2 SURVEY DESCRIPTION, EQUIPMENT AND METHODS

2.1 SURVEY DATES AND WEATHER CONDITIONS

OII conducted the AUV/ROV field operations onboard the M/V *Ocean Project* on June 18th – 19th, 2017 and June 29th – July 1st, 2017. ROV operations were completed onboard the M/V *Ocean Intervention* from September 1st – 4th, 2017. Sea conditions during the survey operations were 0 to 2 meters and winds varied in direction with speeds ranging from calm to 30 knots. Although surface conditions do not affect geophysical data collection or quality, it can affect AUV/ROV launch and retrieval operations.

2.2 SURVEY AREA

The study area is located approximately 122 statute miles south-southwest from Port Fourchon, Louisiana. Regional and Vicinity Maps of the study area are provided in Illustrations 1 and 2, respectively.

2.3 SURVEY EQUIPMENT

The Comanche 25 and Maxx 2 ROVs were used to perform the video investigation and install the monitoring equipment. The AUV acquisition was accomplished using OII's *C-Surveyor III*™ AUV. Geophysical instruments integrated into the *C-Surveyor III*™ include a Kongsberg EM 2040 Multibeam Echosounder (200 kHz), an EdgeTech 2200M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120 & 410-kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5 – 10.0 kHz). All raw digital data were logged utilizing proprietary software developed by OII.

2.4 SURVEY VESSEL AND POSITIONING

Surface positioning of the M/V *Ocean Project* and MSV *Ocean Intervention* was accomplished using OII's C-Nav® 3050 integrated C-Nav/RTK Extend Receiver globally corrected Differential Global Positioning System (DGPS) providing decimeter-level positioning in real time.

Underwater positioning of the AUV/ROV was accomplished using acoustically aided inertial positioning. AUV/ROV positions were calculated using a Kalman filter algorithm, which utilizes input data from a Kongsberg High Precision Acoustic Positioning System (HiPAP), inertial navigation, and a Doppler velocity log. The post-processed positions for the AUV/ROV are accurate to within ±3 meters.

2.5 SURVEY GRID

The survey grid consisted of fifteen primary tracklines (Lines 101 – 115) spaced at 100 meter intervals, and three tie lines (Lines 201 – 203) spaced at 900 meter intervals.

2.6 GEODETIC AND VERTICAL DATUM

Position information was output from the DGPS system to navigation software on the

WGS 84 spheroid. The geodetic datum used to generate the study maps is the North American Datum of 1927 (NAD27) on the Clarke 1866 ellipsoid and projected using the Bureau of Land Management (BLM), Zone 15 North (15N). NADCON software version 2.1 was utilized to convert the DGPS positions from the WGS84 datum to the local NAD27 datum. All coordinates on the study maps and referenced within all reports are presented in this projection. The geodetic parameters for survey and reporting and mapping are listed in Table 1.

The EM 2040 multibeam echosounder data were used to determine water depths within the project area. The multibeam data were corrected for the water column density and tide using CTD data and predicted tides generated from the NASA Goddard Global Ocean Tide Model, respectively. The bathymetric depth values are in meters and referenced to Mean Sea Level (MSL).

Table 1. Geodetic Parameters for Data Acquisition, Reporting and Mapping

PARAMETER	DATA ACQUISITION	REPORTING AND MAPPING
Geodetic Datum	WGS84	NAD27
Ellipsoid	WGS84	Clarke 1866
Grid Units	Meters	U.S. Survey Feet
Projection	Universal Transverse Mercator	Bureau of Land Management
Zone	15N	15N
Central Meridian	93° 00’ W	93° 00’ W
False Easting	500,000 meters at C.M.	1,640,416.67 feet at C.M.
False Northing	0.00 meters at 00° N	0.00 feet at 00° N
Scale Factor	0.9996	0.9996

2.7 GEOPHYSICAL DATA PROCESSING

2.7.1 MULTIBEAM BATHYMETRY DATA PROCESSING

The EM 2040 (200 kHz) multibeam echosounder dataset was used to collect water depths across the study area. For the low frequency (200 kHz) data, there are 256 soundings across a 220-meter swath while the AUV is operating at a 40-meter altitude and pinging at 4.0 Hz. Pitch, roll, and yaw values of the AUV were recorded utilizing precision accelerometers from an Ixsea IMU 90 inertial measurement unit (motion compensator). These values were applied to the raw dataset.

The AUV depth was converted from the pressure data recorded by a stand-alone Digiquartz pressure sensor in the AUV and CTD data using the Standard UNESCO Formula. Barometric pressure readings were logged during the survey and corrections were applied to the recorded pressure sensor depth data in the AUV. A project error budget is provided in Appendix K.

The multibeam soundings were processed using proprietary Hydromap© software developed by OII. Gridded datasets were generated from the median points by applying a weighted-neighbor filtering algorithm, and interpolating or triangulating the data points. The datasets were visually edited to remove stray or erroneous points, and then digitally triangulated for bathymetric surface generation. The bathymetry depth values were referenced to Mean Sea Level (MSL).

Acoustic velocities of the water column were calculated from Conductivity, Temperature, and Depth (CTD) probe measurements performed during the survey (Appendix B). Tide corrections were applied during multibeam data processing using predicted tide information generated from the NASA Goddard Global Ocean Tide Model, GOT99.2 (Ray, 1999). As described by Ray (1999), the model is based on 232 cycles (each cycle comprising data from 9.9156 days) of sea-surface height observations by the altimeters on the Topex/Poseidon space satellite (launched on August 10, 1992), combined with prior hydrodynamic models, several in shallow and inland seas. The model also relied heavily on the global hydrodynamic model developed at the Institute de Mecanique de Grenoble. Corrections used within this model include various biases and drift corrections developed by the instrument engineers, as well as standard media corrections such as tropospheric delay. Models used for altimeter corrections include those for the dynamical forcing from the Earth's gravitational field, from the ocean tide, from the body tide, the load tide (the solid-Earth tide), and atmospheric loading. Comparisons with deep-ocean tide-gauge measurements indicate that this tidal solution is an improvement over previous global models (Ray, 1999), with accuracies for the main semidiurnal lunar constituent M2 now below 1.5 centimeters in deepwater.

2.7.2 SIDE SCAN SONAR DATA PROCESSING

The various reflectivity patterns recorded by the side scan sonar can be used to interpret geological and man-made features on the seafloor. The side scan sonar data were collected with an EdgeTech side scan sonar system set to 120 and 410-kHz frequency bands. The total recorded data for the low frequency (120 kHz) swath was ~420 meters (~210 meters per channel), and the high frequency (410kHz) swath collects a ~150 meter swath (~75 meters per channel). The side scan sonar transmits a sound pulse about 3 times per second (1.8 meters/second).

The raw data were recorded in EdgeTech format and then converted to XTF (eXtended Triton Format) using proprietary tools. These XTF files were reviewed for quality control and data interpretation using Chesapeake Technology, Inc.'s SonarWiz 6 Software. A georeferenced side scan sonar mosaic of the seafloor was created using Chesapeake Technology, Inc.'s SonarWiz 6 Software. The data was bottom tracked, slant ranged corrected, and speed corrected.

2.7.3 SUBBOTTOM PROFILER DATA PROCESSING

The subbottom profiles were recorded using an EdgeTech subbottom profiler with transmission pulses generated in frequencies modulated between 1.5 and 10.0 kHz. During data acquisition, the subbottom profiler collected data at a 3.0 Hz ping rate and a total penetration of up to 150 meters, with time zero occurring at the altitude of 40 meters. The raw data was recorded in a non-topographically corrected mode.

A topographically corrected record was produced by inserting the AUV depth information into the recorded raw seismic data. The subbottom data files were output in SEG-Y format for quality control review with IHS' Kingdom Suite 2d/3dPAK. All depths below seafloor referenced in this report were converted from two-way traveltime by applying an assumed acoustic velocity of 750 meters per second. OII prefers to use this, as it has been found broadly indicative of shallow soft sediment (silts and clays) found in similar water depths and environments.

3 CALIBRATION

Various system calibrations were performed prior to and during field operations. These calibrations are discussed in the following sections with full calibration reports included in Appendices E through J.

3.1 DGPS POSITION CALIBRATION AND VERIFICATION CHECK

A dockside DGPS Antenna Position / Verification Check was performed at the Oceaneering Dock in Fourchon, Louisiana on May 04, 2017. At the time of this procedure, the C-Nav® Model 3050 receivers on the survey vessel *M/V Ocean Project* were Primary SN: 23349 and Tertiary SN: 23288. The distance between the two (2) mounted DGPS antennae was physically measured to be 1.2189 meters. During this endeavor, a total of 5064 comparison data points were collected over a time period of approximately 1 hour 24 minutes utilizing Oceaneering Survey Services proprietary Hydromap software. This results in a 0.0001-meter difference between the measured and calculated DGPS antenna. The full results of the DGPS Calibration and Verification Check are included in Appendix E.

3.2 GYRO CALIBRATION

A Gyro Validation was performed on October 5, 2016 at the Oceaneering Dock in Fourchon, Louisiana. Two control points had been established by a previous dimensional control survey. A Hemisphere VS330 antenna was placed over each control point on a tripod and leveled and centered using a Tri-Brach and adapter. The Hemisphere VS330 was initialized and an TRK Fixed Solution was achieved. The heading sensors were logged at a 1-second interval for 1 hour. Based on the acquired readings, the maximum heading difference in degrees for the Starboard Gyro (Primary, SN 4370) and the Port Gyro (Secondary, SN 5356) were 0.05 and -0.05, respectively. The heading difference standard deviation in degrees for both gyrocompasses was 0.01. Based on these results,