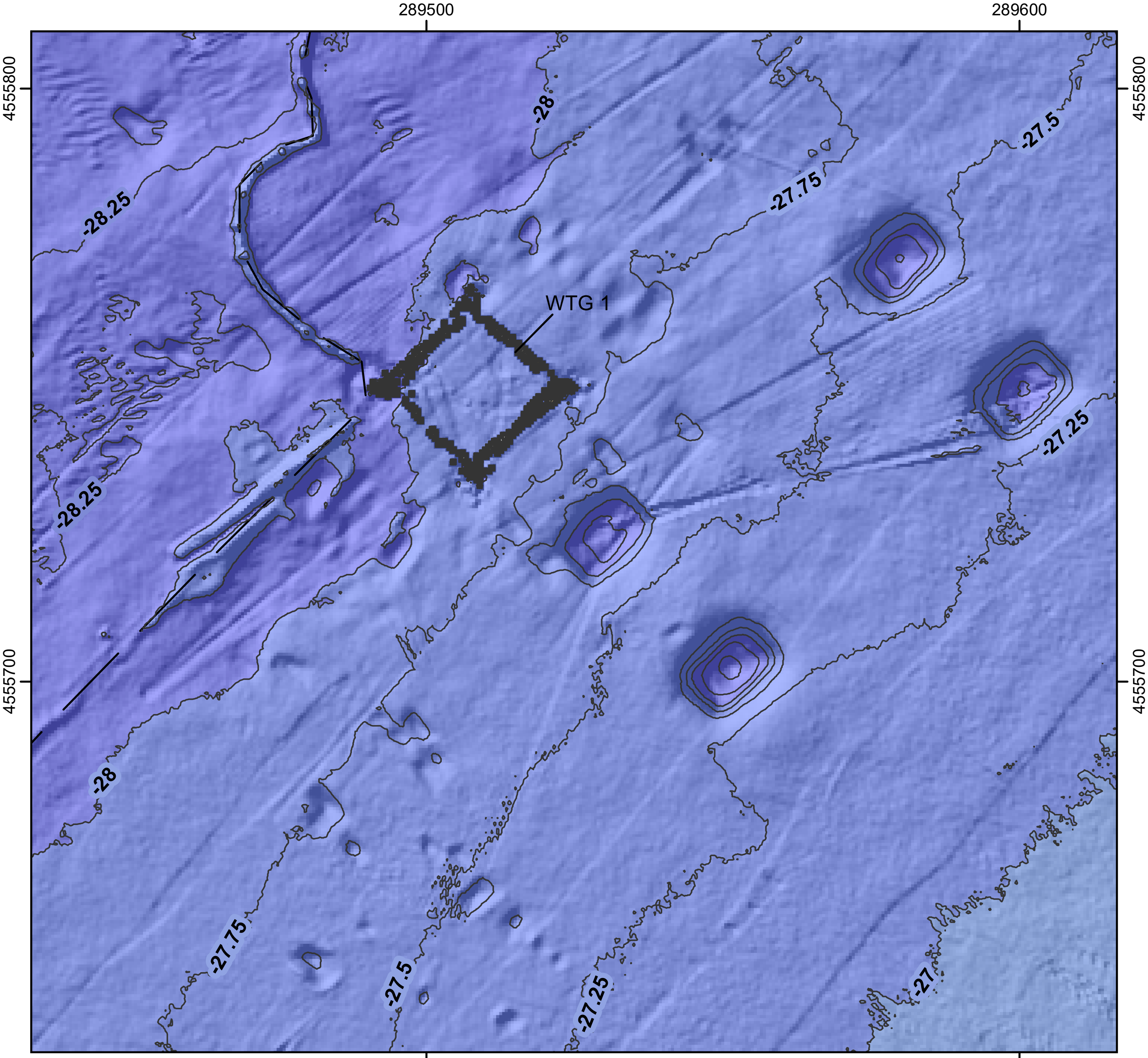
0 200 400 800 Meters

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



Legend

Export Cable/Inter Array Cable

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Contour interval is 0.25 meters

N W E S

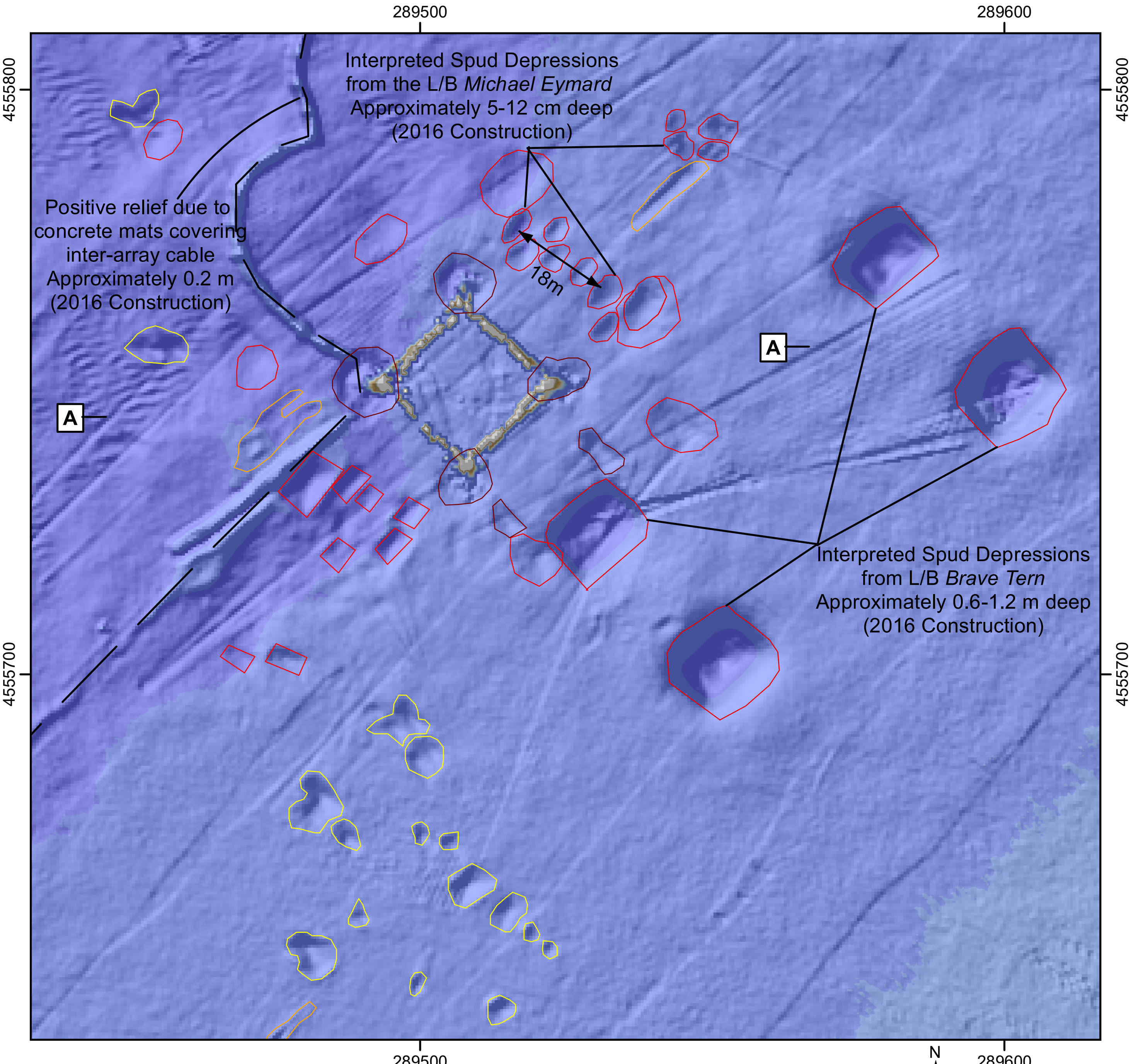
0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

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

FIGURE 3a

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-3a_WTG1_Bathymetry_with_Contours.mxd, 6/2/2017, greenwoodm



Legend

Export Cable/Inter Array Cable

A Data Artifact

Interpreted Seafloor Disturbance Features

Spud

Drag Mark

Circular Depression

Scour

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

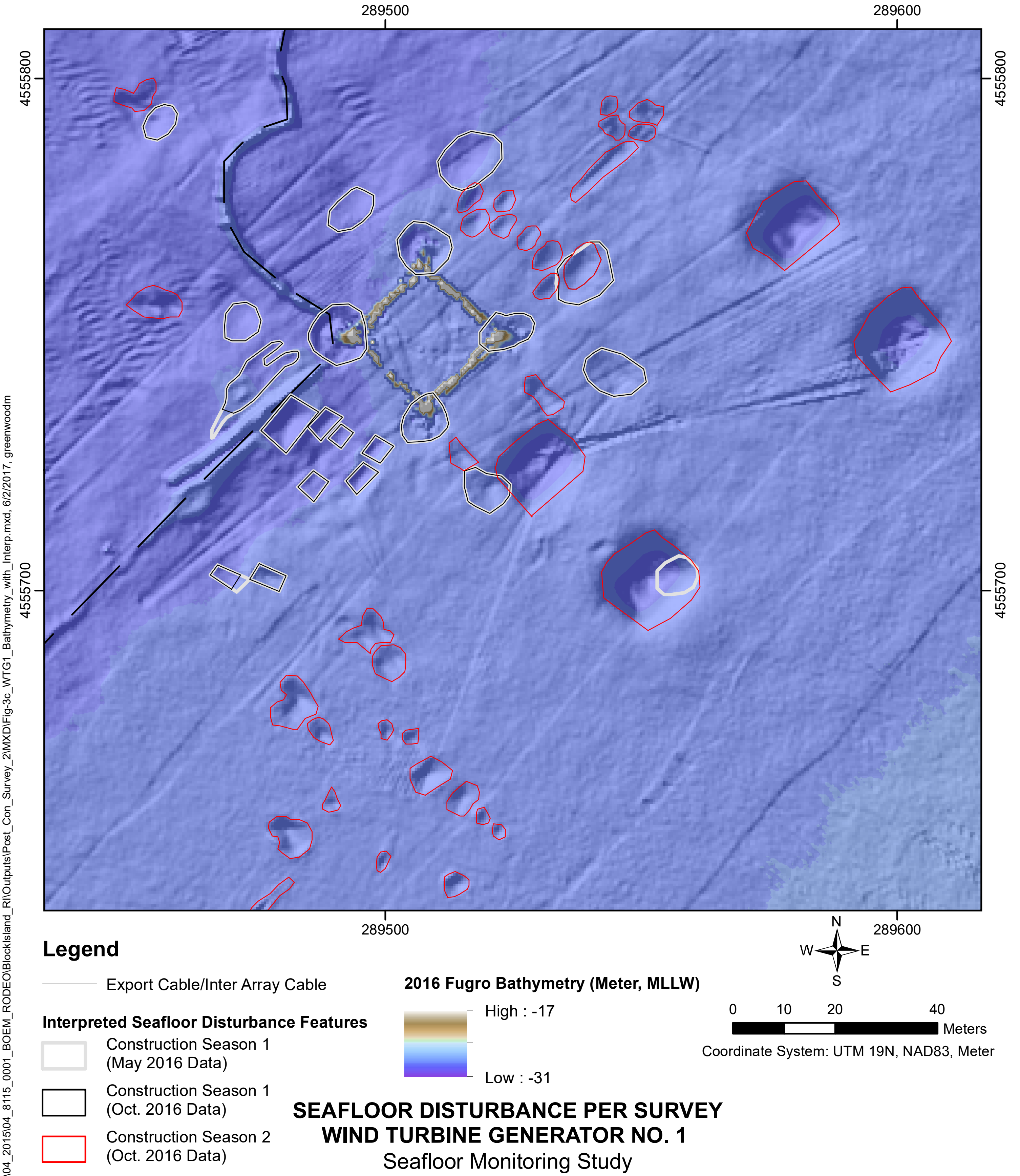
0 10 20 40 Meters

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

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-3b_WTG1_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm

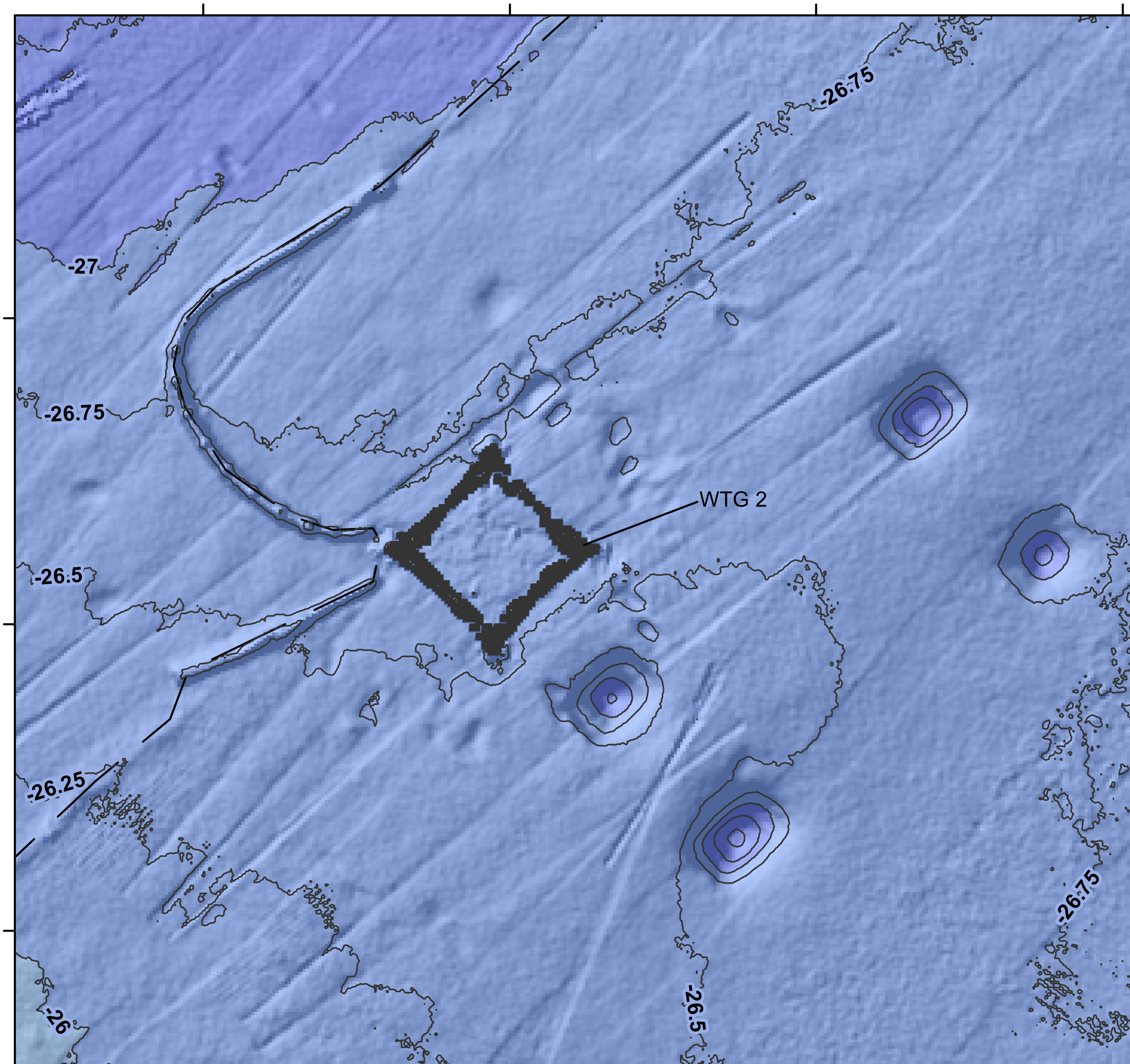


SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 1
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 3c

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-3c_WTG1_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm

BOEM
Project No. 04.81150001



Legend

Export Cable/Inter Array Cable

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Contour interval is 0.25 meters

N W E S

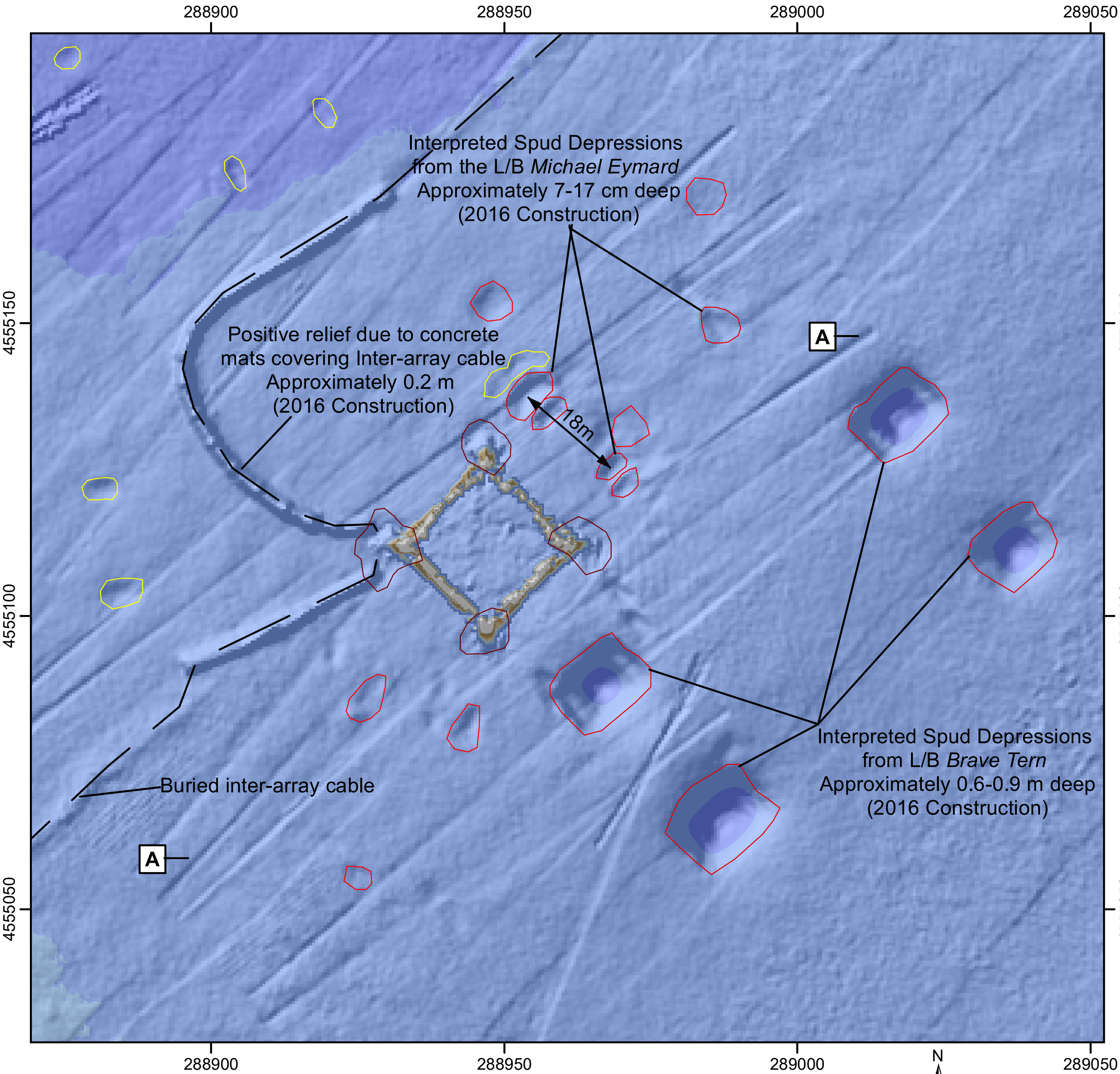
0 10 20 40 Meters

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

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-5a_WTG2_Bathymetry_with_Contours.mxd, 6/2/2017, greenwoodm



Legend

Export Cable/Inter Array Cable

A Data Artifact

Interpreted Seafloor Disturbance Features

Spud

Circular Depression

Scour

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

N W E S

0 10 20 40 Meters

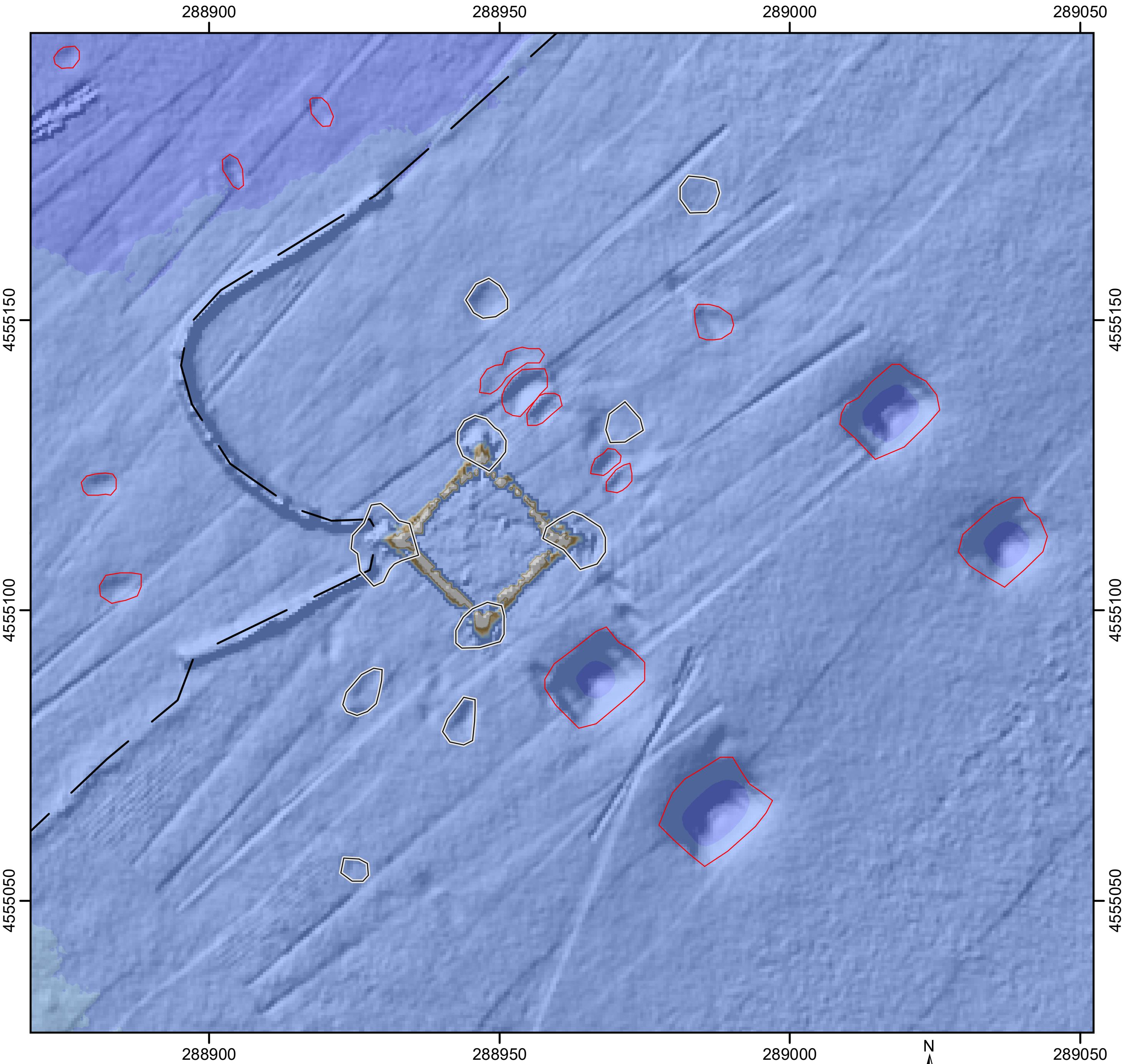
Coordinate System: UTM 19N, NAD83, Meter

INTERPRETED SEAFLOOR DISTURBANCE TYPES
WIND TURBINE GENERATOR NO. 2

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

FIGURE 4b

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-4b_WTG2_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm



Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Construction Season 1 (May 2016 Data)

Construction Season 1 (Oct. 2016 Data)

Construction Season 2 (Oct. 2016 Data)

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

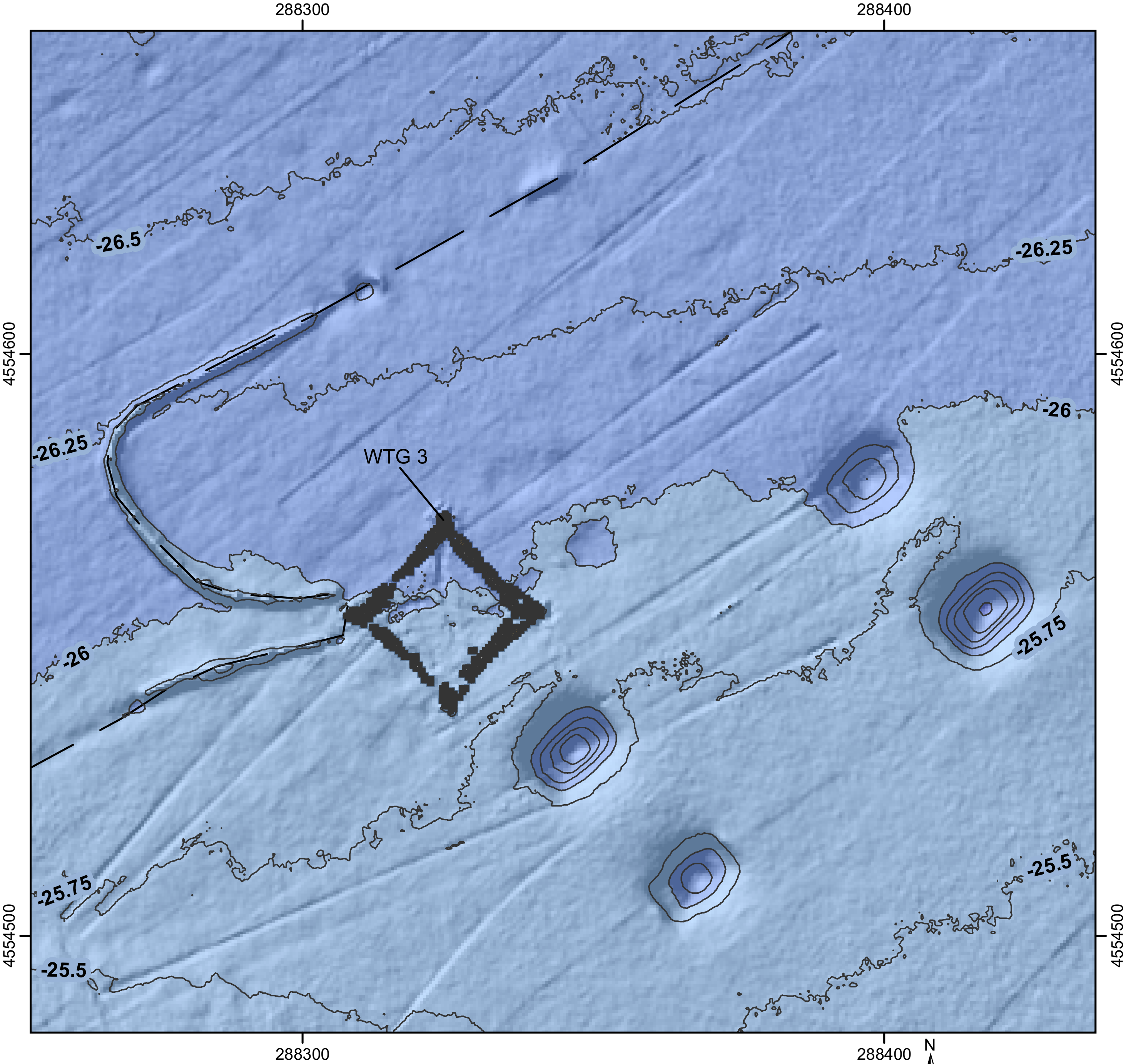
Coordinate System: UTM 19N, NAD83, Meter

SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 2

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

FIGURE 4c

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-4c_WTG2_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm



Legend

Export Cable/Inter Array Cable

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Contour interval is 0.25 meters

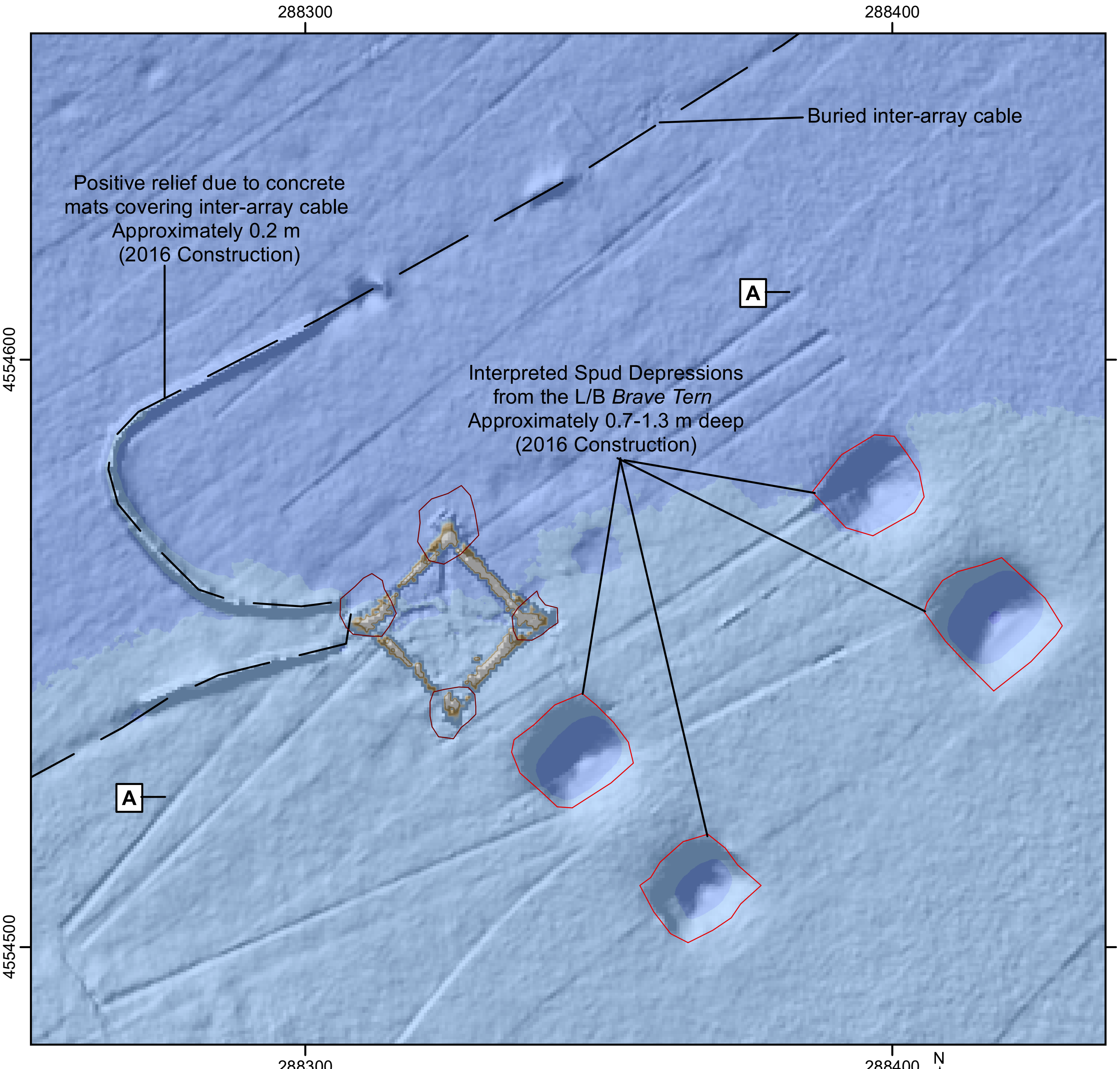
0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_1\MXD\Fig-6a_WTG3_Bathymetry_with_Contours.mxd, 6/2/2017, greenwoodm

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

FIGURE 5a



Legend

Export Cable/Inter Array Cable

A Data Artifact

Interpreted Seafloor Disturbance Features

Spud

Scour

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

N W E S

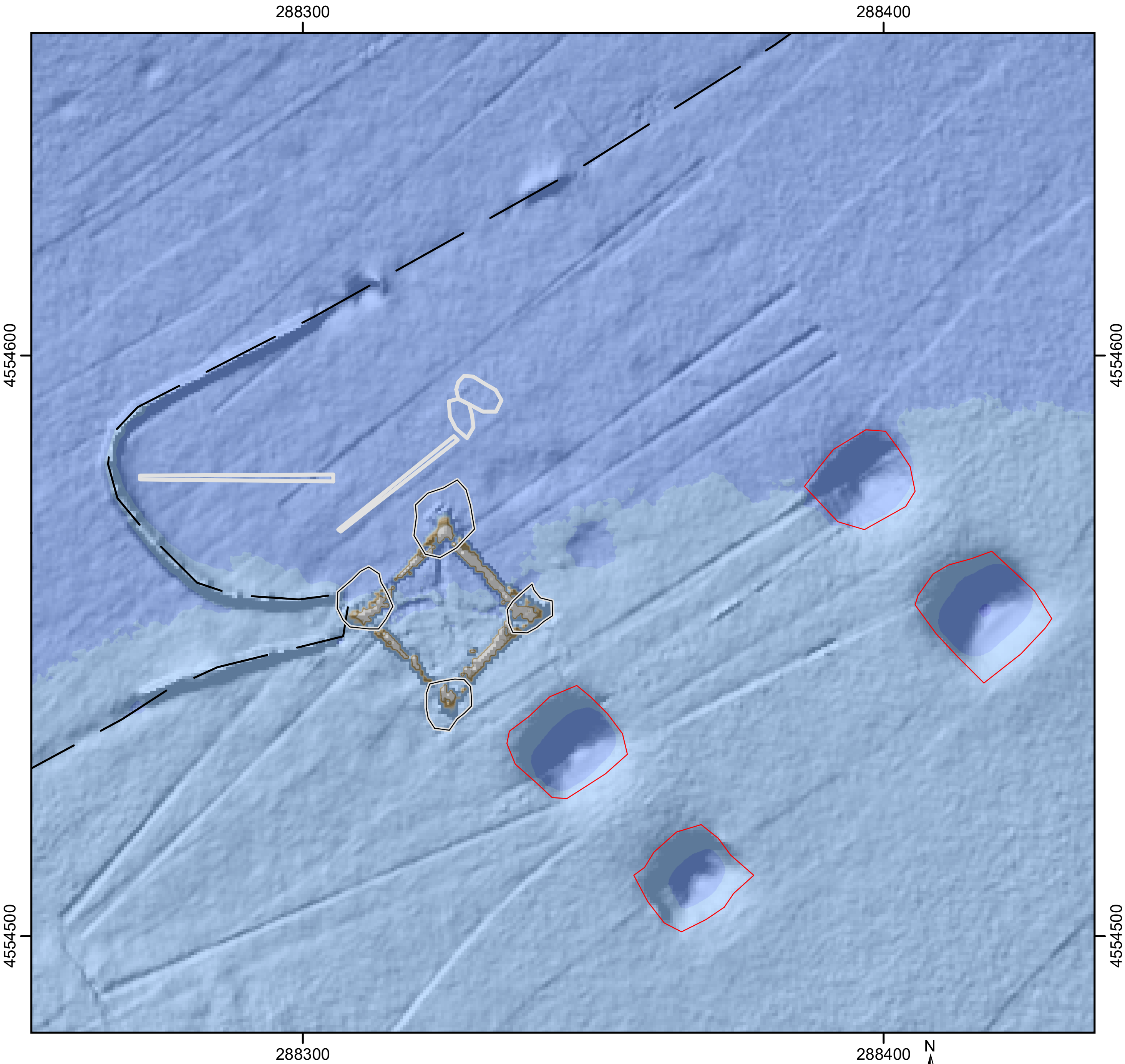
0 10 20 40 Meters

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

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-5b_WTG3_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm



Legend

Export Cable/Inter Array Cable

Interpreted Seafloor Disturbance Features

Construction Season 1 (May 2016 Data)

Construction Season 1 (Oct. 2016 Data)

Construction Season 2 (Oct. 2016 Data)

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

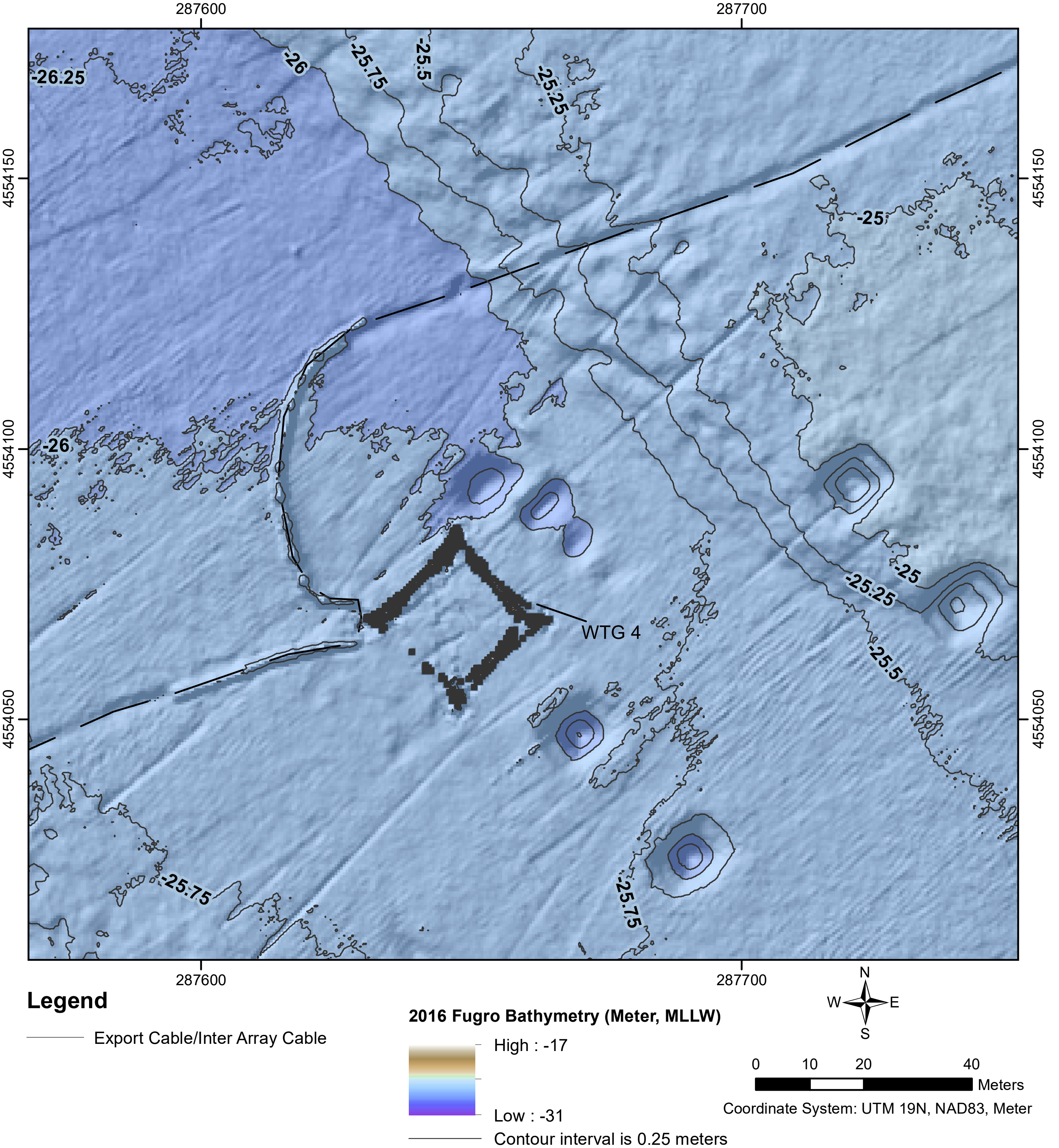
SEAFLOOR DISTURBANCE PER SURVEY
WIND TURBINE GENERATOR NO. 3

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

FIGURE 5c

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-5c_WTG3_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm

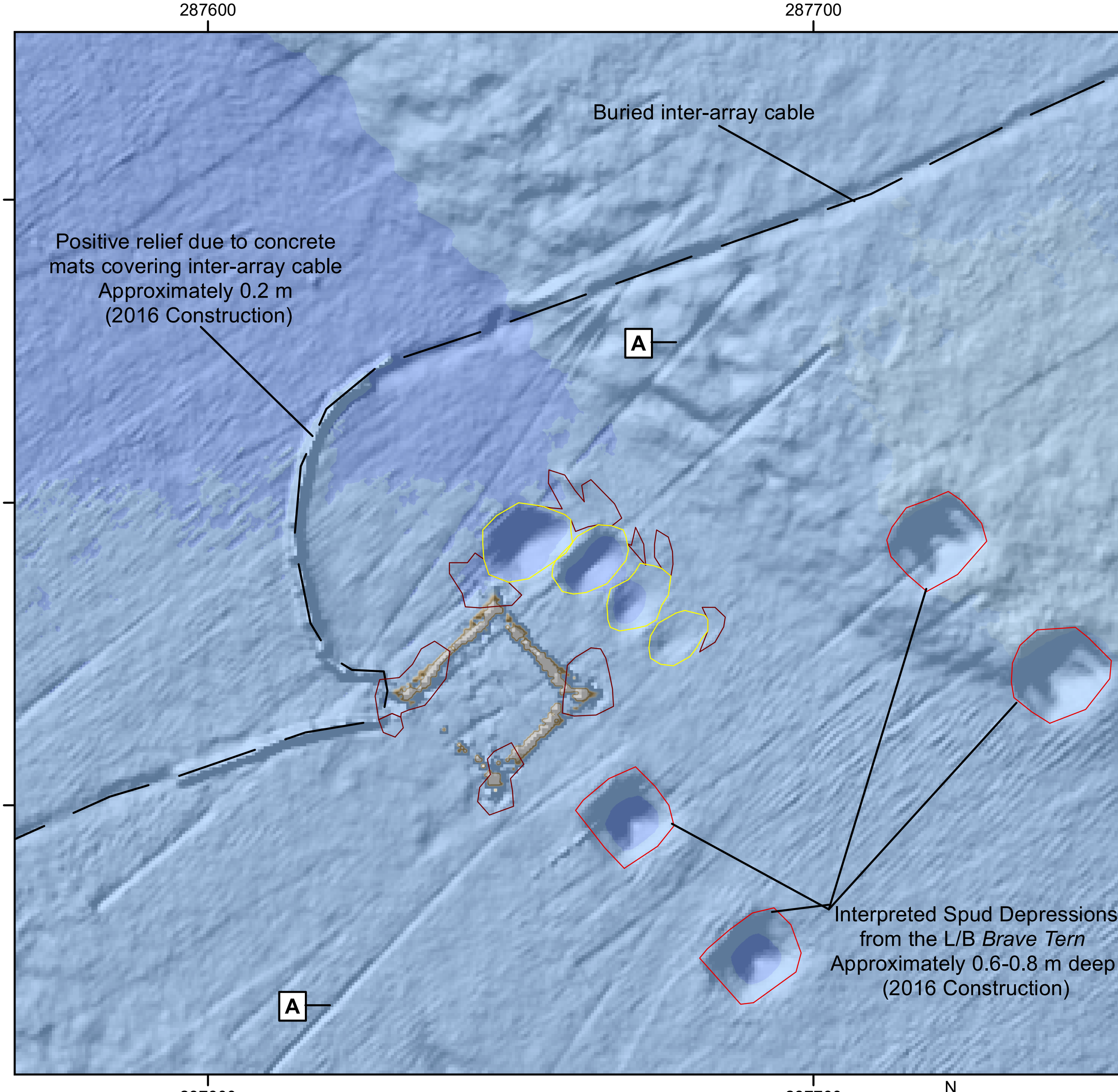
BOEM
Project No. 04.81150001



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

FIGURE 6a

N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-6a_WTG4_Bathymetry_with_Contours.mxd, 6/2/2017, greenwoodm



Legend

Export Cable/Inter Array Cable

A Data Artifact

Interpreted Seafloor Disturbance Features

Spud

Circular Depression

Scour

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

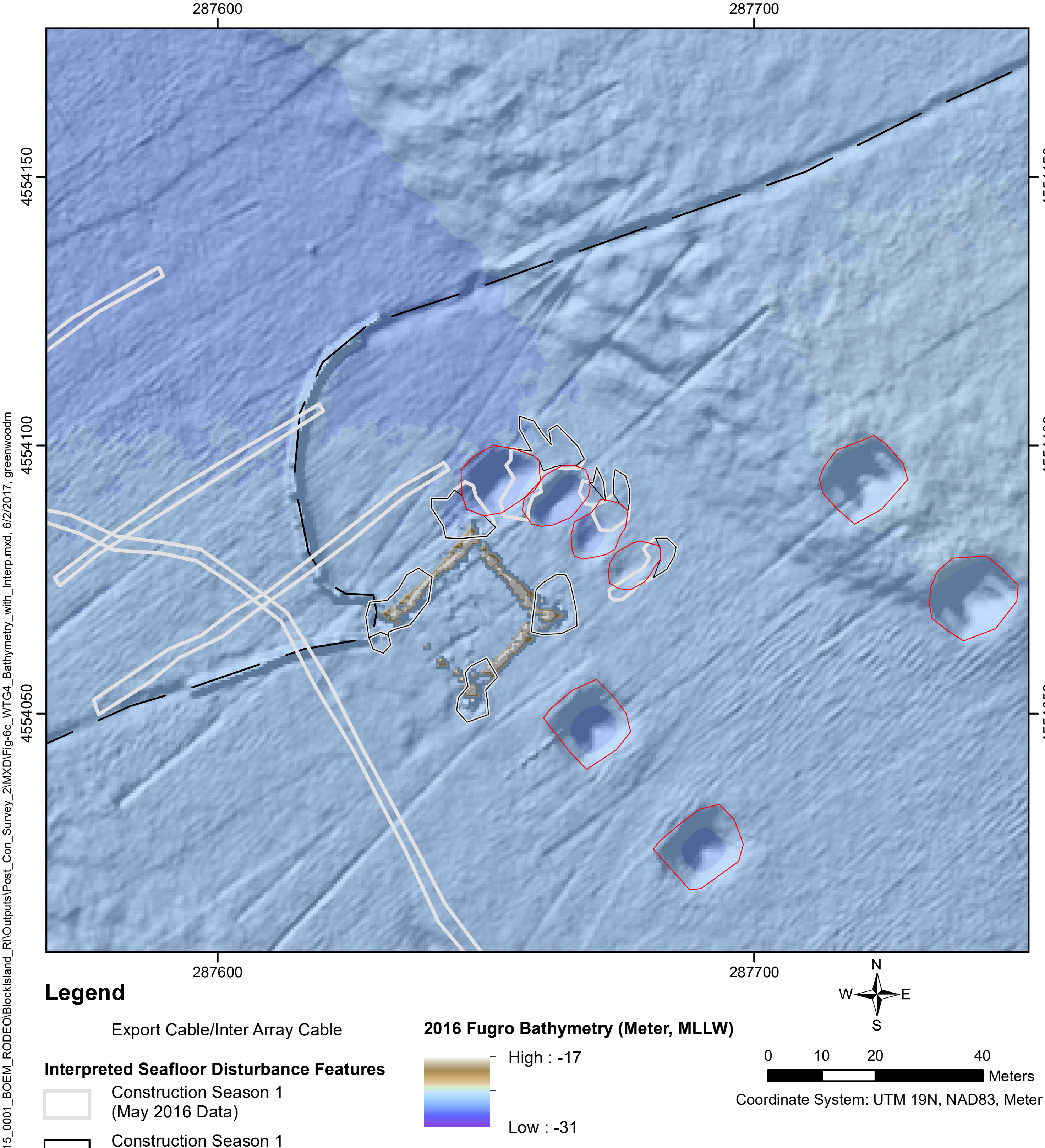
0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

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

FIGURE 6b

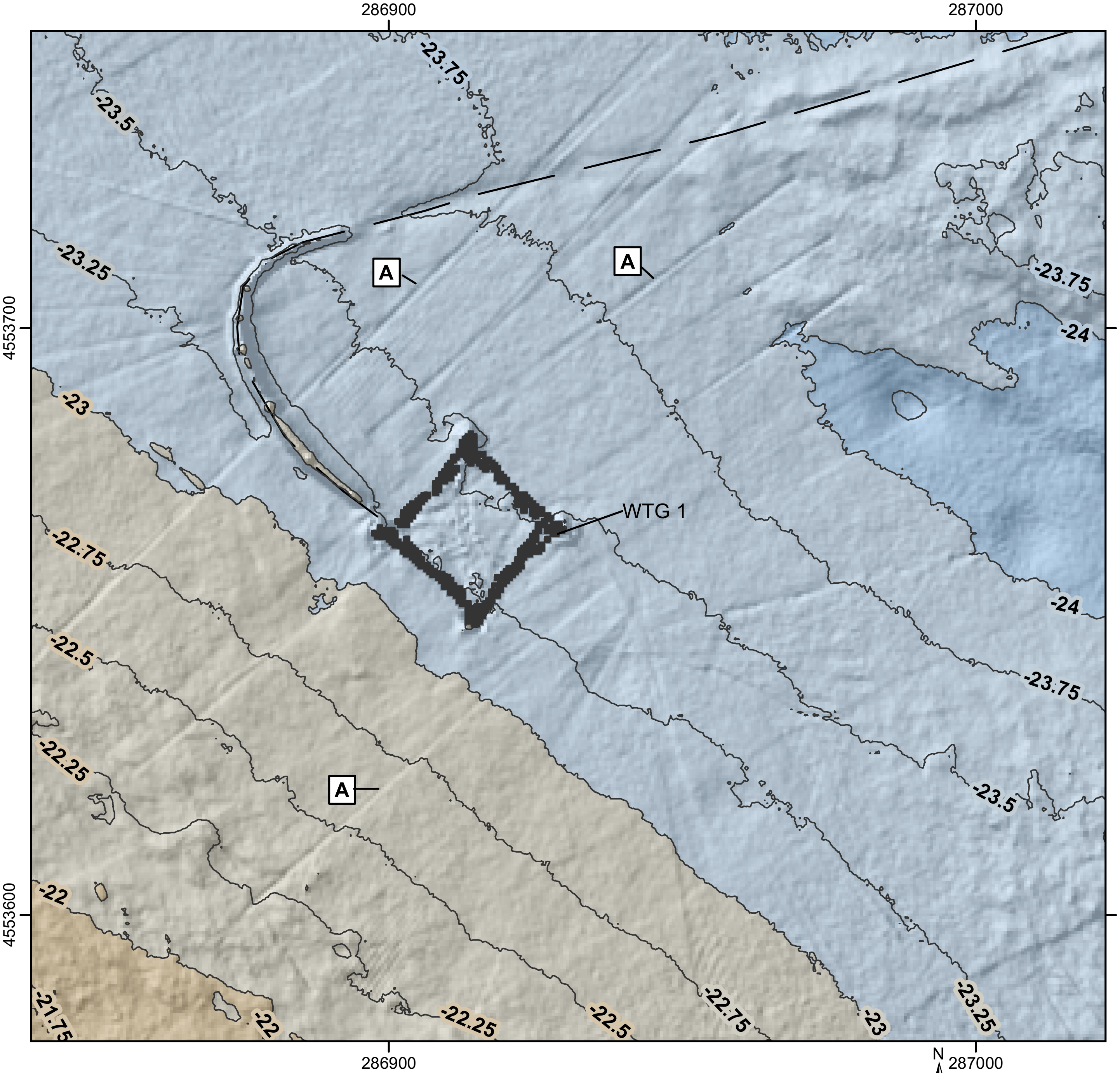
N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-6b_WTG4_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm



N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-6c_WTG4_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm

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

FIGURE 6c



N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-7a_WTG5_Bathymetry_with_Contours.mxd, 6/2/2017, greenwoodm

Legend

Export Cable/Inter Array Cable

A Data Artifact

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

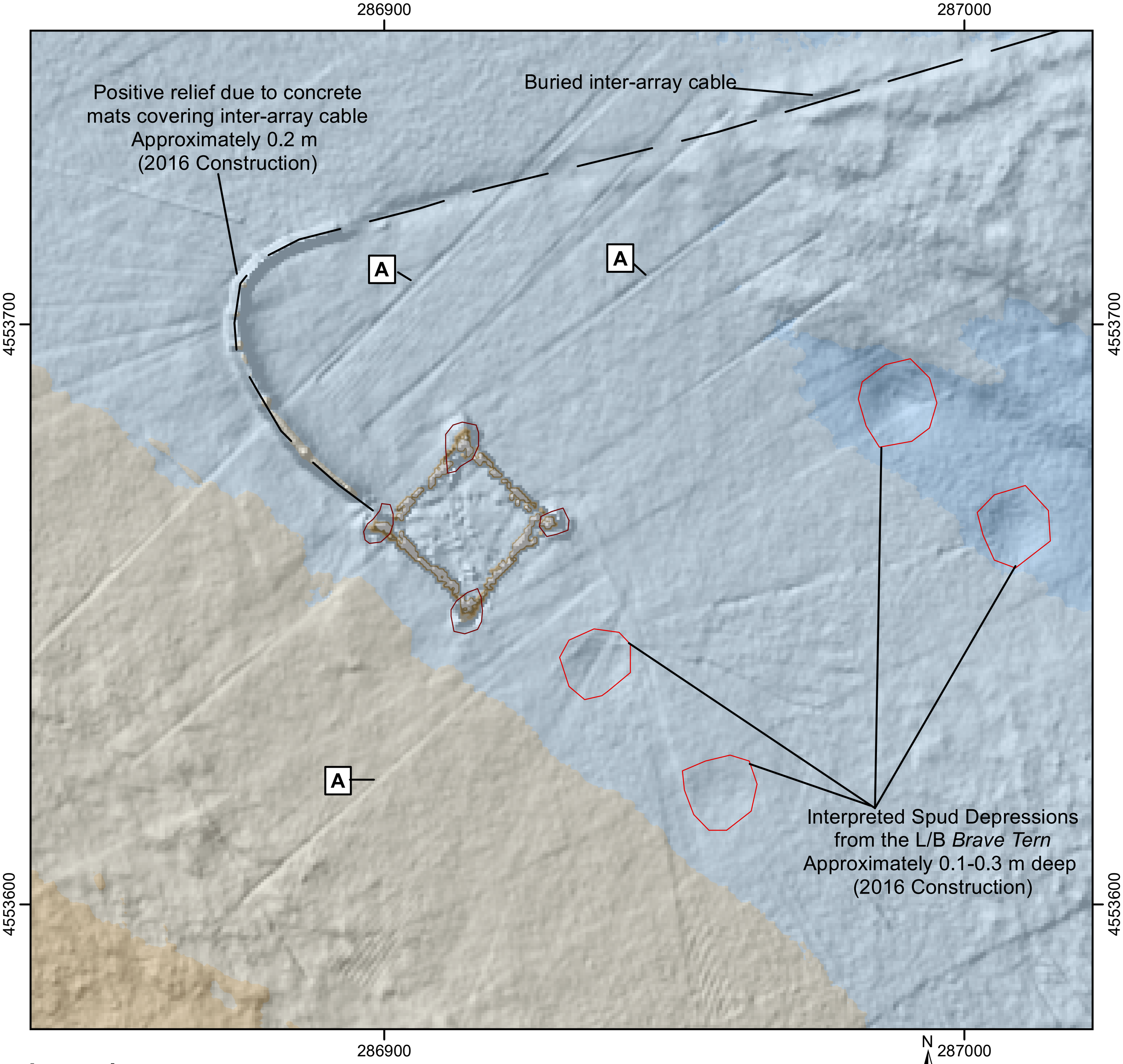
Low : -31

Contour interval is 0.25 meters

Coordinate System: UTM 19N, NAD83, Meter

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

FIGURE 7a



N:\Projects\04_2015\04_8115_0001_BOEM_RODEO\BlockIsland_RI\Outputs\Post_Con_Survey_2\MXD\Fig-7b_WTG5_Bathymetry_with_Interp.mxd, 6/2/2017, greenwoodm

Legend

Export Cable/Inter Array Cable

A Data Artifact

Interpreted Seafloor Disturbance Features

Spud

Scour

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

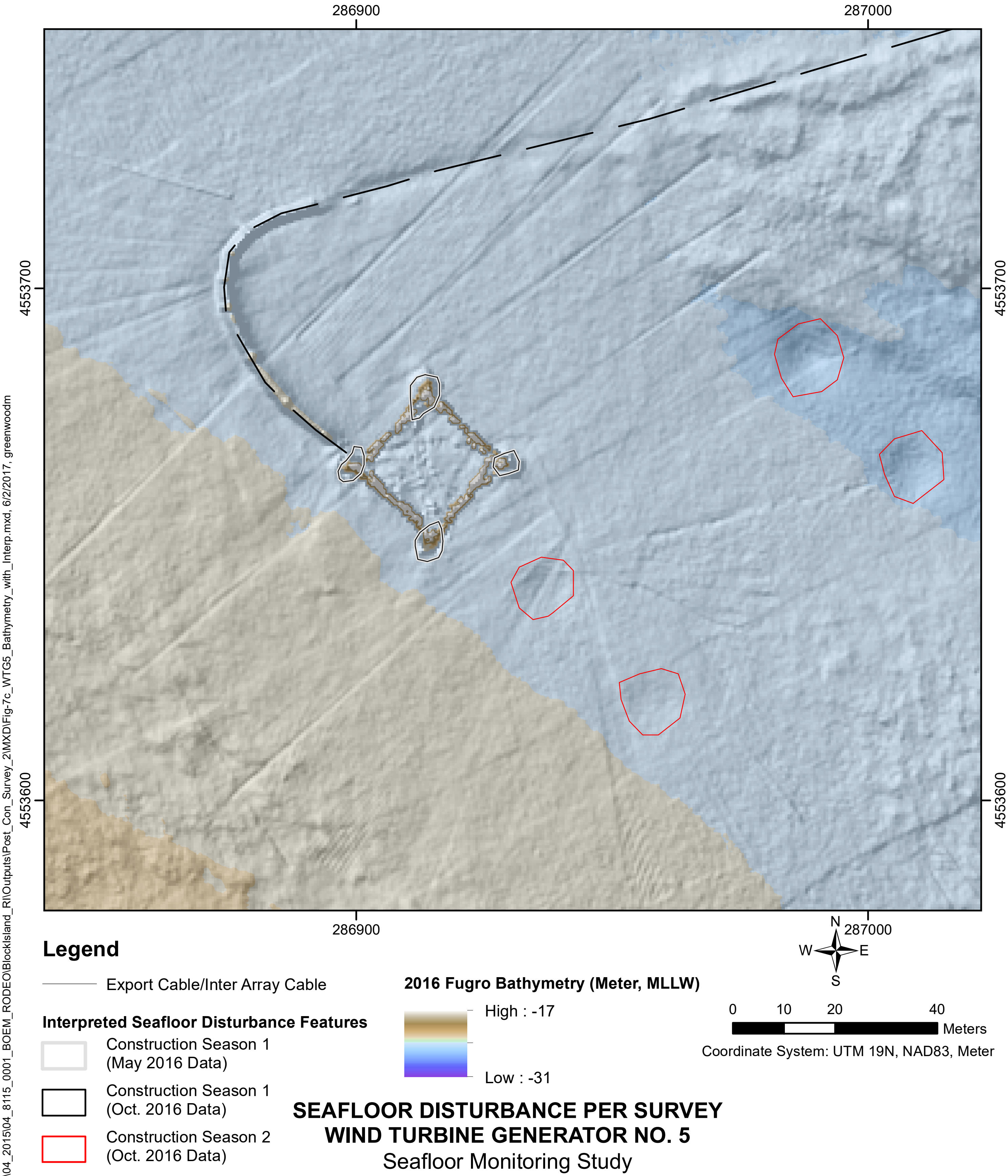
Low : -31

0 10 20 40 Meters

Coordinate System: UTM 19N, NAD83, Meter

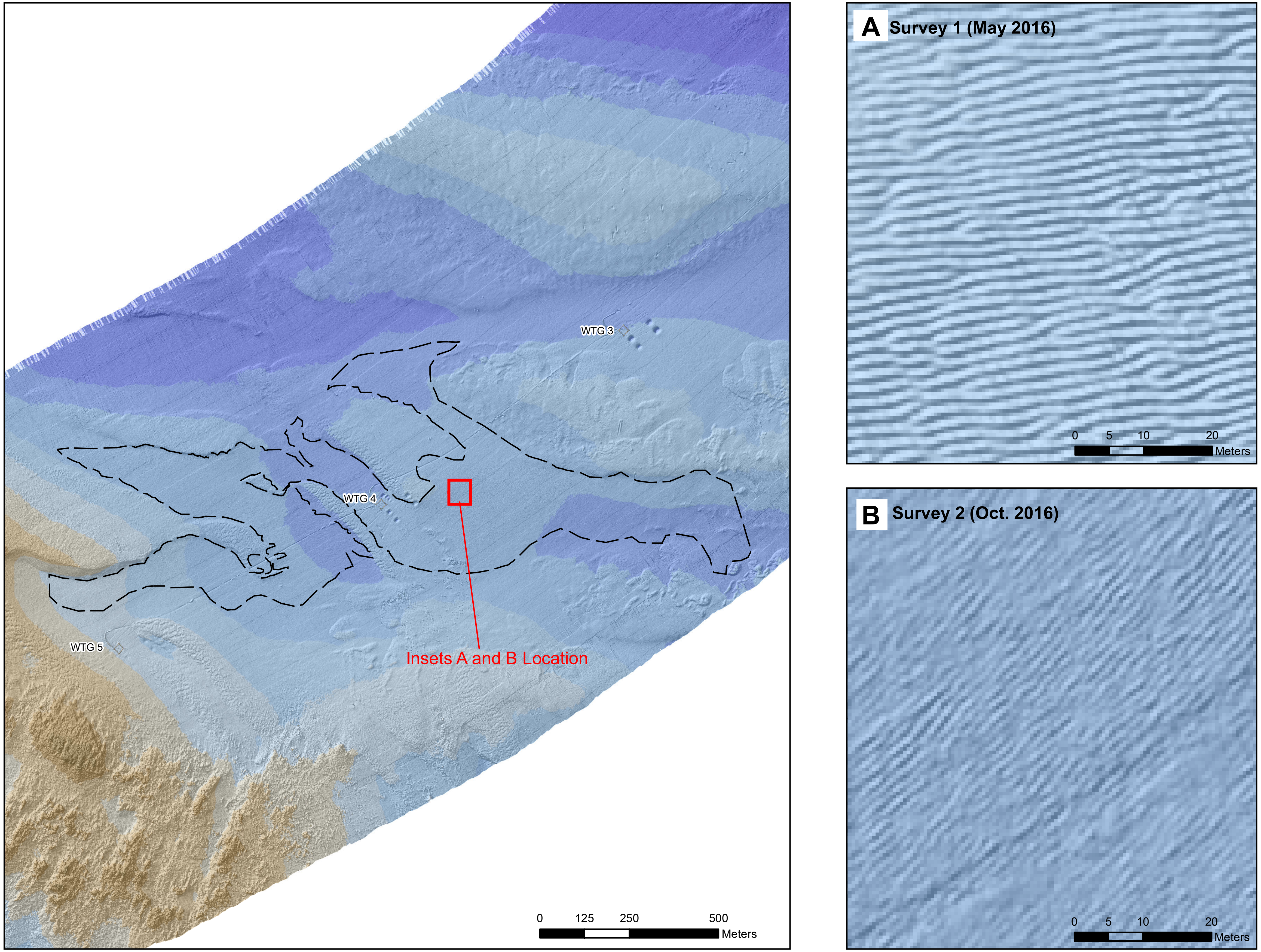
INTERPRETED SEAFLOOR DISTURBANCE TYPES
WIND TURBINE GENERATOR NO. 5
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

FIGURE 7b



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

2016 Fugro Bathymetry (Meter, MLLW)

High : -17

Low : -31

Sand Ripple Field Extent

Notes:

1. Sand ripples are seen to migrate from a predominately East-West orientation, as viewed in Inset A, to more of a Northeast-Southwest orientation (Inset B).

N
W E
S

Coordinate System: UTM 19N, NAD83, Meter

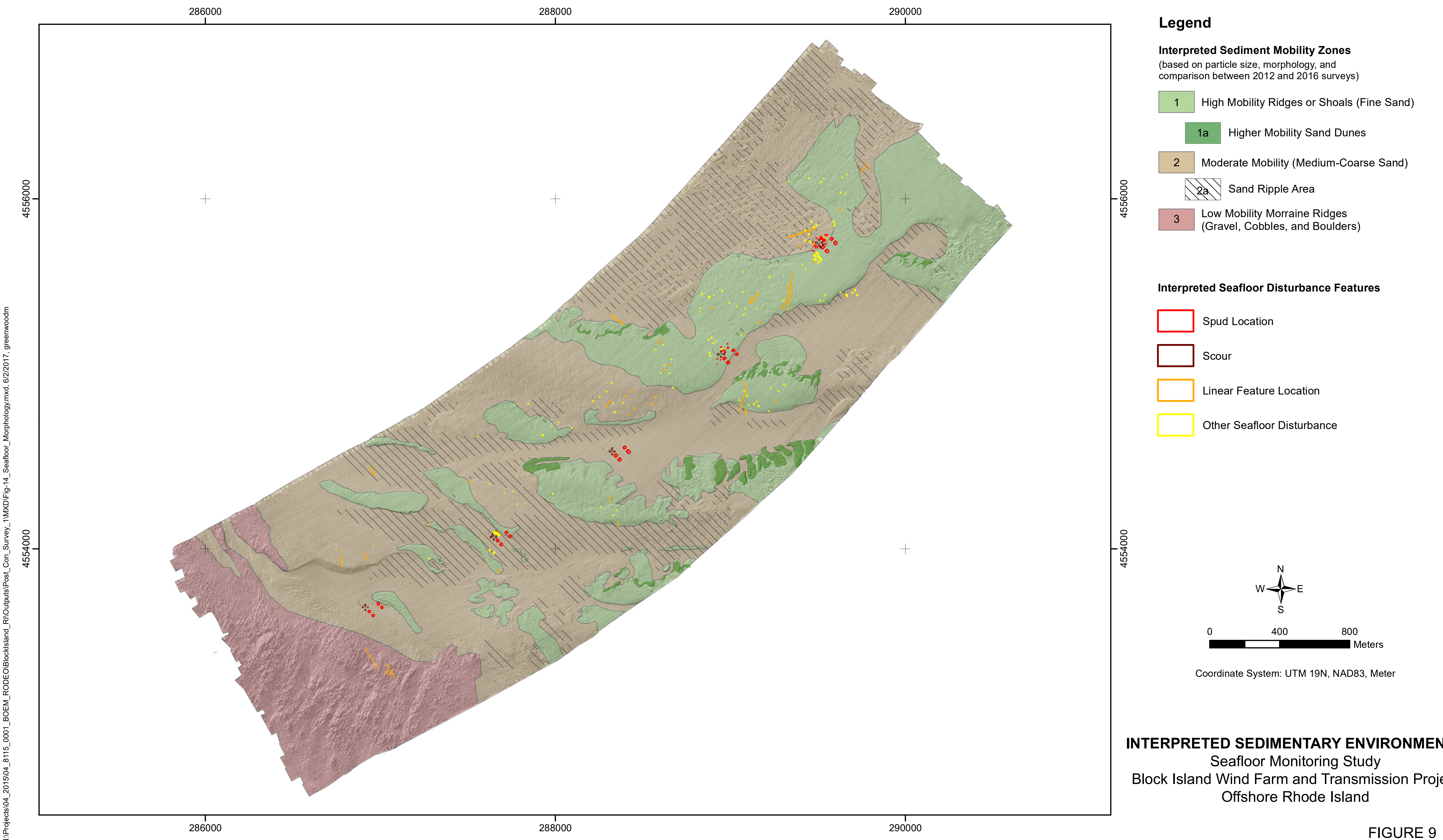
SAND RIPPLE FIELD MIGRATION

Seafloor Monitoring Study

Block Island Wind Farm and Transmission Project

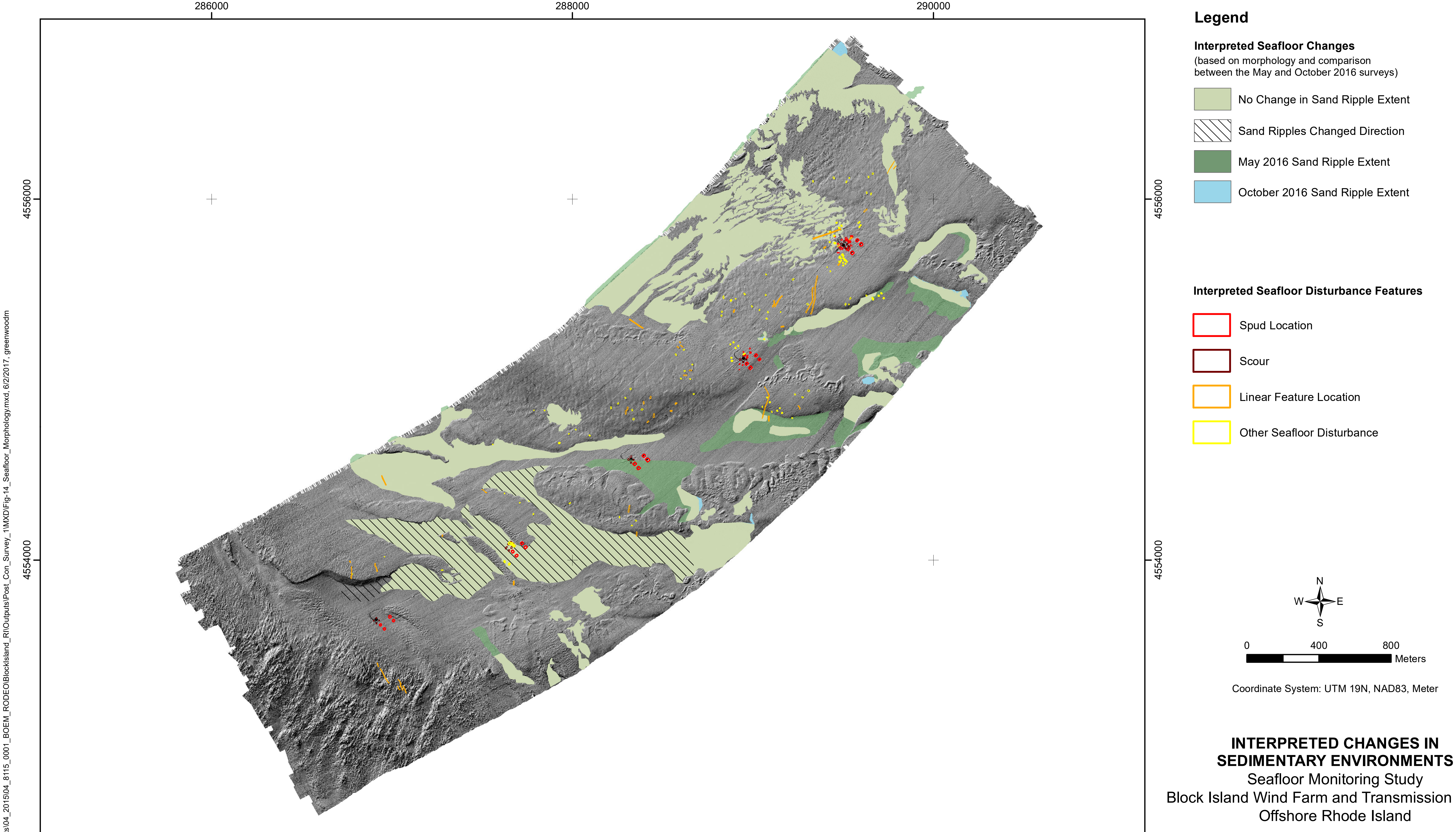
Offshore Rhode Island

FIGURE 8



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

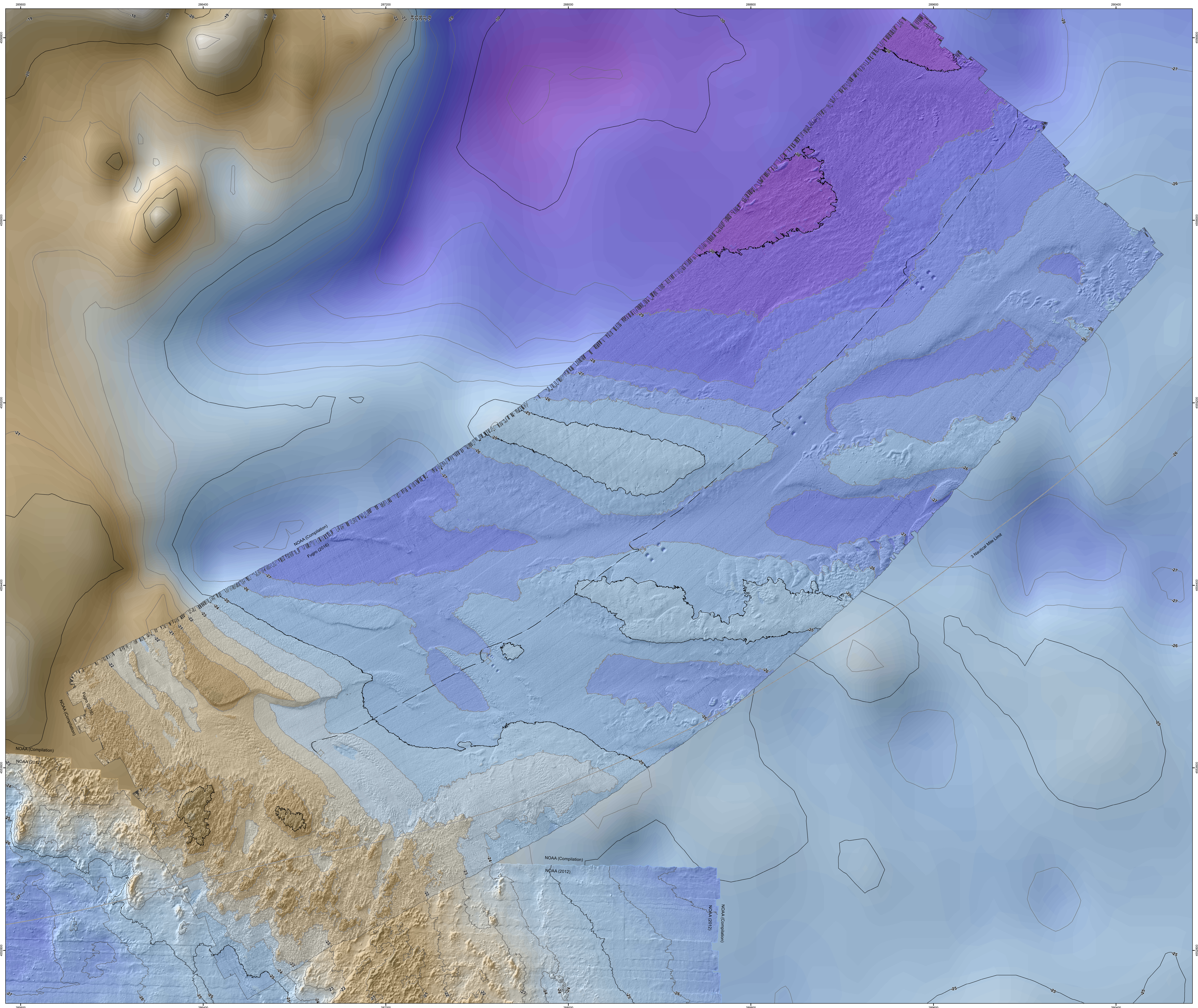
FIGURE 9



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

FIGURE 10

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 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

FUGRO MARINE GEOSERVICES, INC.
World Trade Center, Suite 350
101 West Main Street
Norfolk, Virginia 23510
Tel: (757) 625-3350,
Fax: (757) 625-3352
www.fugro.com

FUGRO 2016 BATHYMETRIC SURVEY

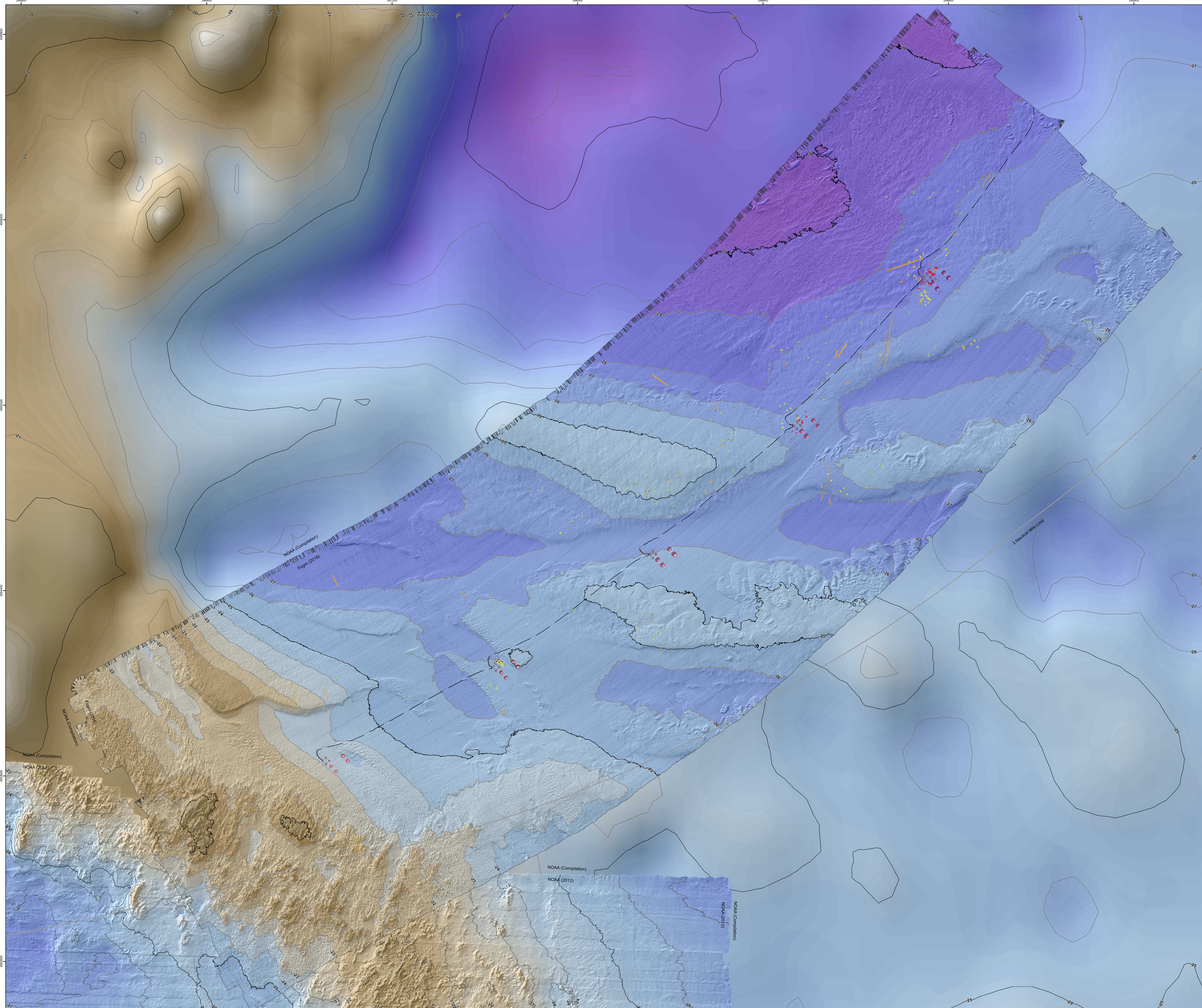
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 | 0.25 | 0.5 Kilometers

0 | 0.125 | 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	Feb. 2017	Fugro 2016 Bathymetry	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 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

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

FUGRO CONSULTANTS, INC.
World Trade Center, Suite 350
101 West Main Street
Norfolk, Virginia 23510
Tel: (757) 625-3350,
Fax: (757) 625-3352
www.fugroconsultants.com

INTERPRETED SEAFLOOR DISTURBANCE FEATURES FROM 2016 FUGRO BATHYMETRY

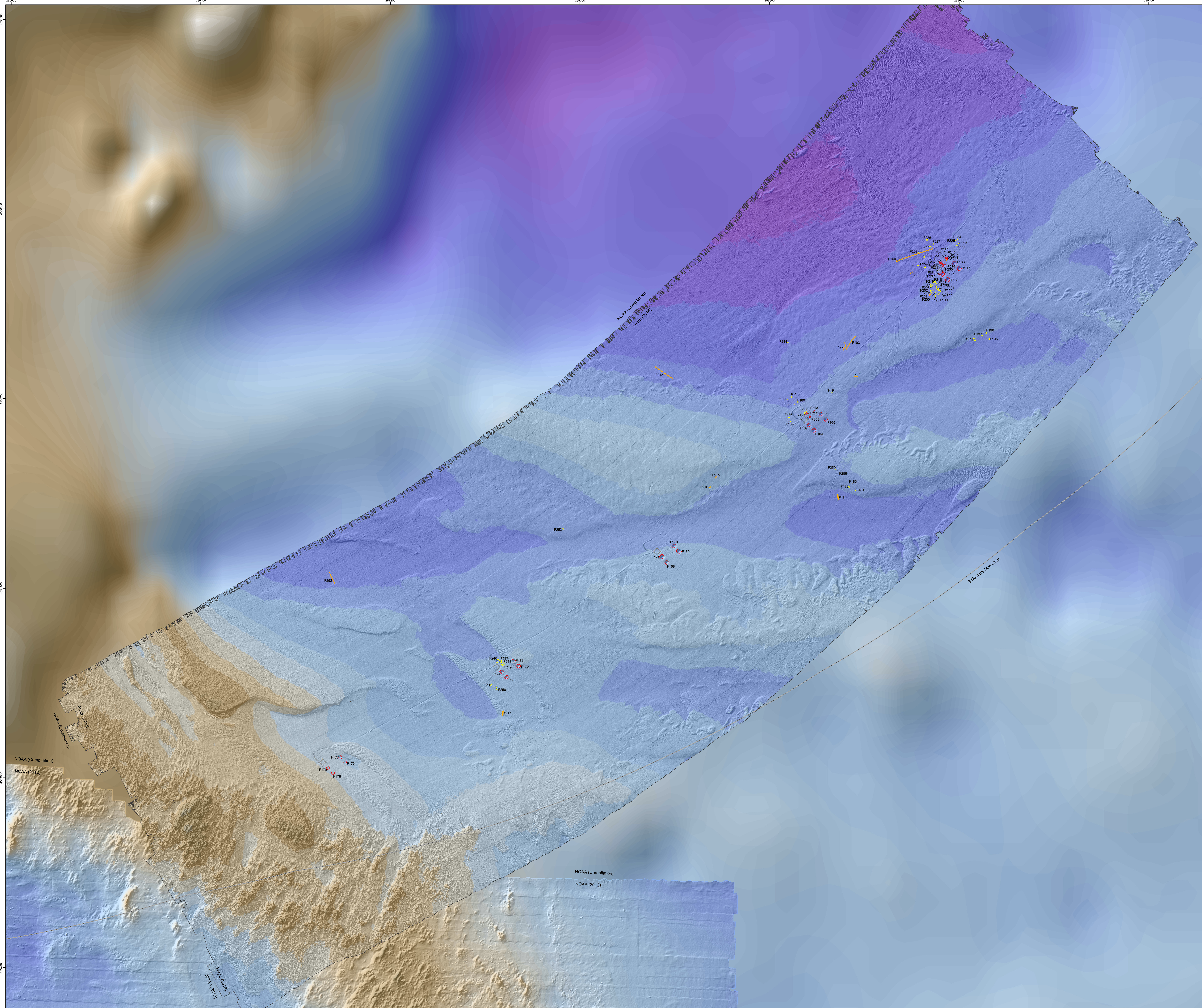
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 — 0.25 — 0.5 Kilometers

0 — 0.125 — 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	Feb. 2017	Fugro 2016 Bathymetry	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 — CHART NO.: 2



LEGEND

3 Nautical Mile Limit

Bathymetry (Meters, MLLW)

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

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

FUGRO MARINE GEOSERVICES, INC.
World Trade Center, Suite 350
101 West Main Street
Norfolk, Virginia 23510
Tel: (757) 625-3350,
Fax: (757) 625-3352
www.fugroconsultants.com

N W E S

SEAFLOOR DISTURBANCE FEATURE CATALOGUE CONSTRUCTION SEASON 2

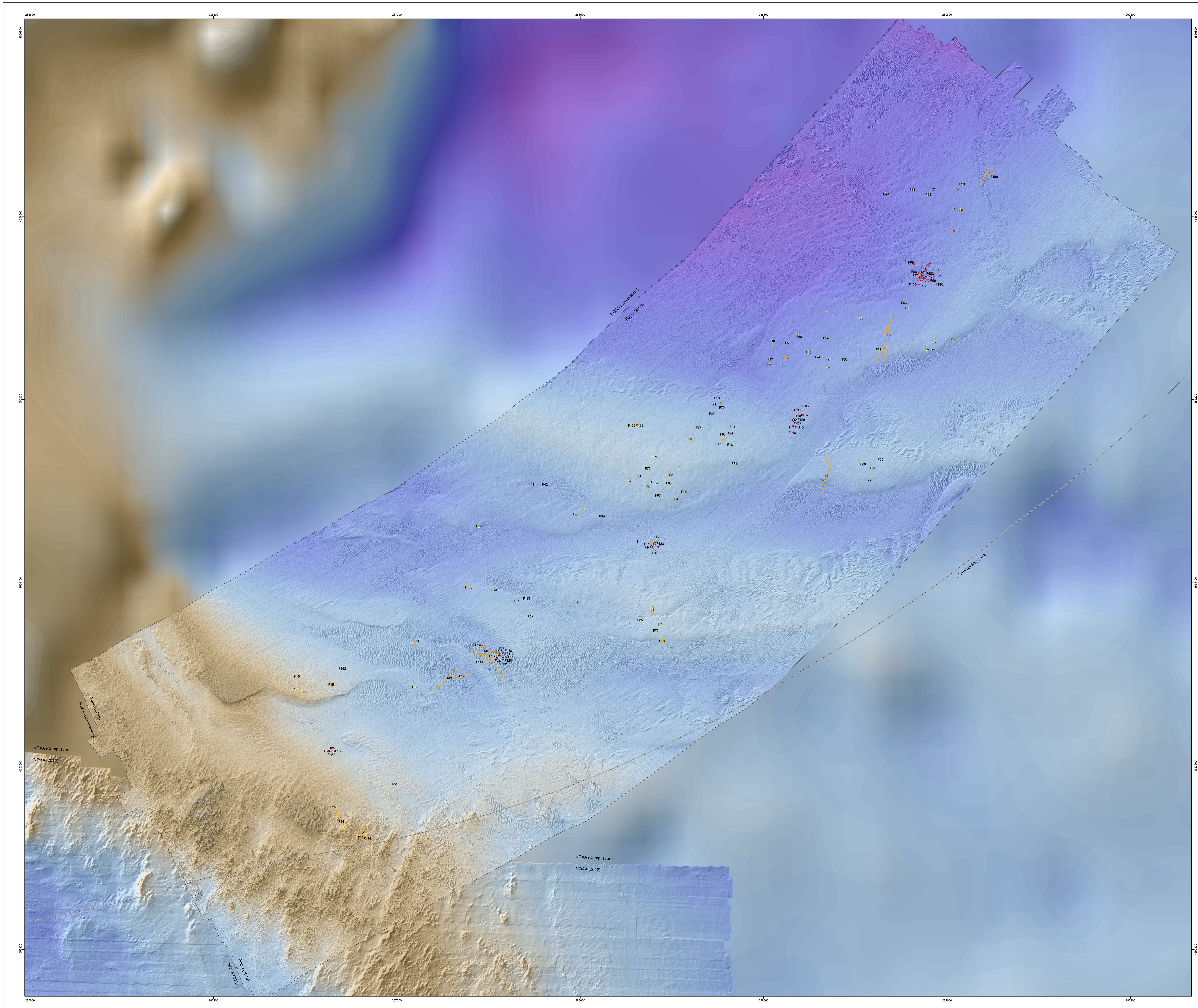
Seafloor Monitoring Study
Block Island Wind Farm and Transmission Project
Offshore Rhode Island

0 | 0.25 | 0.5 Kilometers

0 | 0.125 | 0.25 Nautical Miles

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	Feb. 2017	Seafloor Disturbance Catalogue	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 | CHART NO.: 3



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

- 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

N W E S

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

FUGRO CONSULTANTS, INC.
World Trade Center, Suite 350
101 West Main Street
Norfolk, Virginia 23510
Tel: (757) 625-3350,
Fax: (757) 625-3352
www.fugroconsultants.com

N W E S

SEAFLOOR DISTURBANCE FEATURE CATALOGUE

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	Seafloor Disturbance Catalogue	MLG	WBC	KRS
2					
3					

JOB NUMBER: 04.81150001 CHART NO.: 4

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 October 02 – 05, 2016. 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.

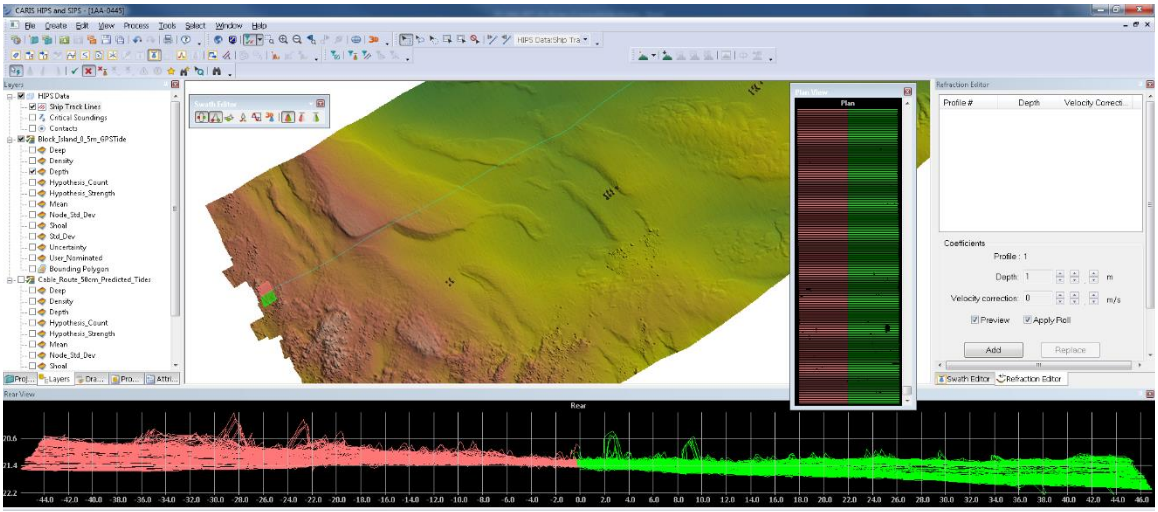


FIGURE A2-1 CARIS SWATH EDITOR

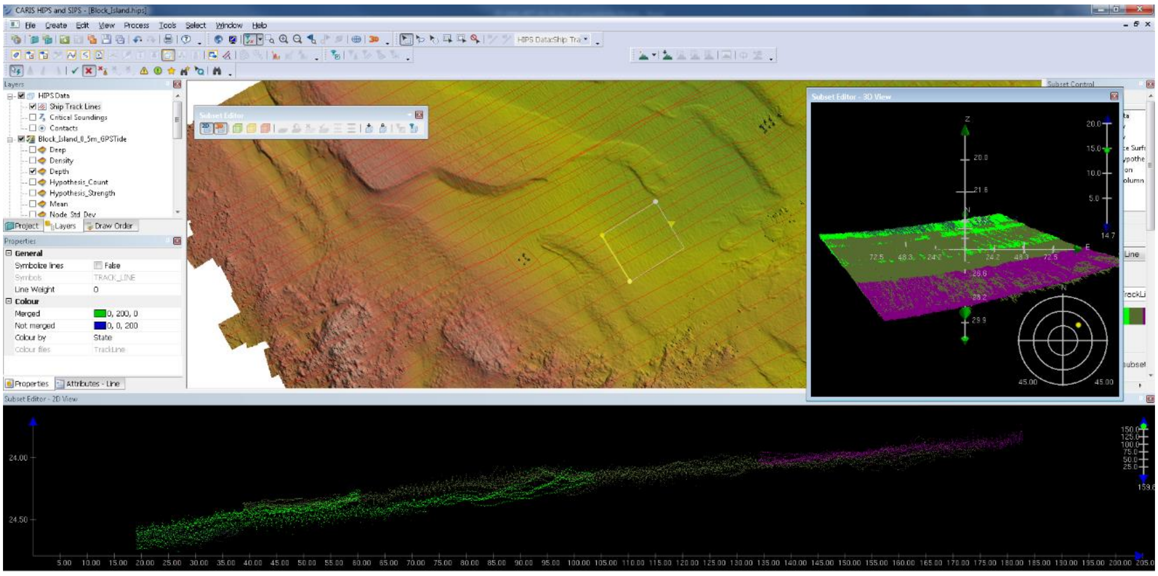


FIGURE A2-2 CARIS SUBSET EDITOR

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

TABLE 2 – PATCH TEST CALIBRATION

Port Sonar	Correction
Navigation Timing Error	0.00 s
Pitch Offset	-0.500º
Roll Offset	16.300º
Azimuth (Yaw) Offset	-1.200º

Starboard Sonar	Correction
Navigation Timing Error	0.00 s
Pitch Offset	-1.200º
Roll Offset	-14.625º
Azimuth (Yaw) Offset	-0.400º

A.3.3 MBES Crosslines

Multibeam data quality was controlled during acquisition and processing. However, to provide another level of quality control, crosslines were acquired approximately perpendicular to the main scheme lines.

These crosslines are used only for quality control purposes and are not included in the main scheme data set or DTM generation. To verify that the survey meets or exceeds the required level of accuracy, the bathymetry from the crosslines was compared to the CUBE surface created from the main scheme lines.

This quality control check was performed through CARIS' QC Report routine. During the quality control check, the bathymetry soundings from the crosslines must fall within an allowable error from the Base surface created from the main scheme lines. For this crossline analysis, IHO Order 1a specifications were used to check accuracy at the 95% confidence level.

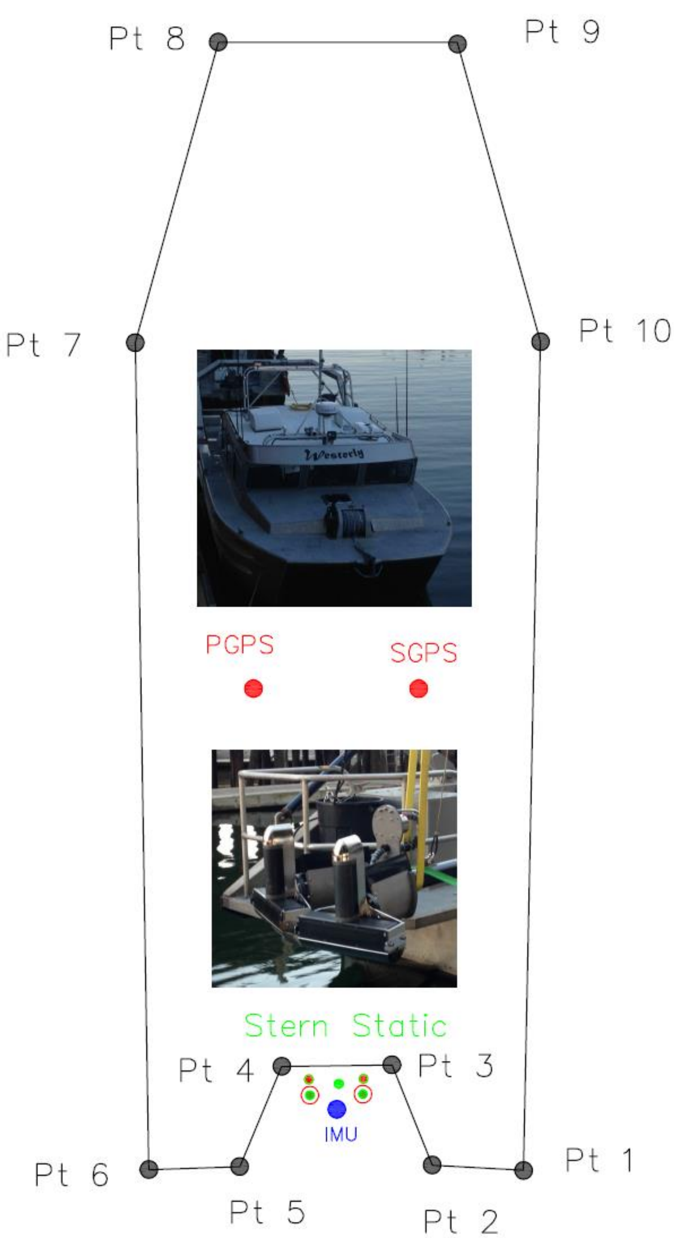
Therefore, the CARIS QC Report routine was run with the following uncertainty budget:

$$\pm\sqrt{(\boldsymbol{a}^{2} + (\boldsymbol{b} * \boldsymbol{d})^{2})}$$

where a = 0.500 m, b=0.013, and d = water depth in meters.

The crossline analysis confirmed that the survey met IHO Special Order requirements, at the 95% confidence level.

R/V Westerly Vessel Offsets



Westerly

Sensor	X	Y	Z
IMU (CRP)	0.000	0.000	0.000
7125 Sonar Acoustic Center (for 7004 records) Port	-0.310	0.176	-0.688
7125 Transmit Acoustic Center (for 7027 records) Port	-0.310	0.176	-0.664
400 kHz Receiver Acoustic Center (for 7027 records) Port	-0.310	0.355	-0.688
200 kHz Receiver Acoustic Center (for 7027 records) Port	-0.310	0.374	-0.688
7125 Sonar Acoustic Center (for 7004 records) STBD	0.291	0.190	-0.692
7125 Transmit Acoustic Center (for 7027 records) STBD	0.291	0.190	-0.668
400 kHz Receiver Acoustic Center (for 7027 records) STBD	0.291	0.369	-0.692
200 kHz Receiver Acoustic Center (for 7027 records) STBD	0.291	0.388	-0.692
PGPS (Phase Center - Trimble)	-0.918	4.665	4.349
SGPS (Phase Center - Trimble)	0.960	4.665	4.336
Stern Static Draft	**0.032**	**0.259**	**1.266**

Notes:

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

POS M/V Reference Frame

Sensor	X	Y	Z
PGPS (Phase Center)	4.665	-0.918	-4.349
2 Ant Sep = 1.877m			
Note:			
X is positive to Bow			
Y is positive towards Stbd			
Z is negative above Ref			

CARIS Reference Frame

Sensor	X	Y	Z
IMU	0.000	0.000	0.000
7125 Sonar Acoustic Center (for 7004 records) Port	-0.310	0.176	0.688
7125 Tx Acoustic Center (for 7027 records) Port	-0.310	0.176	0.664
7125 Rx (400kHz) Acoustic Center (for 7027 records) Port	-0.310	0.355	0.688
7125 Sonar Acoustic Center (for 7004 records) STBD	0.291	0.190	0.692
7125 Sonar Acoustic Center (for 7004 records) STBD	0.291	0.190	0.668
7125 Sonar Acoustic Center (for 7004 records) STBD	0.291	0.369	0.692
Note:			
X is positive towards Stbd			
Y is positive to Bow			
Z is postive below Ref			

Westerly Vessel Outline

Sensor	X	Y
Pt 1	2.12	-0.69
Pt 2	1.08	-0.63
Pt 3	0.63	0.50
Pt 4	-0.63	0.49
Pt 5	-1.10	-0.65
Pt 6	-2.14	-0.68
Pt 7	-2.29	8.69
Pt 8	-1.35	12.10
Pt 9	1.37	12.08
Pt 10	2.31	8.70

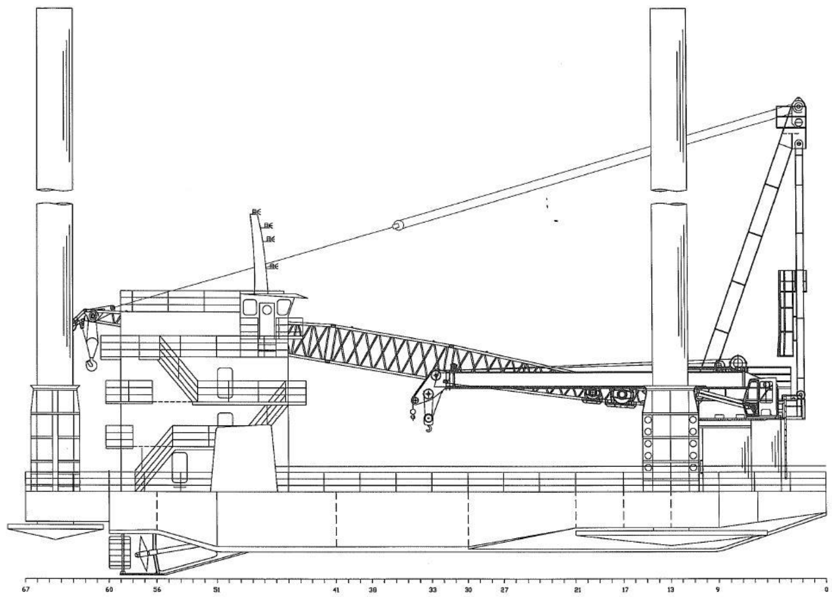
Notes:

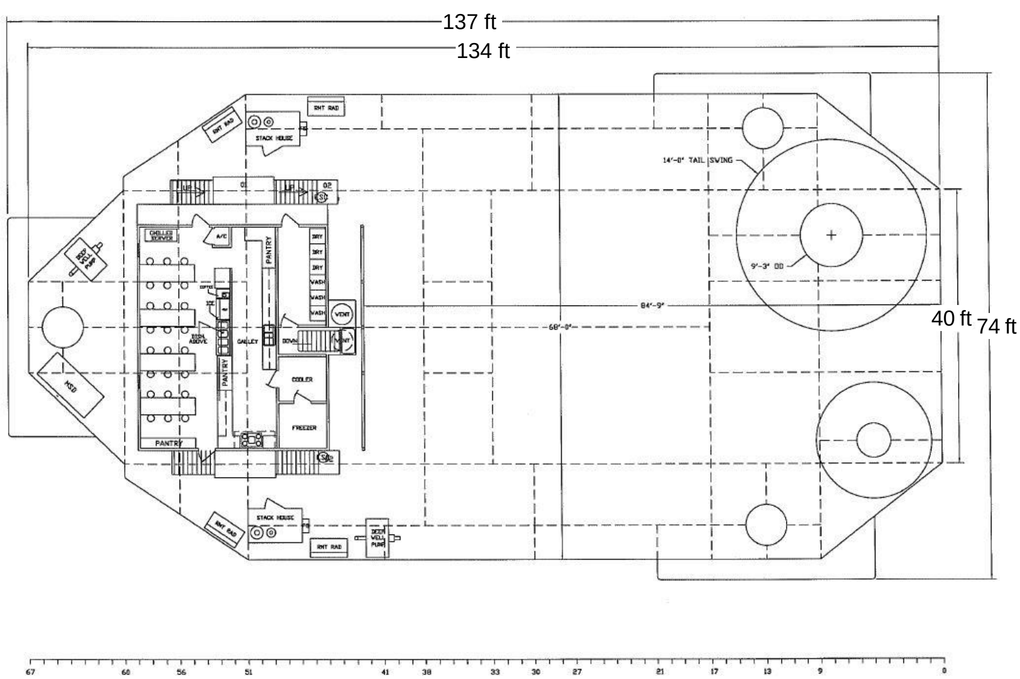
All coordinates are on the IMU reference Frame.
X is positive to Stbd
Y is positive towards Bow

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





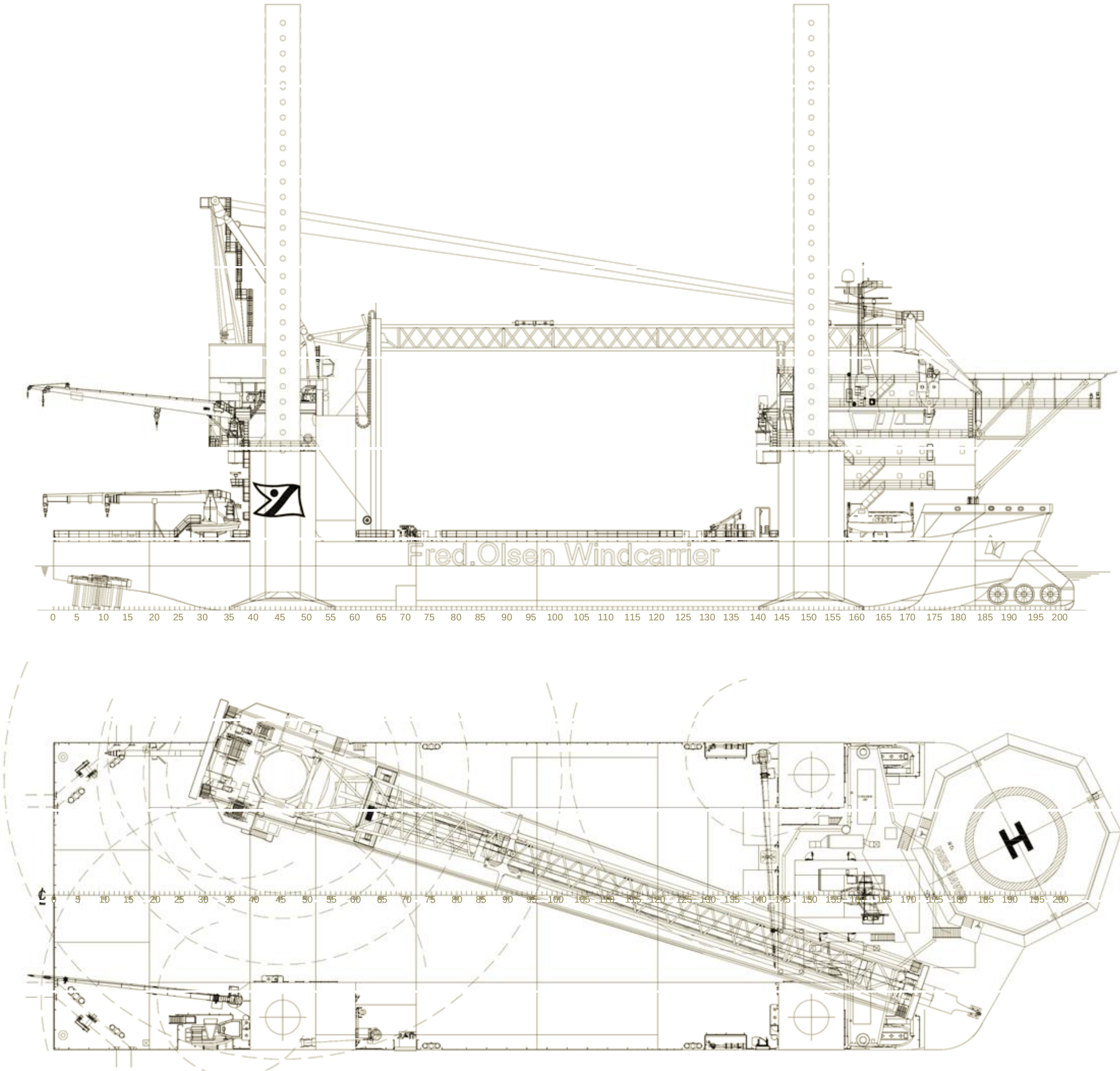
VESSEL SPECIFICATIONS FOR THE *L/B MICHAEL EYMARD*

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 (Construction Season 1)

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	Relative Change
F0	4554820	288297	-25.0	54	120	0.17	Drag Mark	Unknown	Little Change
F1	4554840	288306	-25.0	39	82	0.16	Drag Mark	Unknown	Little Change
F2	4554870	288395	-24.8	36	72	0.14	Drag Mark	Unknown	Little Change
F3	4554900	288433	-24.8	37	76	0.22	Drag Mark	Unknown	Little Change
F4	4554770	288418	-25.4	33	59	0.17	Drag Mark	Unknown	Little Change
F5	4555020	288625	-25.4	49	108	0.13	Drag Mark	Unknown	Little Change
F6	4555470	289343	-27.0	441	983	0.12	Drag Mark	Unknown	Little Change
F7	4555440	289322	-26.9	310	603	0.11	Drag Mark	Unknown	Little Change
F8	4554860	289072	-26.2	380	595	0.15	Drag Mark	Unknown	Little Change
F9	4554290	288314	-24.4	86	205	0.13	Drag Mark	Unknown	Little Change
F10	4554150	288357	-25.1	54	97	0.11	Drag Mark	Unknown	Little Change
F11	4554320	287986	-25.6	30	59	0.25	Circular Depression	Unknown	Little Change

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F12	4554260	287784	-25.7	25	38	0.13	Circular Depression	Unknown	Little Change
F13	4554370	287624	-26.2	19	24	0.09	Circular Depression	Unknown	Little Change
F14	4553940	287279	-25.4	23	34	0.13	Circular Depression	Unknown	Little Change
F15	4553960	286913	-23.5	95	155	0.12	Drag Mark	Unknown	Little Change
F16	4555050	288655	-25.7	35	74	0.2	Drag Mark	Unknown	Little Change
F17	4555010	288601	-25.3	26	42	0.15	Circular Depression	Unknown	Little Change
F18	4555000	288653	-25.4	23	34	0.09	Circular Depression	Unknown	Little Change
F19	4555080	288665	-25.9	22	35	0.07	Circular Depression	Unknown	Little Change
F20	4555140	288574	-26.3	33	69	0.14	Circular Depression	Unknown	Little Change
F21	4555180	288585	-26.7	30	48	0.18	Drag Mark	Unknown	Little Change
F22	4555190	288606	-26.7	37	56	0.12	Drag Mark	Unknown	Little Change
F23	4555210	288597	-27.0	24	31	0.13	Drag Mark	Unknown	Little Change
F24	4554850	289258	-26.0	50	73	0.16	Drag Mark	Unknown	Little Change

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F25	4555940	289623	-28.0	60	151	0.09	Drag Mark	Unknown	Some Change[5]
F26	4556030	289655	-28.1	29	51	0.08	Circular Depression	Unknown	Little Change
F27	4556030	289632	-28.1	30	53	0.08	Circular Depression	Unknown	Little Change
F28	4556120	289641	-28.2	26	41	0.1	Circular Depression	Unknown	Little Change
F29	4556140	289665	-28.3	28	54	0.19	Circular Depression	Unknown	Little Change
F30	4556100	289334	-29.6	27	51	0.07	Circular Depression	Unknown	Little Change
F31	4556120	289449	-29.0	35	74	0.11	Circular Depression	Unknown	Little Change
F32	4556120	289535	-28.8	19	26	0.05	Circular Depression	Unknown	Little Change
F33	4556100	289519	-28.7	31	56	0.1	Circular Depression	Unknown	Little Change
F34	4553360	286958	-22.0	195	247	0.2	Drag Mark	Unknown	Little Change
F35	4553420	286922	-21.8	52	70	0.1	Drag Mark	Unknown	Little Change
F36	4553310	287048	-21.7	146	222	0.16	Drag Mark	Unknown	Little Change
F37	4554690	288094	-26.3	18	22	0.1	Circular Depression	Unknown	Little Change

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F38	4554690	288098	-26.3	15	14	0.06	Circular Depression	Unknown	Little Change
F39	4554720	288019	-26.4	20	28	0.14	Circular Depression	Unknown	Little Change
F40	4554700	287980	-26.4	19	24	0.06	Circular Depression	Unknown	Little Change
F41	4554830	287787	-26.8	12	11	0.1	Circular Depression	Unknown	Little Change
F42	4554830	287846	-26.6	18	23	0.14	Circular Depression	Unknown	Little Change
F43	4555370	289084	-27.2	25	44	0.09	Circular Depression	Unknown	Little Change
F44	4555390	289036	-27.5	21	32	0.07	Circular Depression	Unknown	Little Change
F45	4555380	288895	-28.0	52	80	0.13	Drag Mark	Unknown	Little Change
F46	4555350	288826	-28.1	25	43	0.08	Circular Depression	Unknown	Little Change
F47	4555380	288829	-28.2	26	50	0.06	Circular Depression	Unknown	Little Change
F48	4555460	288838	-28.5	37	76	0.07	Circular Depression	Unknown	Little Change
F49	4555410	288995	-27.7	28	46	0.08	Circular Depression	Unknown	Little Change
F50	4555470	288954	-28.0	32	59	0.1	Circular Depression	Unknown	Little Change

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F51	4555450	288905	-28.2	18	22	0.05	Circular Depression	Unknown	Little Change
F52	4555340	289077	-27.2	33	49	0.08	Circular Depression	Unknown	Little Change
F53	4555380	289154	-27.1	18	24	0.06	Circular Depression	Unknown	Some Change[5]
F54	4555470	289071	-27.8	25	43	0.09	Circular Depression	Unknown	Little Change
F55	4555580	289074	-28.4	21	26	0.09	Circular Depression	Unknown	Little Change
F56	4555560	289223	-27.8	32	67	0.18	Circular Depression	Unknown	Little Change
F57	4555600	289430	-27.9	22	34	0.12	Circular Depression	Unknown	Little Change
F58	4555420	289304	-26.8	32	76	0.17	Circular Depression	Unknown	Little Change
F59	4555450	289541	-26.5	28	52	0.13	Circular Depression	Unknown	Little Change
F60	4555420	289514	-26.5	29	47	0.08	Circular Depression	Unknown	Little Change
F61	4555420	289533	-26.5	17	21	0.03	Circular Depression	Unknown	Little Change
F62	4555470	289629	-26.5	25	44	0.08	Circular Depression	Unknown	Little Change
F63	4555620	289412	-28.1	15	16	0.06	Circular Depression	Unknown	Little Change

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F64	4554900	289275	-25.7	27	46	0.11	Circular Depression	Unknown	Little Change
F65	4554940	289309	-25.6	33	78	0.09	Circular Depression	Unknown	Little Change
F66	4554920	289234	-25.7	23	38	0.06	Circular Depression	Unknown	Little Change
F67	4554850	289053	-26.4	23	37	0.14	Circular Depression	Unknown	Little Change
F68	4554820	289105	-27.0	24	38	0.2	Circular Depression	Unknown	Little Change
F69	4554950	288323	-24.3	28	57	0.1	Circular Depression	Unknown	Little Change
F70	4554900	288294	-24.4	24	35	0.1	Circular Depression	Unknown	Little Change
F71	4554870	288253	-24.6	25	42	0.06	Circular Depression	Unknown	Little Change
F72	4554830	288332	-25.0	27	51	0.11	Circular Depression	Unknown	Little Change
F73	4554190	288330	-24.6	21	31	0.07	Circular Depression	Unknown	Little Change
F74	4554220	288352	-24.4	24	41	0.05	Circular Depression	Unknown	Little Change
F75	4554800	288452	-25.4	43	106	0.09	Drag Mark	Unknown	Little Change
F76	4555080	288517	-25.6	41	64	0.25	Drag Mark	Unknown	Mostly Healed

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F77	4555740	289474	-28.1	64	89	0.07	Drag Mark	Unknown	Some Change[3]
F78	4554100	287659	-26.2	70	135	0.22	Scour	Unknown	Some Change[3]
F79	4555170	288618	-26.6	24	38	0.08	Circular Depression	Unknown	Little Change
F80	4554590	288327	-26.2	17	19	0.07	Circular Depression	Unknown	Mostly Healed
F81	4554090	287646	-26.0	36	79	0.08	Scour	Unknown	Little Change
F82	4555740	289545	-27.8	33	80	0.1	Spud	L/B Robert	Some Change[3]
F83	4555050	288622	-25.7	27	51	0.05	Circular Depression	Unknown	Little Change
F84	4554920	288672	-25.6	25	45	0.05	Circular Depression	Unknown	Little Change
F85	4554240	288261	-24.9	24	36	0.06	Circular Depression	Unknown	Little Change
F86	4554790	289218	-26.7	22	32	0.08	Circular Depression	Unknown	Little Change
F87	4554780	288338	-25.3	33	82	0.09	Circular Depression	Unknown	Little Change
F88	4554830	288386	-24.8	31	68	0.05	Circular Depression	Unknown	Little Change
F89	4554540	288325	-23.8	27	53	0.08	Scour	Unknown	Little Change

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F90	4554840	288214	-25.0	33	69	0.08	Circular Depression	Unknown	Little Change
F91	4553920	286779	-22.0	23	39	0.12	Circular Depression	Unknown	Little Change
F92	4555700	289557	-27.5	25	47	0.12	Spud	L/B Robert	Some Change[5]
F93	4554590	288330	-26.3	22	32	0.07	Circular Depression	Unknown	Mostly Healed
F94	4554560	288311	-26.1	31	71	0.06	Scour	Unknown	Little Change
F95	4555760	289539	-27.8	37	99	0.13	Spud	L/B Robert	Some Change[5]
F96	4555720	289520	-27.9	28	56	0.16	Spud	L/B Robert	Some Change[3]
F97	4555780	289517	-28.0	36	94	0.16	Spud	L/B Robert	Little Change
F98	4555750	289472	-28.2	24	43	0.15	Spud	L/B Robert	Little Change
F99	4555790	289456	-28.4	21	32	0.19	Spud	L/B Robert	Little Change
F100	4555770	289493	-28.2	27	51	0.11	Spud	L/B Robert	Little Change
F101	4555730	289481	-28.3	32	62	0.38	Spud	L/B Michael Eymard	Some Change[3]
F102	4555130	288971	-26.8	21	30	0.1	Spud	L/B Robert	Some Change[3]

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F103	4555720	289486	-28.1	17	19	0.15	Spud	L/B Michael Eymard	Some Change[3]
F104	4555720	289495	-28.2	18	19	0.33	Spud	L/B Michael Eymard	Some Change[3]
F105	4555730	289499	-28.1	17	17	0.20	Spud	L/B Michael Eymard	Some Change[3]
F106	4555730	289491	-28.3	14	12	0.20	Spud	L/B Michael Eymard	Some Change[3]
F107	4555730	289488	-28.2	19	21	0.20	Spud	L/B Michael Eymard	Some Change[3]
F108	4555700	289477	-28.0	19	21	0.14	Spud	L/B Michael Eymard	Little Change
F109	4555700	289470	-28.1	19	19	0.15	Spud	L/B Michael Eymard	Some Change[3]
F110	4555130	288947	-26.7	28	55	0.06	Scour	Unknown	Little Change
F111	4555150	288948	-26.8	21	34	0.1	Spud	L/B Robert	Some Change[3]
F112	4555170	288984	-26.9	21	34	0.07	Spud	L/B Robert	Some Change[3]
F113	4555110	288930	-26.6	40	99	0.11	Scour	Unknown	Little Change
F114	4555090	288927	-26.5	23	35	0.13	Spud	L/B Michael Eymard	Some Change[3]
F115	4555080	288943	-26.5	22	32	0.12	Spud	L/B Michael Eymard	Some Change[3]

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F116	4555060	288925	-26.4	15	15	0.12	Spud	L/B Michael Eymard	Some Change[3]
F117	4554090	287674	-25.9	30	45	0.08	Scour	Unknown	Some Change[3]
F118	4554090	287670	-25.9	20	20	0.06	Scour	Unknown	Some Change[3]
F119	4554080	287682	-25.9	24	32	0.06	Scour	Unknown	Some Change[3]
F120	4554070	287663	-26.0	33	75	0.04	Scour	Unknown	Little Change
F121	4554060	287630	-26.0	12	11	0.12	Scour	Unknown	Little Change
F122	4555750	289524	-23.7	31	66	0.1	Scour	Unknown	Little Change
F123	4555770	289508	-28.0	32	78	0.06	Scour	Unknown	Little Change
F124	4555750	289491	-25.4	36	99	0.07	Scour	Unknown	Little Change
F125	4555730	289508	-28.0	33	65	0.08	Scour	Unknown	Little Change
F126	4555110	288964	-26.6	30	62	0.02	Scour	Unknown	Little Change
F127	4555100	288947	-18.7	25	47	0.03	Scour	Unknown	Little Change
F128	4554570	288324	-13.8	37	98	0.06	Scour	Unknown	Little Change

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F129	4554560	288339	-26.0	25	42	0.03	Scour	Unknown	Little Change
F130	4554070	287634	-17.7	43	90	0.12	Scour	Unknown	Little Change
F131	4554050	287648	-26.0	32	52	0.05	Scour	Unknown	Little Change
F132	4553650	286914	-18.9	21	32	0.05	Scour	Unknown	Little Change
F133	4553670	286929	-23.6	16	18	0.09	Scour	Unknown	Little Change
F134	4553670	286899	-23.3	19	22	0.1	Scour	Unknown	Little Change
F135	4553680	286913	-19.2	24	38	0.02	Scour	Unknown	Little Change
F136	4553280	287071	-21.7	93	155	0.05	Drag Mark	Unknown	Little Change
F137	4553290	287037	-21.1	58	65	0.1	Drag Mark	Unknown	Little Change
F138	4555090	288255	-25.3	48	40	0.09	Drag Mark	Unknown	Mostly Healed
F139	4555090	288225	-25.1	91	60	0.06	Drag Mark	Unknown	Mostly Healed
F140	4555030	288476	-25.1	86	34	0.06	Drag Mark	Unknown	Mostly Healed
F141	4554580	288290	-26.1	68	30	0.03	Drag Mark	Unknown	Mostly Healed

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F142	4554580	288317	-26.2	53	19	0.06	Drag Mark	Unknown	Mostly Healed
F143	4554380	287514	-26.3	76	69	0.11	Drag Mark	Unknown	Little Change
F144	4554070	287607	-26.0	164	176	0.02	Drag Mark	Unknown	Mostly Healed
F145	4554090	287595	-26.1	146	131	0.02	Drag Mark	Unknown	Mostly Healed
F146	4554120	287565	-26.1	112	109	0.02	Drag Mark	Unknown	Mostly Healed
F147	4554050	287615	-26.0	272	292	0.03	Drag Mark	Unknown	Mostly Healed
F148	4553990	287487	-26.3	142	121	0.02	Drag Mark	Unknown	Mostly Healed
F149	4553990	287423	-26.1	291	225	0.05	Drag Mark	Unknown	Mostly Healed
F150	4553930	286775	-22.1	141	151	0.08	Drag Mark	Unknown	Little Change
F151	4553990	286768	-22.9	29	39	0.21	Drag Mark	Unknown	Little Change
F152	4554020	286959	-24.2	13	12	0.15	Circular Depression	Unknown	Little Change
F153	4553510	287184	-23.3	10	7	0.12	Circular Depression	Unknown	Mostly Healed
F154	4554140	287279	-25.8	28	41	0.07	Drag Mark	Unknown	Some Change[4]

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

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	Relative Change
F155	4554640	287558	-27.0	16	18	0.12	Circular Depression	Unknown	Little Change
F156	4554330	287759	-26.1	12	9	0.20	Circular Depression	Unknown	Little Change
F157	4554320	287709	-26.0	16	18	0.10	Circular Depression	Unknown	Little Change
F158	4556180	289764	-28.0	161	129	0.02	Drag Mark	Unknown	Little Change
F159	4556180	289793	-28.0	90	63	0.03	Drag Mark	Unknown	Some Change[5]

Notes: See Chart 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 deepening of feature.
[5] Change was due to overprint of new features.

Table 2. Seafloor Disturbance Features (Construction Season 1—May-Oct 2016)

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
F160	4555720	289530	-28.4	54	196	0.60	Spud	L/B *Brave Tern*
F161	4555700	289552	-28.6	58	246	1.2	Spud	L/B *Brave Tern*
F162	4555750	289601	-28.3	58	245	0.90	Spud	L/B *Brave Tern*
F163	4555770	289579	-28.5	52	187	0.87	Spud	L/B *Brave Tern*
F164	4555070	288987	-27.5	56	214	0.90	Spud	L/B *Brave Tern*
F165	4555110	289037	-27.3	46	148	0.60	Spud	L/B *Brave Tern*
F166	4555130	289017	-27.4	50	170	0.85	Spud	L/B *Brave Tern*
F167	4555090	288966	-27.3	51	185	0.86	Spud	L/B *Brave Tern*
F168	4554510	288367	-26.4	57	222	0.85	Spud	L/B *Brave Tern*
F169	4554560	288417	-27.0	67	313	1.27	Spud	L/B *Brave Tern*
F170	4554580	288397	-26.8	54	213	0.75	Spud	L/B *Brave Tern*
F171	4554530	288345	-26.8	59	255	1.16	Spud	L/B *Brave Tern*
F172	4554070	287741	-25.8	50	191	0.62	Spud	L/B *Brave Tern*

Notes: See Chart 2 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the 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
F173	4554090	287720	-25.7	49	174	0.75	Spud	L/B *Brave Tern*
F174	4554050	287669	-26.5	48	160	0.75	Spud	L/B *Brave Tern*
F175	4554030	287690	-26.4	48	164	0.75	Spud	L/B *Brave Tern*
F176	4553670	287009	-24.2	41	124	0.14	Spud	L/B *Brave Tern*
F177	4553690	286988	-24.3	45	150	0.30	Spud	L/B *Brave Tern*
F178	4553620	286958	-23.2	41	124	0.06	Spud	L/B *Brave Tern*
F179	4553640	286937	-23.4	38	110	0.09	Spud	L/B *Brave Tern*
F180	4553870	287675	-25.5	47	68	0.10	Drag Mark	Unknown
F181	4554820	289162	-26.7	16	19	0.12	Circular Depression	Unknown
F182	4554830	289135	-26.6	15	15	0.10	Circular Depression	Unknown
F183	4554840	289150	-26.4	12	10	0.07	Circular Depression	Unknown
F184	4554790	289089	-27.2	59	84	0.08	Drag Mark	Unknown
F185	4555100	288885	-26.6	21	30	0.08	Circular Depression	Unknown
F186	4555120	288881	-26.7	17	19	0.09	Circular Depression	Unknown

Notes: See Chart 2 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the 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
F187	4555210	288894	-27.4	16	19	0.09	Circular Depression	Unknown
F188	4555200	288876	-27.3	13	13	0.03	Circular Depression	Unknown
F189	4555190	288919	-27.1	14	14	0.05	Circular Depression	Unknown
F190	4555180	288904	-27.1	15	15	0.07	Circular Depression	Unknown
F191	4555220	289063	-27.0	12	9	0.09	Circular Depression	Unknown
F192	4555420	289116	-27.3	76	61	0.06	Drag Mark	Unknown
F193	4555440	289142	-27.4	145	107	0.06	Drag Mark	Unknown
F194	4555450	289665	-27.1	35	69	0.08	Circular Depression	Unknown
F195	4555450	289725	-27.2	21	28	0.06	Circular Depression	Unknown
F196	4555480	289713	-27.1	21	30	0.06	Circular Depression	Unknown
F197	4555460	289698	-27.1	21	33	0.06	Circular Depression	Unknown
F198	4555630	289501	-27.5	15	16	0.11	Circular Depression	Unknown
F199	4555640	289514	-27.4	16	18	0.13	Circular Depression	Unknown
F200	4555650	289499	-27.5	11	8	0.06	Circular Depression	Unknown

Notes: See Chart 2 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the 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
F201	4555650	289482	-27.8	27	49	0.16	Circular Depression	Unknown
F202	4555660	289489	-27.6	13	10	0.06	Circular Depression	Unknown
F203	4555640	289477	-27.6	27	25	0.07	Drag Mark	Unknown
F204	4555650	289522	-27.4	9	6	0.05	Circular Depression	Unknown
F205	4555660	289519	-27.4	10	7	0.07	Circular Depression	Unknown
F206	4555670	289505	-27.6	11	8	0.07	Circular Depression	Unknown
F207	4555670	289500	-27.6	11	8	0.06	Circular Depression	Unknown
F208	4555670	289487	-27.8	16	18	0.11	Circular Depression	Unknown
F209	4555120	288971	-26.7	15	15	0.04	Spud	L/B *Michael Eymard*
F210	4555130	288968	-26.7	15	15	0.09	Spud	L/B *Michael Eymard*
F211	4555130	288958	-26.8	18	22	0.10	Spud	L/B *Michael Eymard*
F212	4555140	288954	-26.9	25	44	0.17	Spud	L/B *Michael Eymard*
F213	4555150	288987	-26.8	21	33	0.07	Spud	L/B *Michael Eymard*
F214	4555140	288952	-26.8	31	37	0.05	Circular Depression	Unknown

Notes: See Chart 2 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the 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
F215	4554870	288574	-25.6	27	28	0.08	Drag Mark	Unknown
F216	4554830	288547	-25.9	24	19	0.06	Drag Mark	Unknown
F217	4555680	289482	-27.8	33	62	0.13	Circular Depression	Unknown
F218	4555690	289501	-27.7	22	37	0.13	Circular Depression	Unknown
F219	4555690	289497	-27.8	31	43	0.10	Circular Depression	Unknown
F220	4555660	289515	-27.5	20	28	0.14	Circular Depression	Unknown
F221	4555660	289509	-27.6	24	41	0.15	Circular Depression	Unknown
F222	4555850	289591	-27.8	17	14	0.11	Circular Depression	Unknown
F223	4555860	289598	-27.8	11	9	0.09	Circular Depression	Unknown
F224	4555870	289592	-27.9	12	10	0.06	Circular Depression	Unknown
F225	4555870	289585	-27.9	7	3	0.03	Circular Depression	Unknown
F226	4555870	289464	-28.6	20	27	0.10	Circular Depression	Unknown
F227	4555850	289491	-28.5	21	26	0.16	Circular Depression	Unknown
F228	4555820	289428	-28.7	20	23	0.15	Circular Depression	Unknown

Notes: See Chart 2 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the 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
F229	4555730	289398	-28.4	28	30	0.05	Drag Mark	Unknown
F230	4555760	289426	-28.4	17	20	0.08	Circular Depression	Unknown
F231	4555780	289517	-28.0	17	18	0.12	Spud	L/B *Michael Eymard*
F232	4555770	289518	-28.0	17	22	0.07	Spud	L/B *Michael Eymard*
F233	4555780	289523	-28.0	14	13	0.05	Spud	L/B *Michael Eymard*
F234	4555770	289523	-27.9	16	17	0.04	Spud	L/B *Michael Eymard*
F235	4555760	289532	-27.8	16	17	0.09	Spud	L/B *Michael Eymard*
F236	4555760	289538	-27.9	25	44	0.11	Spud	L/B *Michael Eymard*
F237	4555770	289532	-27.9	19	24	0.11	Spud	L/B *Michael Eymard*
F238	4555770	289528	-27.8	15	16	0.04	Spud	L/B *Michael Eymard*
F239	4555790	289544	-27.9	12	10	0.05	Spud	L/B *Michael Eymard*
F240	4555790	289551	-27.9	19	23	0.12	Spud	L/B *Michael Eymard*
F241	4555790	289545	-27.9	16	17	0.06	Spud	L/B *Michael Eymard*
F242	4555790	289550	-27.9	14	14	0.05	Spud	L/B *Michael Eymard*

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

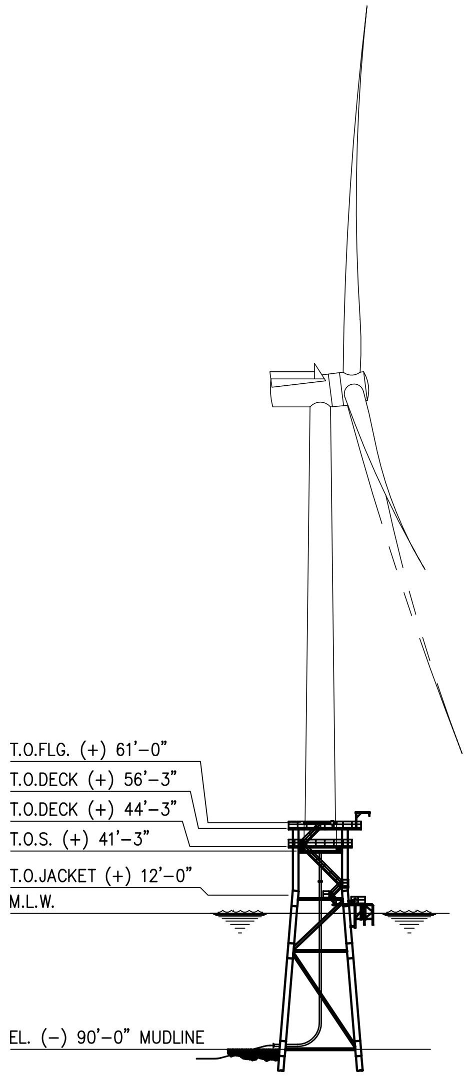
Feature ID	Northing[1] (m)	Easting[1] (m)	Elevation[2] (m)	Feature Perimeter (m)	Feature Area (m^2)	Max Depth (m)	Feature Interpretation	Attributed Vessel
F243	4555780	289543	-27.9	37	48	0.08	Drag Mark	Unknown
F244	4555440	288879	-28.2	24	41	0.08	Circular Depression	Unknown
F245	4555310	288352	-27.6	178	169	0.08	Drag Mark	Unknown
F246	4554090	287652	-26.4	44	145	0.41	Circular Depression	Unknown
F247	4554090	287663	-26.3	37	100	0.41	Circular Depression	Unknown
F248	4554080	287671	-26.1	35	82	0.11	Circular Depression	Unknown
F249	4554080	287678	-25.9	30	63	0.10	Circular Depression	Unknown
F250	4553980	287650	-25.9	32	72	0.17	Circular Depression	Unknown
F251	4553990	287625	-25.8	27	51	0.25	Circular Depression	Unknown
F252	4554440	286955	-27.4	112	80	0.13	Drag Mark	Unknown
F253	4554650	287927	-26.3	25	39	0.07	Circular Depression	Unknown
F254	4555760	289455	-28.3	28	50	0.13	Circular Depression	Unknown
F255	4555800	289452	-28.4	25	32	0.13	Circular Depression	Unknown
F256	4555840	289479	-28.4	26	36	0.08	Circular Depression	Unknown

Notes: See Chart 2 for the location of each seafloor disturbance feature.
[1] UTM Zone 19, NAD83, Meter
[2] Elevation represents centroid location of the 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
F257	4555290	289165	-26.8	34	36	0.04	Drag Mark	Unknown
F258	4554880	289095	-26.2	15	16	0.08	Circular Depression	Unknown
F259	4554900	289079	-26.2	13	13	0.06	Circular Depression	Unknown
F260	4555800	289404	-28.6	333	376	0.27	Drag Mark	Unknown
F261	4555730	289515	-27.9	19	20	0.09	Scour	Unknown
F262	4555740	289531	-27.8	24	31	0.12	Scour	Unknown

Notes: See Chart 2 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

"Providing Value Added Engineering Services"

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

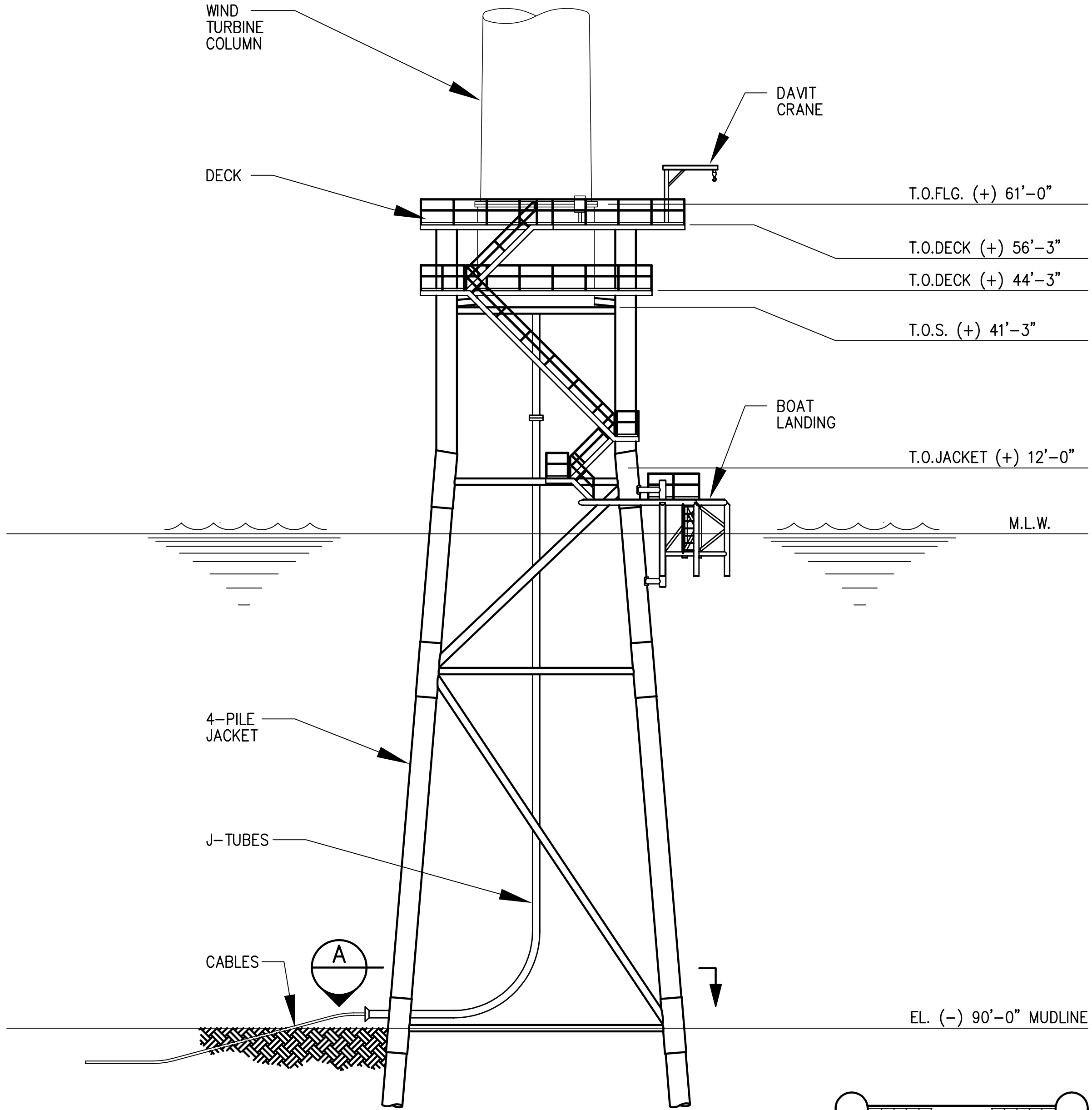
PROJ. No.: P12–002

FILENAME: 9001.dwg

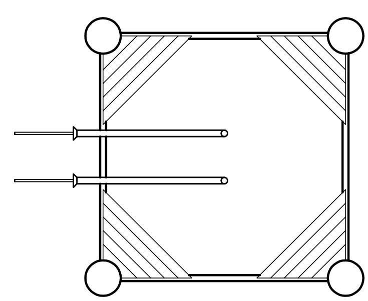
Figure 1

REV. No.: B

jim.rhame, F:\Projects\2012\P12–002 Deepwater Wind Permit Dwgs\Drafting\PLD\9001.dwg, PAPERSPACE, 04/20/2012 – 09:18am



ELEVATION



SECTION A
SCALE 1"=40'–0"

Upstream Engineering LLC
"Providing Value Added Engineering Services"
HOUSTON, TEXAS www.upstreamengineering.com (281) 531–0047

Registration No.: F-2752

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

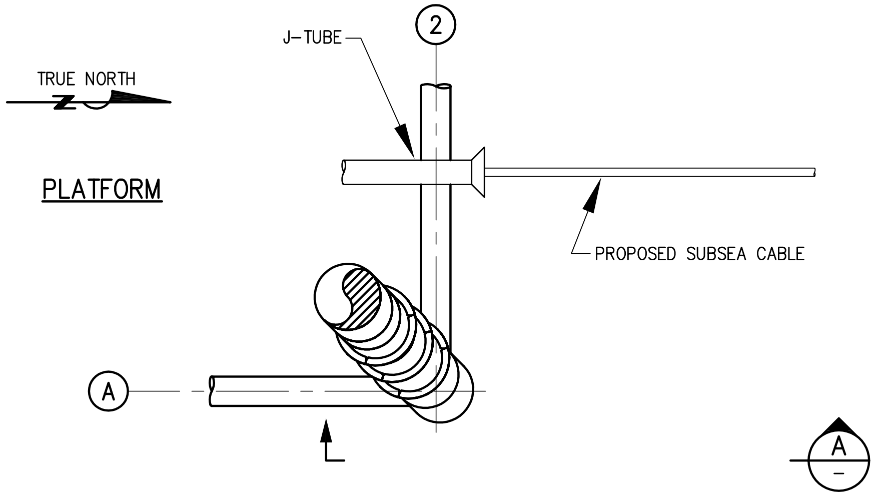
DESIGNED BY: D. YBARRA
SCALE: 1/32"=1'–0"
DRAWN BY: J. RHAME
DATE: 01/11/12

DEEPWATERWIND®

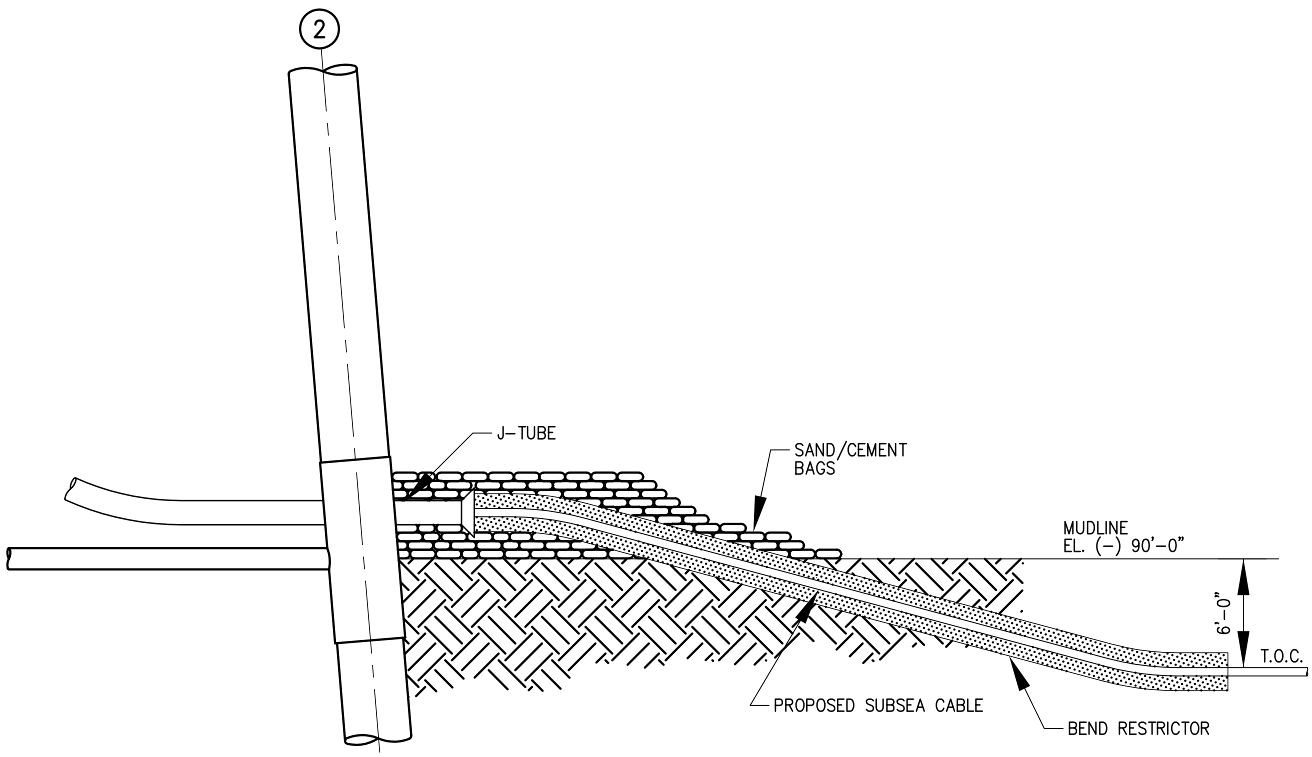
4–PILE JACKET w/DECK STRUCTURE

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

jim.rhame, F:\Projects\2012\P12–002 Deepwater Wind Permit Dwgs\Drafting\PLD\9002.dwg, PAPERSPACE, 04/20/2012 – 09:18am



DETAIL 1
SCALE —— 3/16"=1'-0"



ELEVATION A
SCALE —— 3/16"=1'-0"

Upstream Engineering LLC
"Providing Value Added Engineering Services"
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: AS NOTED
DRAWN BY: J. RHAME
DATE: 01/11/12

DEEPWATERWIND®

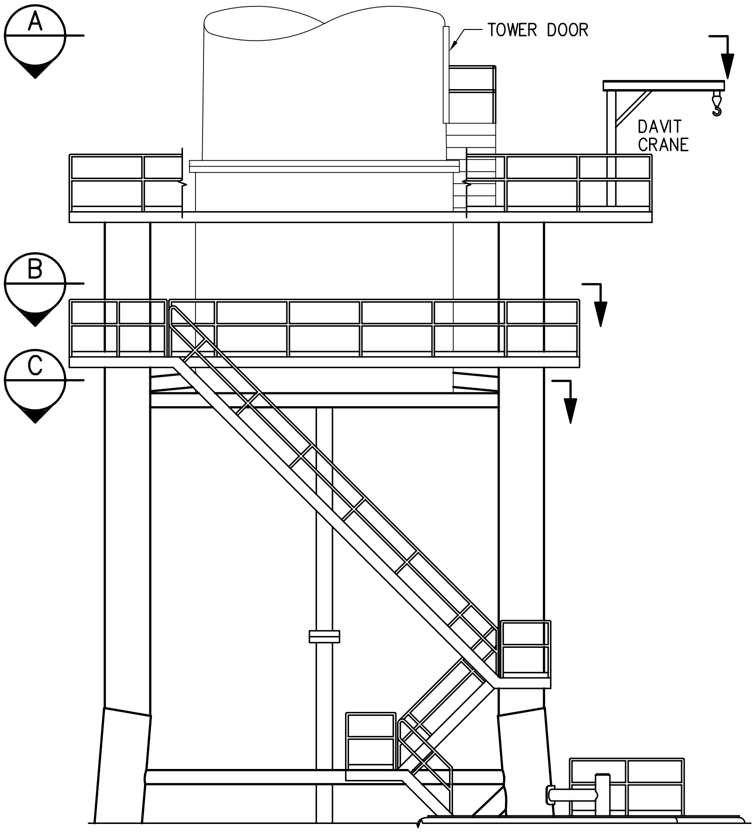
CABLE AT J-TUBE

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

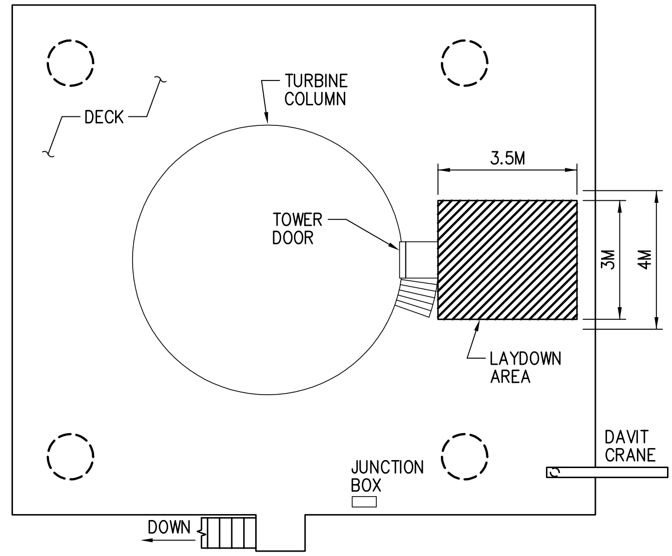
Figure 3

REV. No.: B

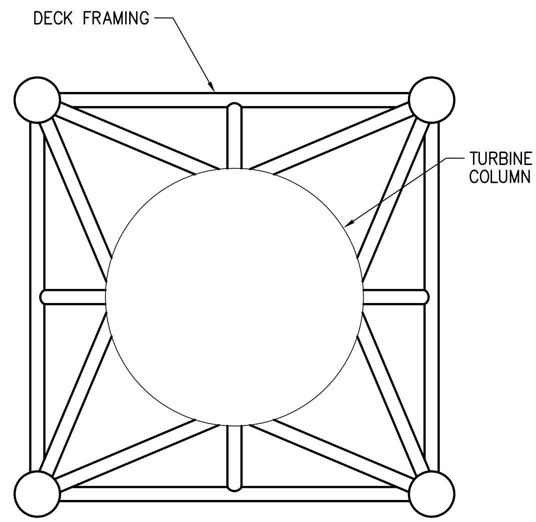
jim.rhame, F:\Projects\2012\P12-002 Deepwater Wind Permit Dwgs\Drafting\PLD\9009.dwg, PAPERSPACE, 04/20/2012 - 09:21am



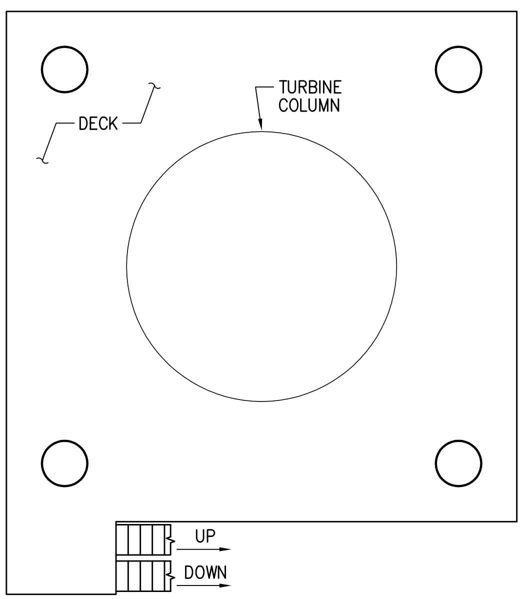
DETAIL 1
SCALE —— 1/16"=1'-0"



SECTION A
SCALE —— 1/16"=1'-0"



SECTION C
SCALE —— 1/16"=1'-0"



SECTION B
SCALE —— 1/16"=1'-0"

Upstream Engineering LLC
"Providing Value Added Engineering Services"
HOUSTON, TEXAS www.upstreamengineering.com (281) 531-0047

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®

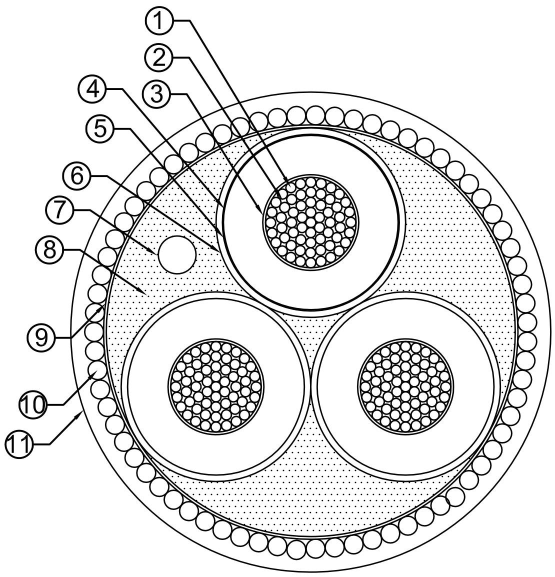
DETAILS AND SECTIONS

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

THIS DRAWING WAS PREPARED BY MOTT MACDONALD FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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



35KV 3-CORE SUBMARINE CABLE

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

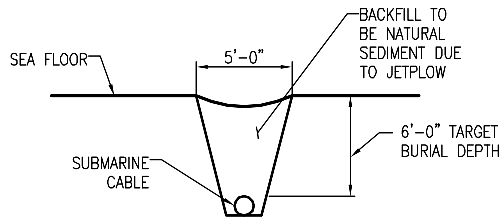
SUBMARINE CABLE DETAIL.dwg

DEEPWATERWIND

	DSGN	CMD	02/09/2012	Mott MacDonald	DEEPWATER WIND	JOB NUMBER 276847
	DRN	MT	02/09/2012		BLOCK ISLAND TRANSMISSION PROJECT	REV A
	CKD	CMD	02/09/2012			
	SCALE:	N.T.S			TYPICAL 3-CORE SUBMARINE CABLE	Figure 5
REFERENCE DRAWINGS	FOR 8.5x11 DWG ONLY					

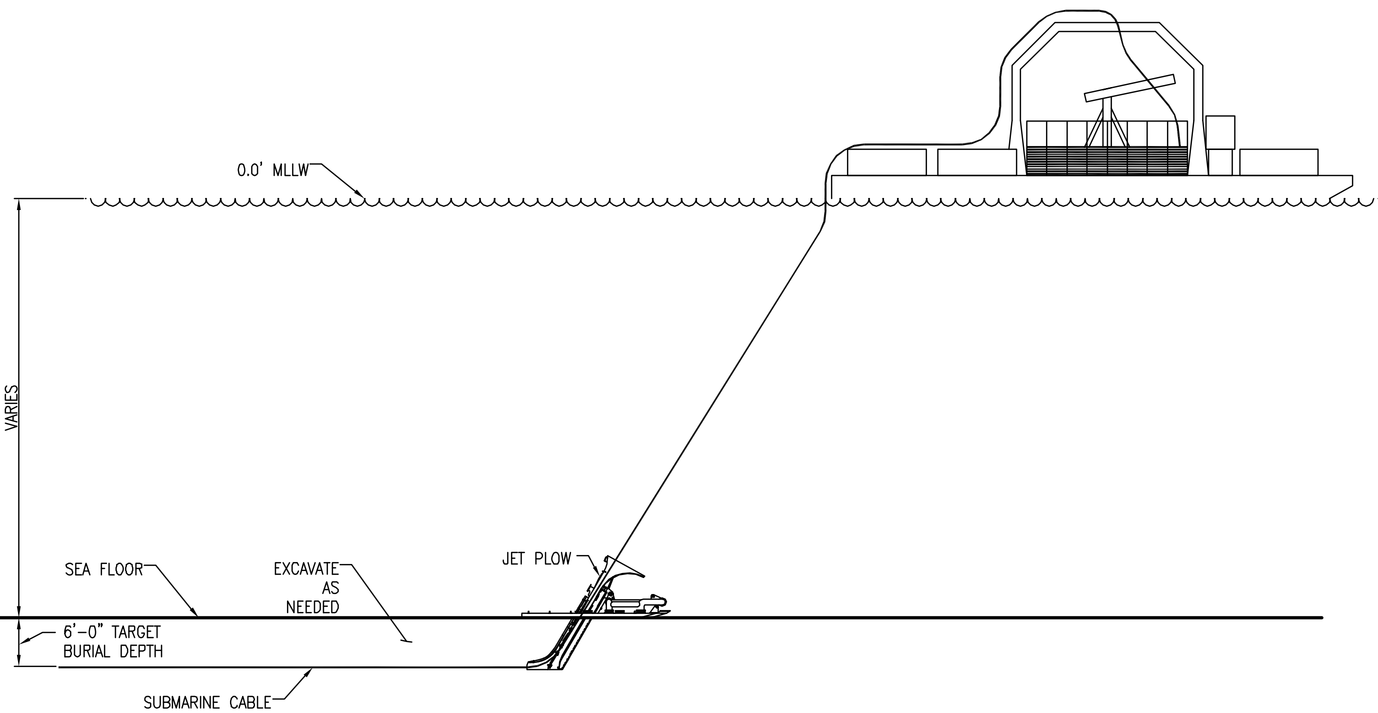
THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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	01/17/2012	JJS	JJS	DEJ	



SECTION

SCALE N.T.S.



ELEVATION VIEW

SCALE N.T.S.

DEEPWATERWIND

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

POWER ENGINEERS

DEEPWATER WIND

BLOCK ISLAND TRANSMISSION PROJECT

SUBMARINE DETAIL

JOB NUMBER 119630

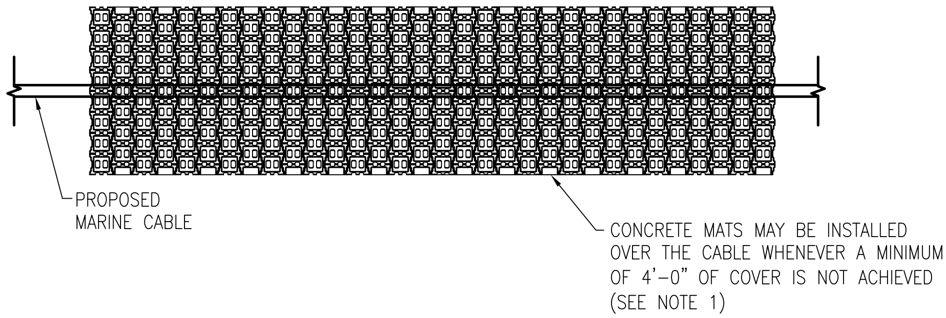
REV D

Figure 6

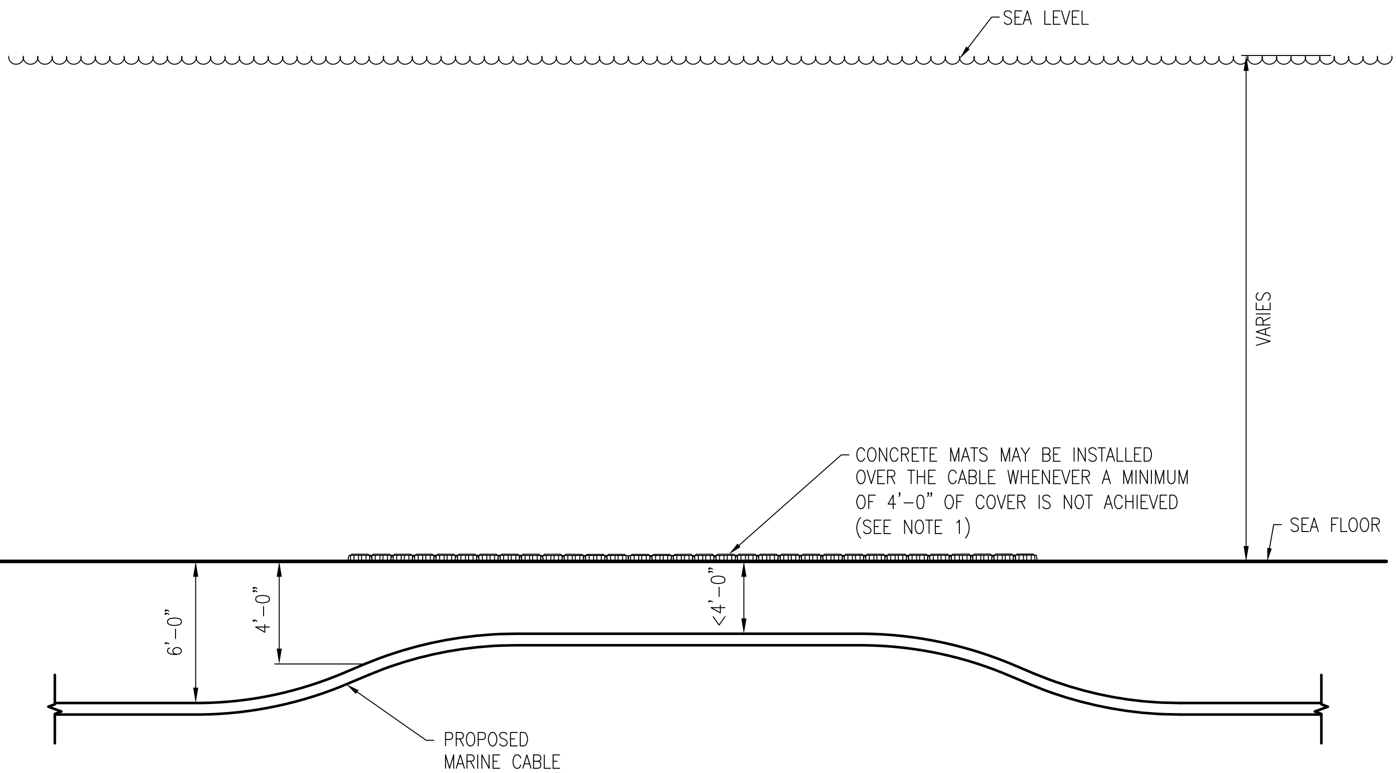
Submarine Detail.dwg

THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

B	ISSUED FOR REVIEW	04/16/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	04/13/2012	JJS	JJS	DEJ	
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD



PLAN VIEW



PROFILE VIEW

SHALLOW PENETRATION DETAIL

SCALE N.T.S.

NOTES:

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

AECOM

DEEPWATERWIND

		DSGN	JJS	04/13/2012
		DRN	JJS	04/13/2012
		CKD	DEJ	04/13/2012
		SCALE:	N.T.S.	
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY		

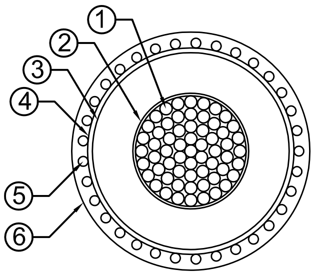
POWER ENGINEERS

DEEPWATER WIND	JOB NUMBER	REV
BLOCK ISLAND TRANSMISSION PROJECT	119630	B
SHALLOW PENETRATION DETAIL	Figure 7	

SHALLOW PENETRATION.dwg

THIS DRAWING WAS PREPARED BY MOTT MACDONALD FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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

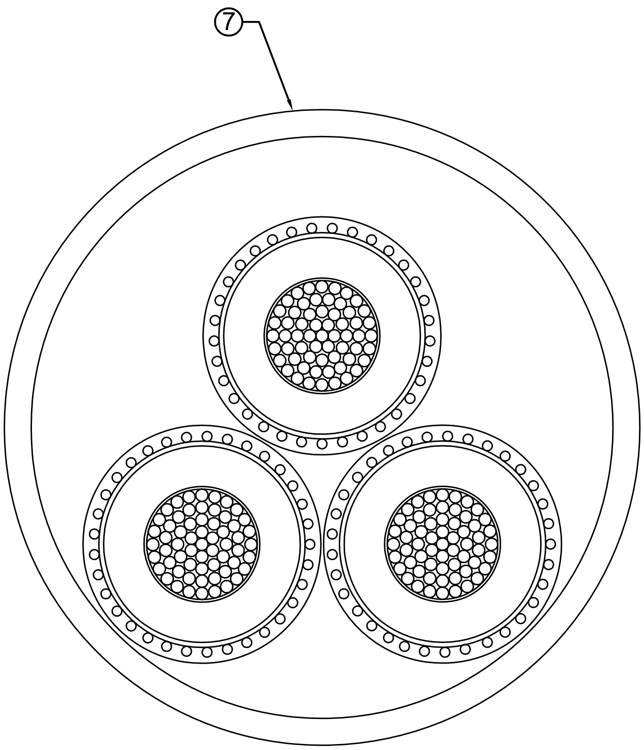
3 - INSULATION

4 - INSULATION SCREEN

5 - CONCENTRIC CONDUCTOR

6 - JACKET

7 - CONDUIT



35KV CABLE TREFOIL IN CONDUIT

DEEPWATERWIND

UPLAND CABLE DETAIL.dwg

		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

BLOCK ISLAND TRANSMISSION PROJECT

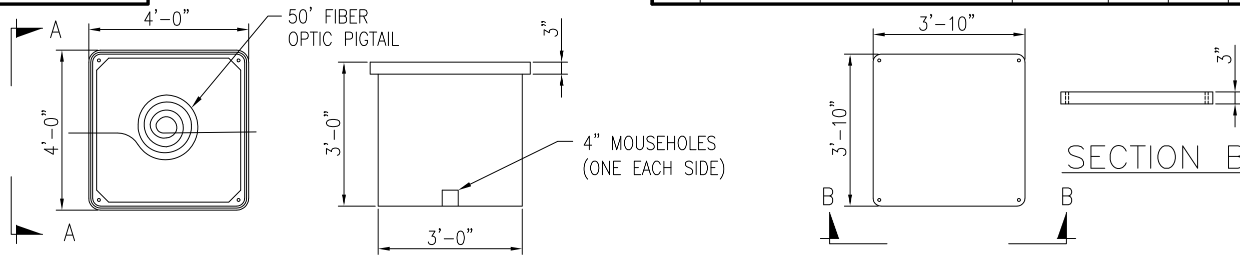
TYPICAL UPLAND CABLE

JOB NUMBER	REV
276847	A

Figure 8

THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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	



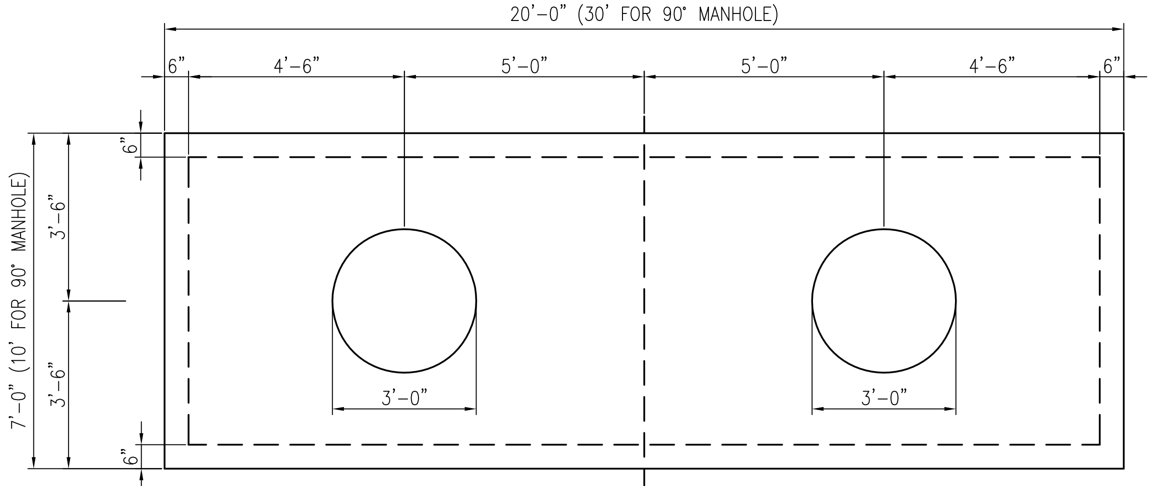
PLAN SECTION A COVER

FIBER OPTIC HAND HOLE

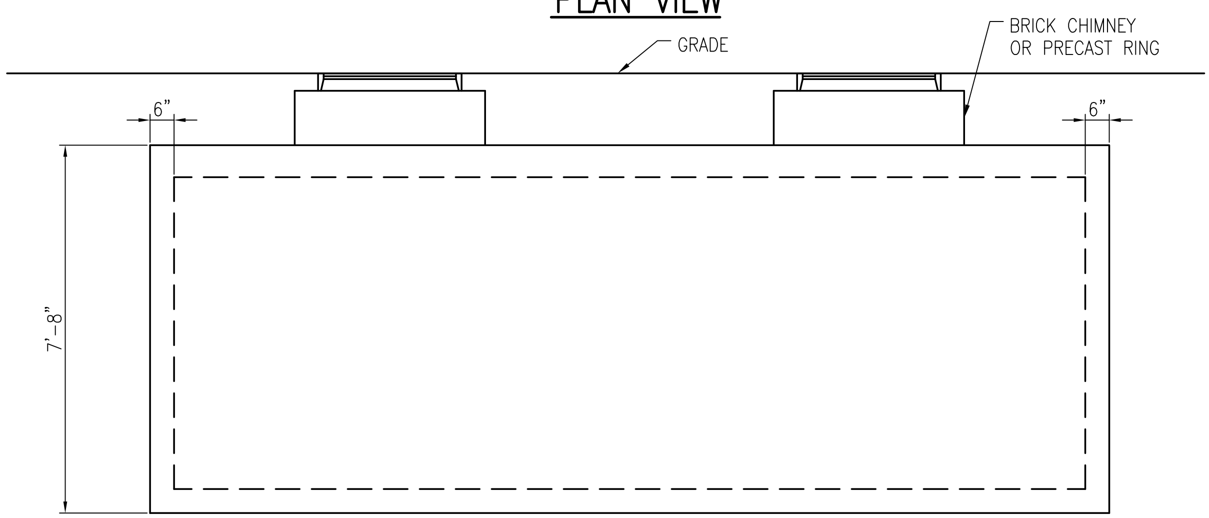
SCALE N.T.S.

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	JOB NUMBER	REV
DRN	JJS	12/01/2011	BLOCK ISLAND TRANSMISSION PROJECT	119630	C
CKD	DEJ	12/01/2011	TYPICAL MANHOLE DETAIL	Figure 9	
SCALE:	N.T.S.				

REFERENCE DRAWINGS

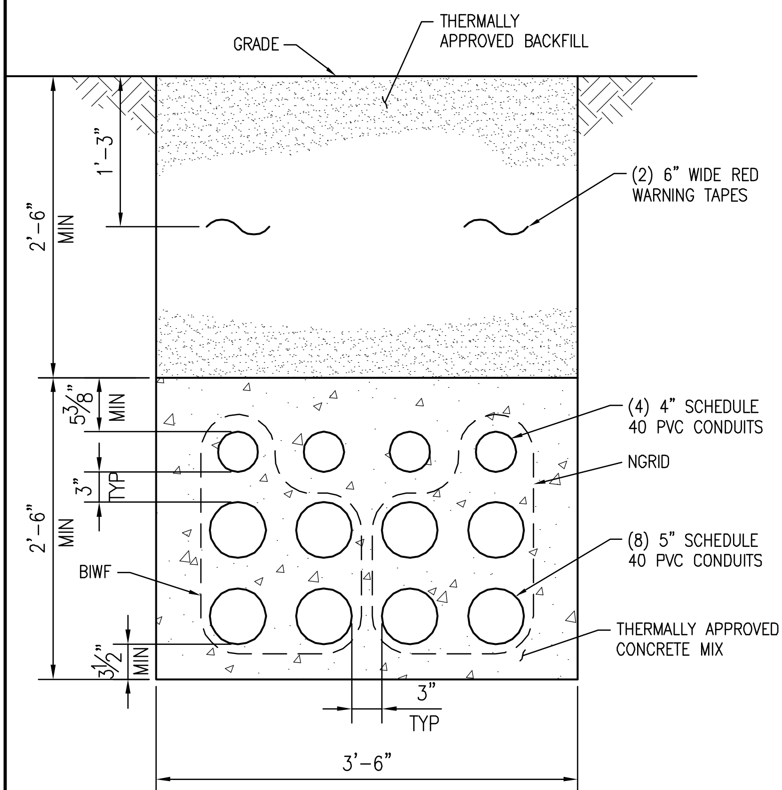
FOR 8.5x11 DWG ONLY

POWER ENGINEERS

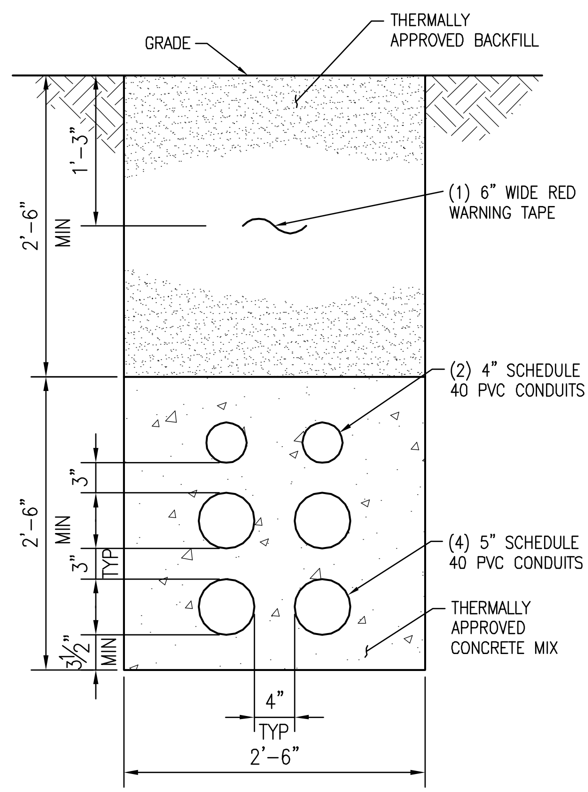
Manhole Detail.dwg

THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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	
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD



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



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

DEEPWATERWIND®

TRENCH DETAIL ALUMINUM.dwg

	DSGN	JJS	01/12/2012	DEEPWATER WIND
	DRN	JJS	01/12/2012	BLOCK ISLAND TRANSMISSION PROJECT
	CKD	DEJ	01/12/2012	
	SCALE:	N.T.S.		TRENCH DETAIL (ALUMINUM)
REFERENCE DRAWINGS	FOR 8.5x11 DWG ONLY			

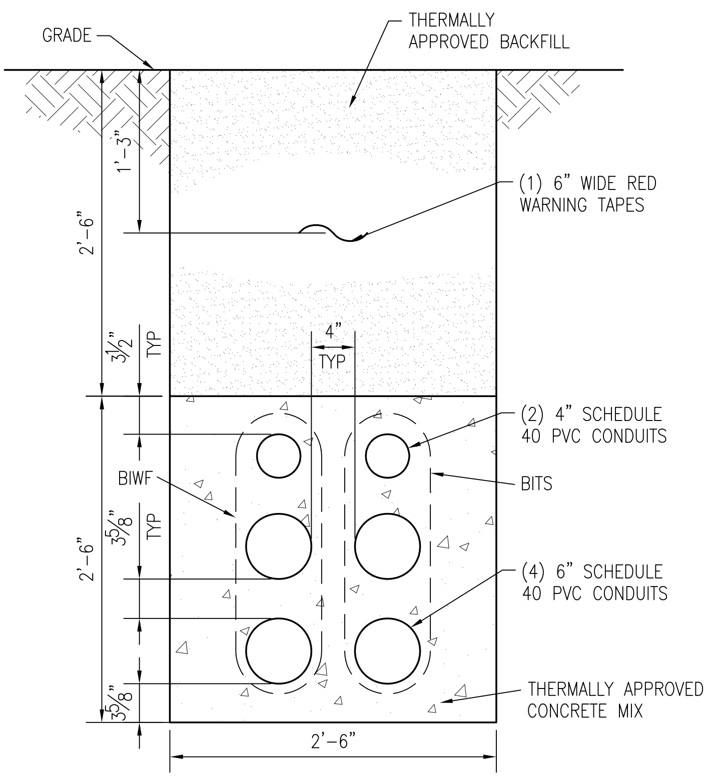
POWER ENGINEERS

JOB NUMBER	REV
119630	C

Figure 10

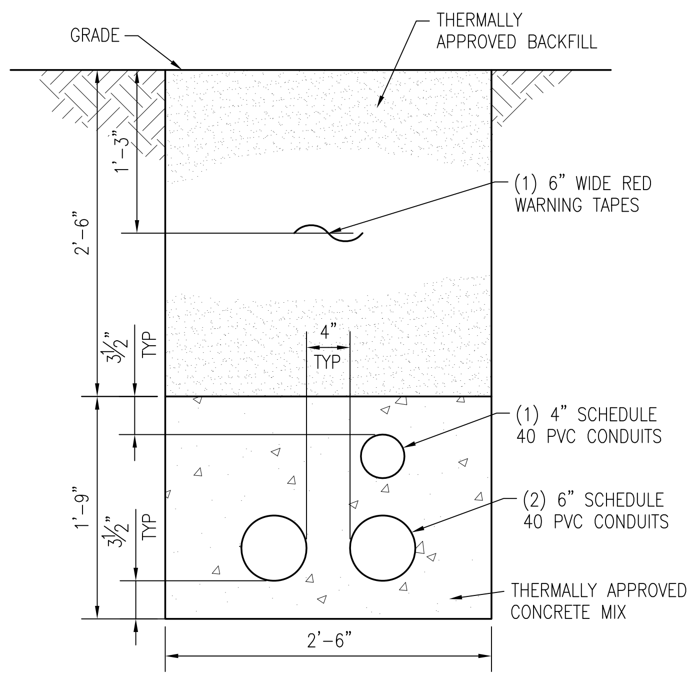
THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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	
	DRN	JJS	12/01/2011	
	CKD	DEJ	12/01/2011	
	SCALE:	N.T.S.		
	FOR 8.5x11 DWG ONLY			

POWER ENGINEERS

DEEPWATER WIND

BLOCK ISLAND TRANSMISSION PROJECT

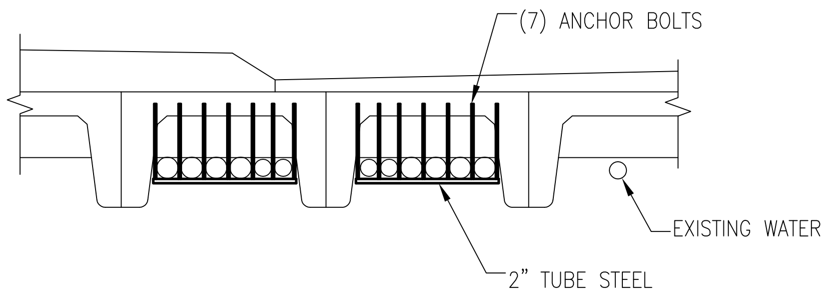
TRENCH DETAIL (COPPER)

JOB NUMBER	REV
119630	C

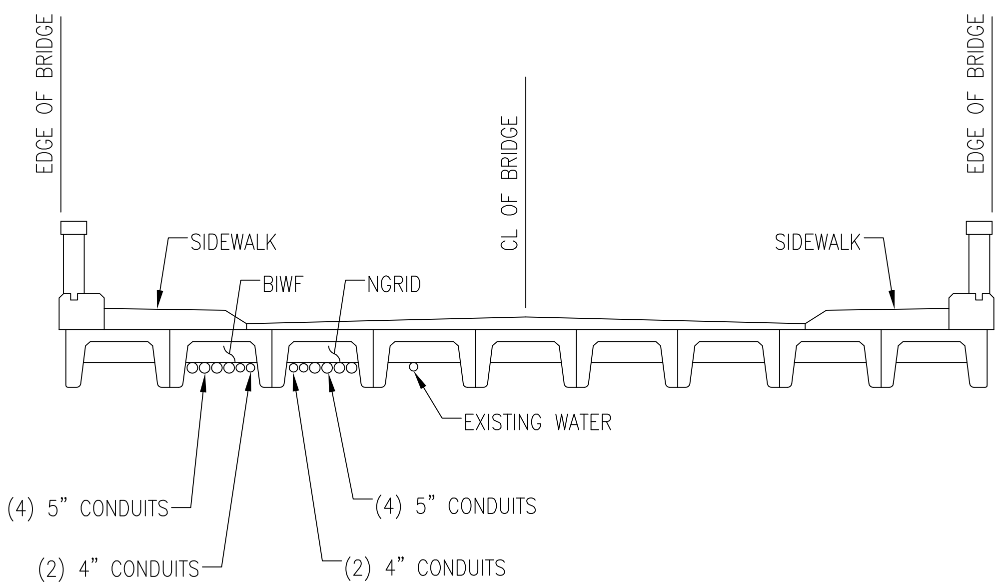
Figure 11

THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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
		DRN	JJS	1/19/2012
		CKD	DEJ	1/19/2012
		SCALE:	N.T.S.	
REFERENCE DRAWINGS		FOR 8.5x11 DWG ONLY		

POWER ENGINEERS

DEEPWATER WIND

BLOCK ISLAND TRANSMISSION PROJECT

BRIDGE DETAIL

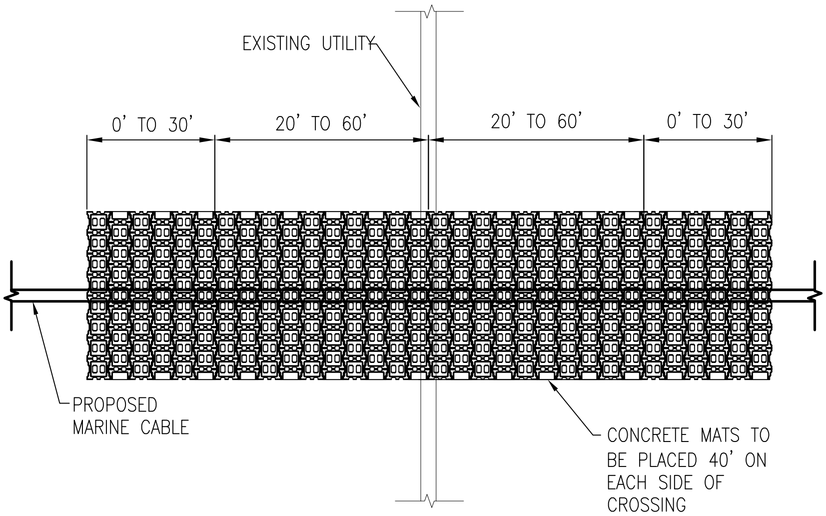
JOB NUMBER	REV
119630	C

Figure 12

Bridge Detail.dwg

THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

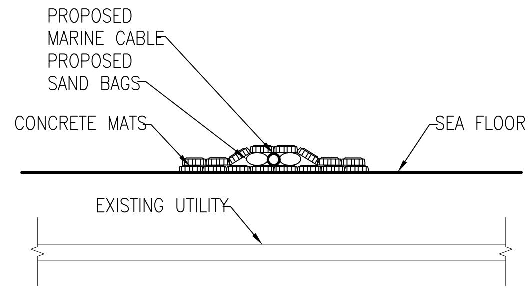
REV	REVISIONS	DATE	DRN	DSGN	CKD	APPD
D	ISSUED FOR REVIEW	02/14/2012	JJS	JJS	DEJ	
C	ISSUED FOR REVIEW	02/03/2012	JJS	JJS	DEJ	
B	ISSUED FOR REVIEW	01/30/2012	JJS	JJS	DEJ	
A	ISSUED FOR REVIEW	12/30/2011	JJS	JJS	DEJ	



PLAN VIEW

EXISTING UTILITY CROSSING

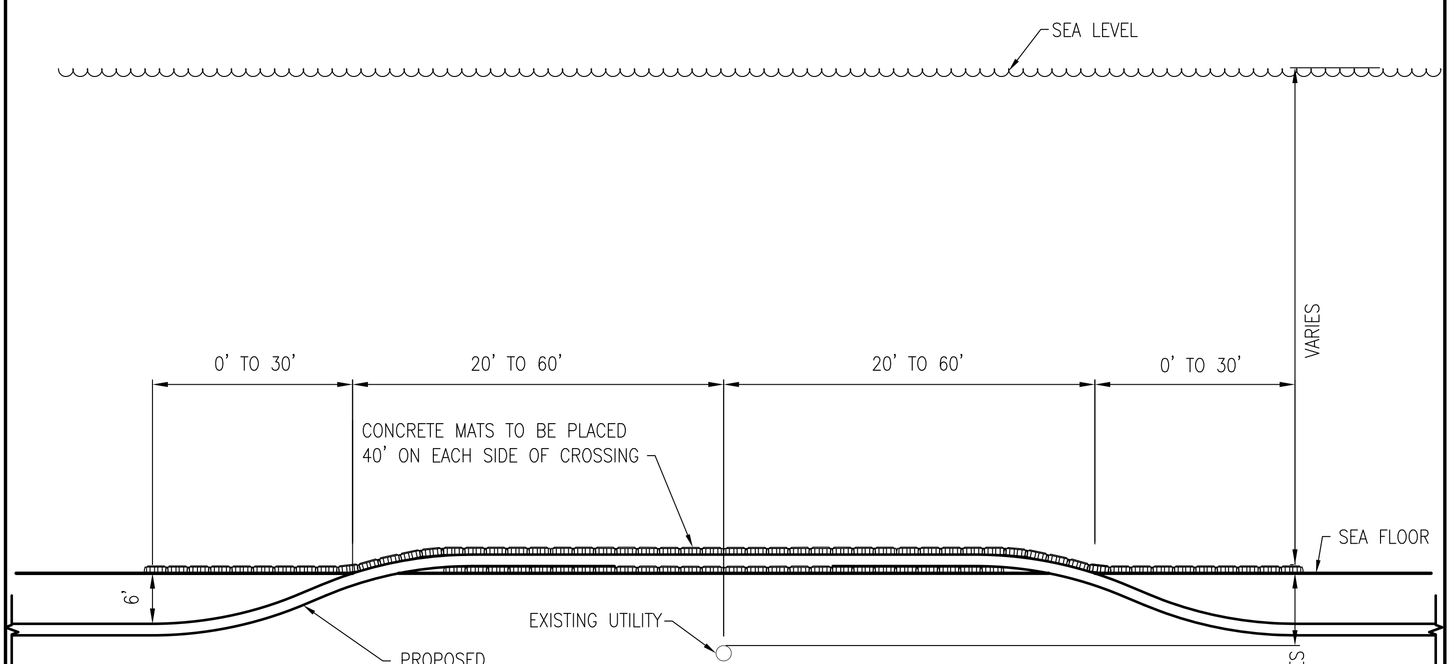
SCALE N.T.S.



CROSS SECTION

EXISTING UTILITY CROSSING

SCALE N.T.S.



PROFILE VIEW

EXISTING UTILITY CROSSING

SCALE N.T.S.

DEEPWATERWIND®

UTILITY CROSSING.dwg

REFERENCE DRAWINGS

DSGN	JJS	12/30/2011
DRN	JJS	12/30/2011
CKD	DEJ	12/30/2011
SCALE:	N.T.S.	

FOR 8.5x11 DWG ONLY

POWER ENGINEERS

DEEPWATER WIND

BLOCK ISLAND TRANSMISSION PROJECT

TYPICAL OCEAN UTILITY CROSSING DETAIL

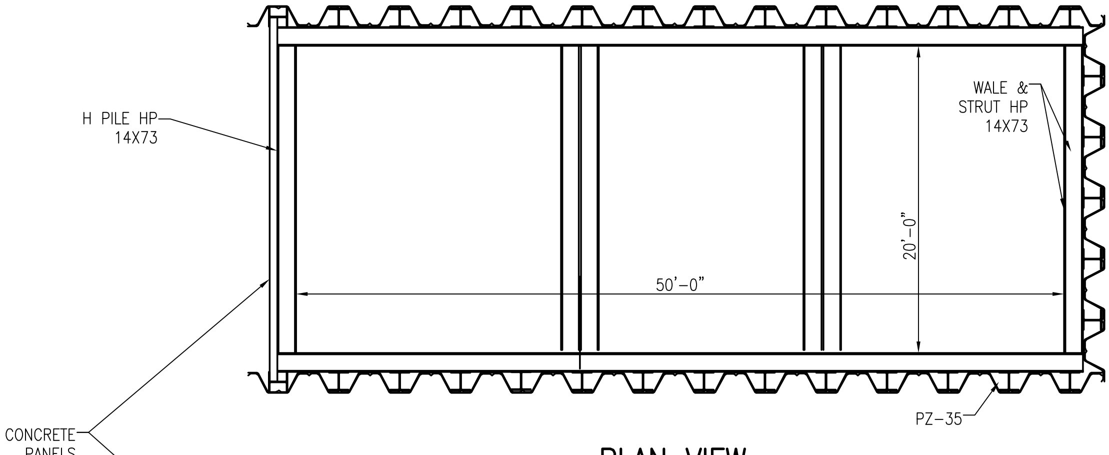
JOB NUMBER 119630

REV D

Figure 13

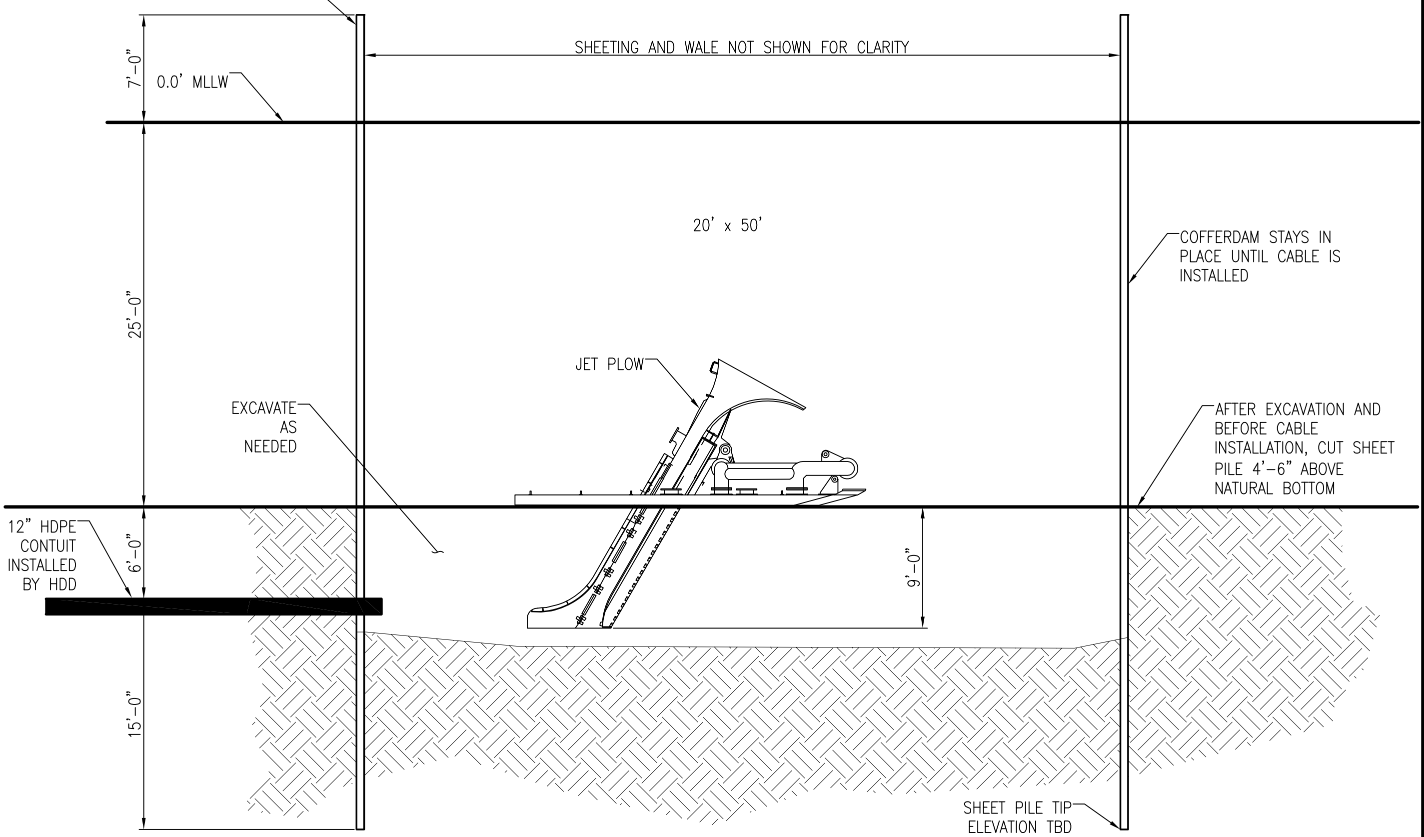
THIS DRAWING WAS PREPARED BY POWER ENGINEERS, INC. FOR A SPECIFIC PROJECT, TAKING INTO CONSIDERATION THE SPECIFIC AND UNIQUE REQUIREMENTS OF THE PROJECT. REUSE OF THIS DRAWING OR ANY INFORMATION CONTAINED IN THIS DRAWING FOR ANY PURPOSE IS PROHIBITED UNLESS WRITTEN PERMISSION FROM BOTH POWER AND POWER'S CLIENT IS GRANTED.

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	
DRN	JJS	1/12/2012	
CKD	DEJ	1/12/2012	
SCALE:	N.T.S.		

REFERENCE DRAWINGS

FOR 8.5x11 DWG ONLY

POWER ENGINEERS

DEEPWATER WIND

BLOCK ISLAND TRANSMISSION PROJECT

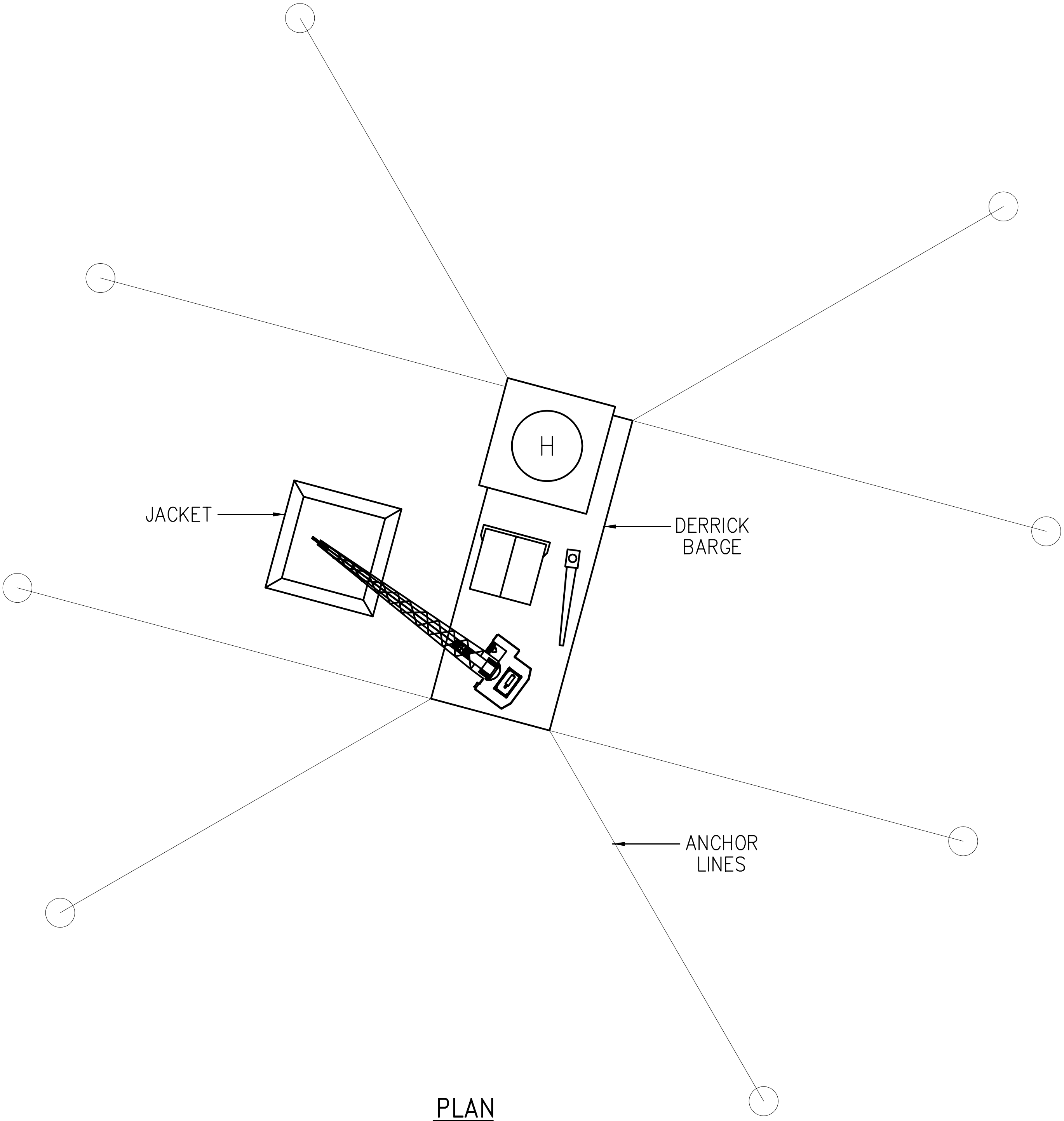
COFFER DAM DETAIL

JOB NUMBER: 119630

REV: D

Figure 14

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

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

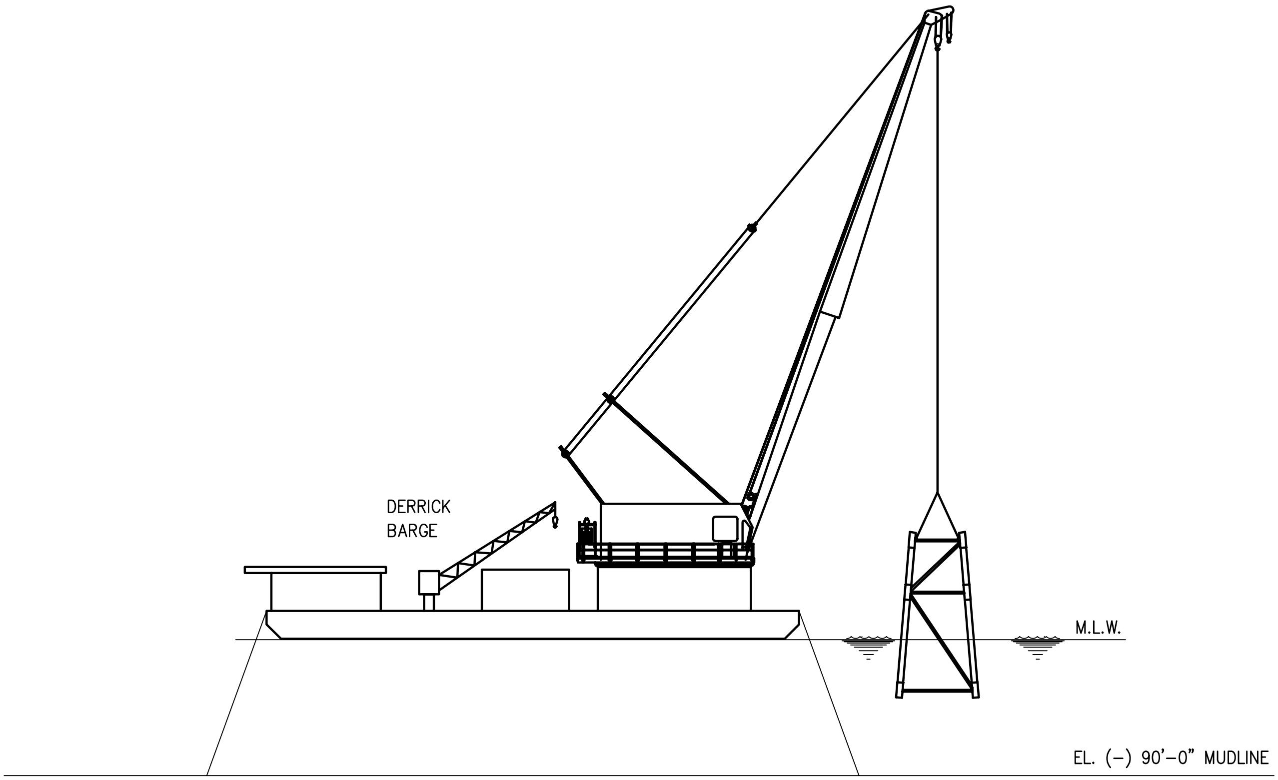
DESIGNED BY: D. YBARRA	SCALE: N.T.S.
DRAWN BY: J. RHAME	DATE: 01/11/12

DEEPWATERWIND®

JACKET INSTALLATION
w/DERRICK BARGE

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

jim.rhame, F:\Projects\2012\P12-002 Deepwater Wind Permit Dwgs\Drafting\PLD\9004.dwg, MODELSPACE, 04/20/2012 - 09:19am



ELEVATION

Upstream Engineering LLC
"Providing Value Added Engineering Services"
HOUSTON, TEXAS www.upstreamengineering.com (281) 531–0047

Registration No.: F-2752

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

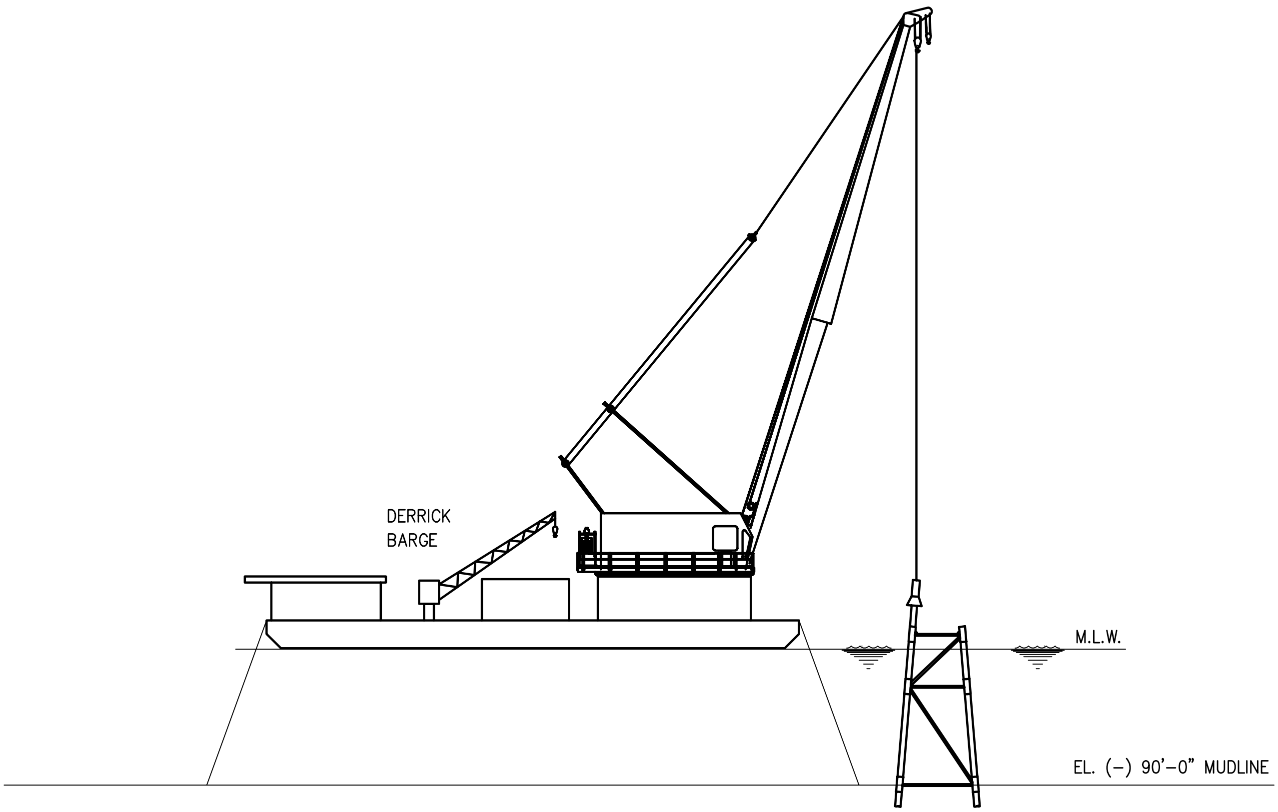
DESIGNED BY: D. YBARRA
SCALE: 1/128"=1'–0"
DRAWN BY: J. RHAME
DATE: 01/11/12

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



ELEVATION

Upstream Engineering LLC
"Providing Value Added Engineering Services"
HOUSTON, TEXAS www.upstreamengineering.com (281) 531–0047

Registration No.: F-2752

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

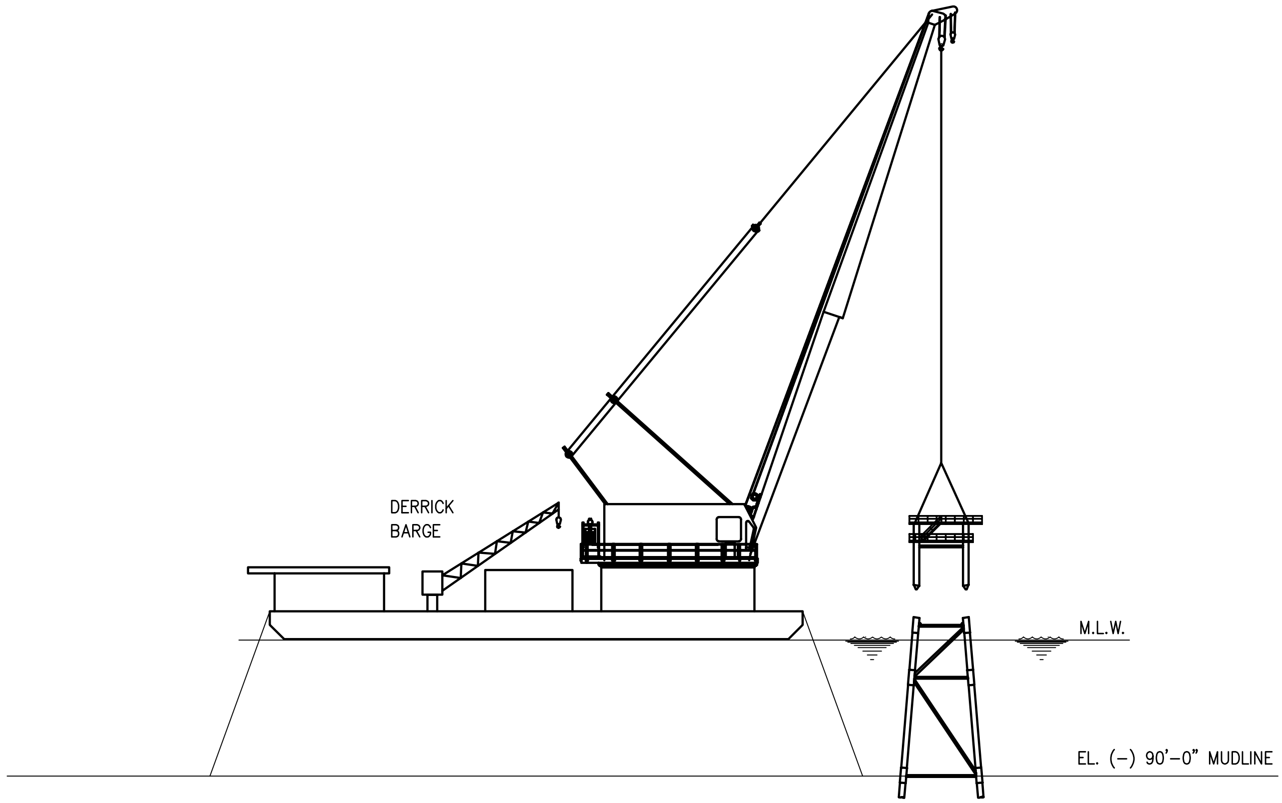
DESIGNED BY: D. YBARRA
SCALE: 1/128"=1'–0"
DRAWN BY: J. RHAME
DATE: 01/11/12

DEEPWATERWIND®

PILE DRIVING
w/DERRICK BARGE

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

jim.rhame, F:\Projects\2012\P12–002 Deepwater Wind Permit Dwgs\Drafting\PLD\9006.dwg, PAPERSPACE, 04/20/2012 – 09:20am



ELEVATION

Upstream Engineering LLC

"Providing Value Added Engineering Services"

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: 02/02/12

DEEPWATERWIND®

DECK INSTALLATION
w/DERRICK BARGE

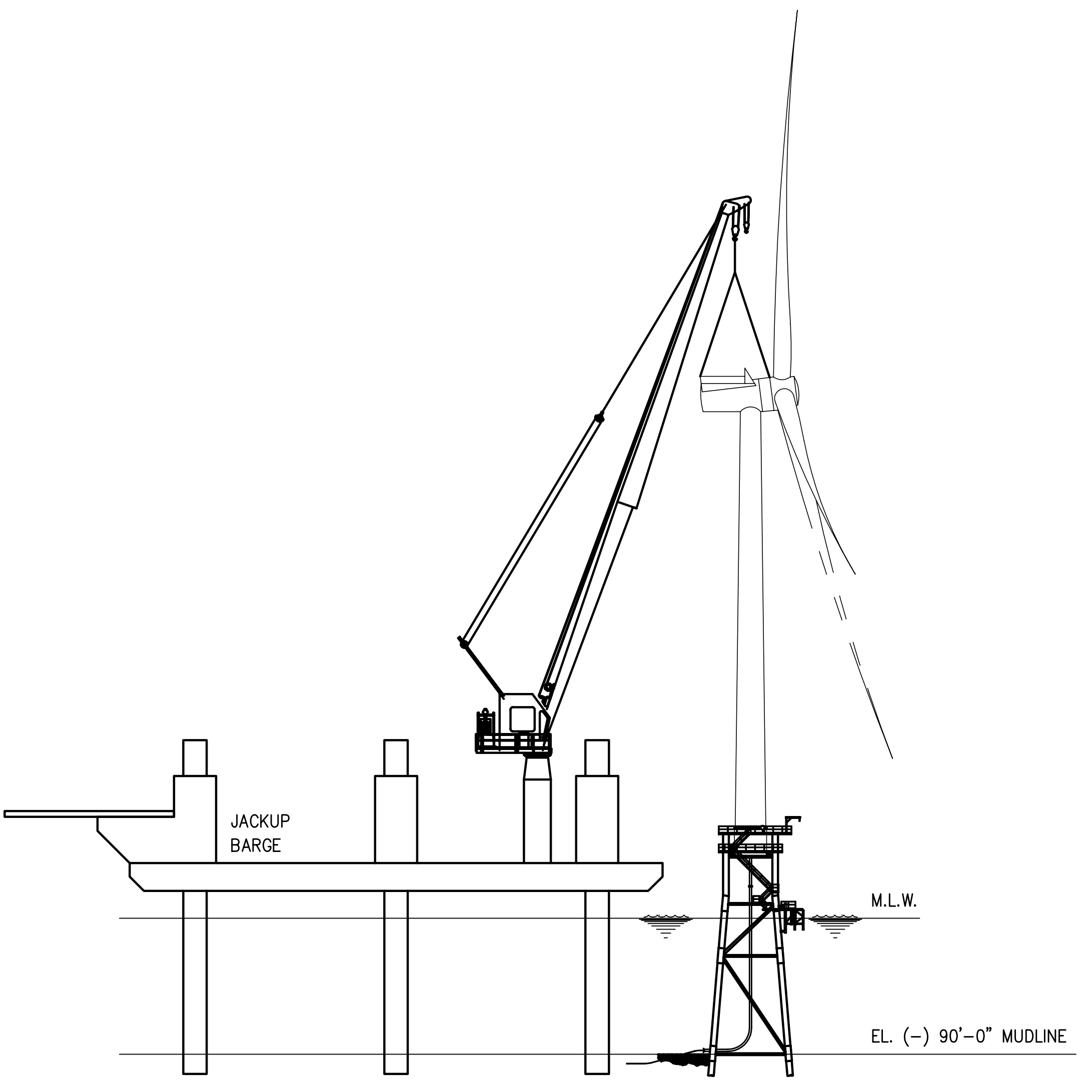
PROJ. No.: P12–002

FILENAME: 9007.dwg

Figure 18

REV. No.: B

jim.rhame, F:\Projects\2012\P12–002 Deepwater Wind Permit Dwgs\Drafting\PLD\9007.dwg, PAPERSPACE, 04/20/2012 – 09:20am



ELEVATION

Upstream Engineering LLC
"Providing Value Added Engineering Services"
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®

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