Cover Sheet (NOAA Form 76-35A)

NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

Data Acquisition and Processing Report

Type of Survey HYDROGRAPHIC

Field No OPR-P182-KR-06

Registry No. H11517, H11518, H11519, H11520, H11521, H11522, H11523, H11524, H11525 and H11526

LOCALITY

State ALASKA

General Locality Southwestern Alaskan Peninsula

Sublocality N/A

2006

CHIEF OF PARTY

DEAN MOYLES

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DATE ....

U.S. GOV. PRINTING OFFICE: 1985—566-054

Title Sheet (NOAA Form 77-28)

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTER NO.
HYDROGRAPHIC TITLE SHEET	H11517, H11518, H11519, H11520, H11521, H11522, H11523, H11524, H11525 and H11526
INSTRUCTIONS – The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office	FIELD NO.

State ALASKA

General Locality Southwestern Alaskan Peninsula

Locality N/A

Scale 1:10000 & 1:20000 Date of Survey 06/02/06 – 07/26/06

Instructions dated February 3, 2006 Project No. OPR-P182-KR-06

Vessel R/V QUICKSILVER (947419) and R/V OCEAN PIONEER (557401)

Chief of party DEAN MOYLES

Surveyed by MOYLES, ORTHMANN, REYNOLDS, GILL, MOUNT, STOCK, FARLEY, ET AL

Soundings taken by echo sounder, hand lead, pole RESON 8101 (Hull Mounted) & 8111 (Hull Mounted)

Graphic record scaled by FUGRO PELAGOS, INC. PERSONNEL

Graphic record checked by FUGRO PELAGOS, INC. PERSONNEL

Protracted by N/A Automated plot by HP DESIGN JET 500

Verification by

Soundings in METERS at MLLW

REMARKS: The purpose of this work is to provide NOAA with modern and accurate hydrographic survey data for the areas in Southwestern Alaskan Peninsula that extends from Chiachi Islands to Lighthouse Rocks.

ALL TIMES ARE RECORDED IN UTC.

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A – Equipment

The R/V Quicksilver and the R/V Ocean Pioneer acquired all of the sounding data during the course of this project. The Quicksilver was utilized to collect multibeam data and sound velocity profiles in shallow to medium water depths while the Ocean Pioneer collected multibeam data and sound velocity profiles in medium to deep water depths. The equipment list and vessel descriptions are included in Appendices I and II.

SOUNDING EQUIPMENT

The R/V Quicksilver was equipped with a hull mounted Reson SeaBat 8101 multibeam system during the OPR-P182-KR-06 project. The Reson 8101 system operates at a frequency of 240 kHz, with 101 horizontal beams centered 1.5º apart (150º across-track beam width) and 1.5º along-track beam width. It transmits and receives a sonar signal to measure the relative water depth over the 150º swath. The range scale, gain, power level, and ping rates were a function of water depth and data quality. Any changes to these parameters were noted on the survey line logs (see Separate 1).

The line orientation for the Quicksilver was generally parallel to the coastline and bathymetric contours in the area. The line spacing depended on the water depth and data quality, but never exceeded two and a half times the water depth.

The R/V Ocean Pioneer was equipped with a hull mounted Reson SeaBat 8111 multibeam system during the OPR-P182-KR-06 project. The Reson 8111 system operates at a frequency of 100 kHz, with 101 horizontal beams centered 1.5º apart (150º across-track beam width) and 1.5º along-track beam width. It transmits and receives a sonar signal to measure the relative water depth over the 150º swath. The range scale, gain, power level, and ping rates were a function of water depth and data quality. Any changes to these parameters were noted on the survey line logs (see Separate 1).

The line orientation for the Ocean Pioneer was generally parallel to the bathymetric contours in the area. The line spacing depended on the water depth and data quality, but never exceeded three times the water depth.

A 25 ft skiff, referred to as the DP Skiff, was used to perform item investigations and shoreline verification. The skiff was equipped with a CSI GBX-PRO DGPS receiver, WinFrog v3.6.0 data acquisition system (operated on a Dell laptop), laser range finder and a Sony digital camera. NOAA nautical charts & LIDAR Smooth Sheets were displayed as a layer in WINFROG for reference. All soundings on submerged features were collected by the Quicksilver. The DP skiff was utilized to mark locations of exposed rocks. A West Marine Single Beam Echosounder was used to aid the hydrographer on the skiff in locating the shoalest point of targets near the surf zone or areas of limited visibility. No soundings from this system were used in the BASE surfaces.

Heights were taken on features awash or above the water level by visual estimation, using simultaneous comparison to a known reference (the vessel's bow).

SIDE SCAN SONAR

Towed Side Scan Sonar (SSS) operations were not required by this contract. Backscatter data from the Reson 8101 & 8111 multibeam systems was logged but used only to facilitate data cleaning.

POSITIONING EQUIPMENT

Each vessel was equipped with an Applanix Position and Orientation System for Marine Vessels (POS MV V4) to measure and calculate each position. Position was determined in real time using a Trimble Zephyr L1/L2 GPS antenna, which was connected to a Trimble BD950 L1/L2 GPS card residing in the POS MV. The POS MV was configured to accept differential corrections, which were output from a CSI MBX-3S Coast Guard beacon receiver and/or the Fugro Pelagos L1 base station. This unit also provided the position and velocity values to the POS MV's Inertial Measurement Unit (IMU). The inertial navigation system, implemented by the POS MV, computes a position by way of a complex form of dead reckoning using the GPS position, heading and motion of the IMU.

An MBX-S differential receiver that used the U.S. Coast Guard (USCG) network of differential beacons was the main source of RTCM (Radio Technical Commission for Maritime Services). It was also necessary to acquire dual frequency GPS data at known locations on the ground so that a Kinematic GPS (KGPS) solution could be used for final positioning. John Oswald & Associates LLC (JOA) established two local control points: station SITE 1 was located on the USCGS station MIT (UW0401) and station SITE 2, was located on a piece of pipe off of SITE 1. Refer to Appendix B of the OPR-P182-KR-06 "Horizontal and Vertical Control Report" for procedures and results.

The numerous real time displays of the POS MV controller software were monitored throughout the survey to ensure that the positional accuracies specified in the NOS Hydrographic Surveys Specifications and Deliverables (version June 2006) were achieved. These include, but are not limited to the following: GPS Status, Position Accuracy, Receiver Status (which included HDOP) and Satellite Status. During periods of high HDOP and/or low number of available satellites survey operations were suspended.

SOFTWARE

Acquisition

The primary data sets were collected with Triton Elics International's Isis Sonar V 7.0. Isis Sonar operated on an Athlon 2800 Dual Processor PC running Windows XP Pro and logged data in the XTF file format. The XTF files contain all multibeam bathymetry, position, attitude, heading and UTC time stamp data required by CARIS to process the soundings. Delph Map was utilized on the same computer to assist with real time QC of the acquired data.

The following display windows are available in Isis & Delph Map for operators to monitor data quality:

1. Parameter Display: The display window shows navigation, attitude and heading information. It gives the user the ability to switch files during data acquisition and also displays important information on ping counts and file sizes.
2. View 2-D and 3-D: The 2-D window displays the current multibeam profile. The 3-D window displays a 3-D mesh of the current line of profiles. The data in both windows have attitude data applied for quality control purposes.
3. Waterfall: The Waterfall displays backscatter data.
4. Graph Window: The user can display the sensor data in a graphical format, which aids in determining heave filter settings for the HDMS and POS MV.
5. Delph Map: Delph Map displays binned soundings in plan view or 3-D. The bin size is user defined and can be filtered by beam number and quality.

The Quicksilver and the Ocean Pioneer were both equipped with an additional computer running WinFrog (version 3.6.0).

WinFrog offers the following display windows for operators to monitor data quality:

1. Devices: The Devices window shows the operator which hardware is attached to the PC. It also allows the operator to configure the devices, determine whether they are functioning properly and view received data.
2. Graphic: The Graphic window shows navigation information in plan view. This includes vessel position, survey lines, background vector plots and raster charts.
3. Vehicle: The Vehicle window can be configured to show any tabular navigation information required. Typically, this window displays position, time, line name, heading, HDOP, speed over ground, distance to start of line, distance to end of line, and distance off line. Many other data items are selectable.
4. Calculation: The Calculation window is used to look at specific data items in tabular or graphical format. Operators look here to view the status of the GPS satellite constellation and position solutions.

In addition to monitoring position, attitude, and heading accuracies, the Applanix POS MV controller software was used to log raw POS MV data—consisting of the POSPac groups and group 3 (Primary GPS Data), 102 (Sensor 1 Data) and 111 (True Heave). These data were collected via the Ethernet to the Winfrog computer at an update rate of 50 Hz and later post-processed and applied in Caris HIPS.

MBSurvey Tools was used to aid in file administration and reporting during data acquisition. This program created a daily file that contained survey line, SVP and static draft logs. These logs were stored digitally thus eliminating the constant printing and manual input of items such as start and end of line times, Reson settings, etc. on each log sheet.

Processing

All Soundings were processed using CARIS (Computer Aided Resource Information System) HIPS (Hydrographic Information Processing System) 6.0.

CARIS Notebook 2.2 was utilized for conversion of shoreline data to CARIS HOB format, shoreline editing functions, and to generate the S57 Feature Files.

AutoDesk Map R 5.0 and ESRI ArcMap 9.1 were utilized for general survey planning, reviewing coverage plots, creating fill-in lines, tielines, etc.

ESRI ArcMap 9.1 with the Shoreline Correlator add-on was utilized for processing the additional item investigations DPs.

Applanix POSPac 4.3 was utilized for post-processing the dual frequency GPS data sets acquired by the survey vessels and the base stations. For every survey day and vessel, a new project was setup in POSPac. The software then extracted the POS data collected on the survey vessel into the POSPac project, separating it into component data sets such as IMU, primary GPS and secondary GPS.

Using POS GPS—part of the POSPac suite—dual frequency GPS data from the vessels and ground control base stations were converted from their native format (Novatel), to the POS GPS .gpb format. The KGPS data sets were then post-processed using the JOA antenna phase center positions given in Appendix II of the Horizontal and Vertical Control Report.

The POSPac module POSProc was then run to integrate the post-processed KGPS positions with the POSMV attitude data and refine the inertial solution. This final solution was exported to an SBET (Smoothed Best-Estimate of Trajectory) format file, which was then converted to text using an in-house converter program. The text files (.GDP format) were then imported and applied to the CARIS HDCS data using the CARIS Generic Data Parser routine.

Applanix POS Convert 1.4 was used to extract True Heave data from the raw POS data collected on the survey vessels. This text file was parsed to a format acceptable by the CARIS Generic Data Parser using MBSurvey Tools. This was only utilized on days where the GPS week rollover occurred; otherwise the True Heave was applied directly via the True Heave Import routine in CARIS.

A complete summary of the GPS post processing accuracy estimates can be found in Appendix III of the Horizontal and Vertical Control Report.

Sound Velocity Profiles

Sound velocity profile (SVP) data from the Applied Microsystems Ltd. (AML) Smart Probes were acquired using Windows' Hyper Terminal. MBSurvey Tools was used to split the profile into its up and down components, decimate the data and write a CARIS format that contained time and position. A complete list of software and versions used on this project is included in Appendix I. Refer to the "2006-NOAAProcessing Procedures" document for a detailed processing routine with procedures used.

B –Quality Control

With the implementation of the Combined Uncertainty Bathymetry Estimator (CUBE) in CARIS, a different approach is taken to analyze the data sets. In the vessel configuration file we now input or create an error model of our survey sensors that is used to calculate the Total Propagated Error (at the 95% Confidence Interval for the horizontal and vertical components) for each individual sounding collected during data acquisition. The values that were input in the CARIS HVF file for the survey sensors are the specified manufacturer accuracy values and can be downloaded from the CARIS website @ http://www.caris.com/tpe/. The following is a breakdown on the manufacturer and Fugro Pelagos derived values used in the error model (which are entered into the CARIS HVF and Fugro_CUBEParams.xml files):

- Navigation – In the CARIS HVF a value of 0.25m was entered for the Positional accuracy. Both vessels were equipped with an Applanix POS MV 320 and all raw positions were post-processed and the PPK solution was parsed back into the data set. The accuracies yielded from the PPK routine were usually less than ten centimeters.
- Gyro/Heading – As mentioned above the vessels were equipped with a POS MV 320 and had a baseline of about 3m, so therefore a value of 0.020 was entered in the HVF.
- Heave – The heave percentage of amplitude was set to 5% and the Heave was set to 0.05m, as per the manufacturer accuracy values.
- Pitch and Roll - As per the manufacturer accuracy values, both were set to 0.02 degrees.
- Precise Timing – All data was time stamped when it was created not when it was logged using a single clock/epoch. Position, attitude (including True Heave) and heading are all time stamped in the POS MV on the UTC epoch. This UTC string was also sent to the Reson processors and ISIS software via a serial string, thus yielding timing accuracies better then one millisecond.
- All vessel and sensor offsets were derive via conventional surveying techniques while the vessels were in dry dock. The results yielded a standard deviation of 0.025m.
- Tide values and Zoning were both set to 0.05m during TPE computing.
- Sound Speed Values were set to 1 m/s and 2.5 m/s for the Surface.
- MRU Align StdDev for the Gyro and Roll/Pitch were set to zero.

The calculated vertical and horizontal uncertainty or TPE values were then used to:

- filter the data to IHO order 1 specifications
- create a CUBE surface which used during subset cleaning stages
- create the final combined Bathymetric with Associated Statistical Error (BASE) surfaces.

The discussion that follows is an overview of our processing flow:

In order for the XTF files collected by ISIS to be used by CARIS, they must be converted to HDCS format using an XTF converter routine. Prior to the XTF files being converted using the XTF to HDCS function, vessel offsets, patch test calibration values, TPE values and static draft were entered into the vessel configuration file.

Once converted, the SVP, Dynamic Draft, True Heave, and KGPS data were loaded into each line and then SVP corrected in CARIS HIPS. Once SVP corrected the TPE was computed for each sounding in CARIS HIPS and the attitude, navigation and bathymetry data for individual lines were all examined for noise, as well as to ensure the completeness and correctness of the data set. Filter setting files used during processing of the Reson 8101 and 8111 lines were: TPE-60-01.hft and TPE-65-01.hft, which rejected beams outside IHO Order 1, beams greater than 60 and 65 degrees past nadir and all soundings with a quality flag other than 2 & 3 (a quality flag is assigned to each sounding by the multibeam system). Data quality determined which filter setting file was applied. Note: "Rejected" does not mean the sounding data point was deleted, but that it was flagged as being bad. Data flagged as rejected due to the angle from nadir parameters, did contain valid data, but the routine was conducted to flag noise and speed the processing flow. Valid data could have been reinserted into the data set during line and subset editing to fill data gaps. The filter settings used were noted on each corresponding line log (refer to Separate 1).

In high noise areas additional filters may have been applied to specific sections or entire lines. In these instances, the additional filters were noted on the line logs (refer to Separate 1).

After each individual line was examined and cleaned in CARIS HIPS the tide zone file was loaded and the lines merged. Combined Uncertainty Bathymetry Estimator (CUBE) surfaces were then created at varying resolutions depending on the depth range. For example:

- Depth Threshold: 0 to 17 meters resolution = 0.5m
- Depth Threshold: 15 to 33 meters resolution = 1m
- Depth Threshold: 30 to 65 meters resolution = 2m
- Depth Threshold: 60 to Max depth resolution = 5m

Subsets Tiles were then created in CARIS HIPS and adjacent lines of data were examined to identify tidal busts, sound velocity errors, and roll errors, as well as to reject any remaining noise in the data set that adversely affected the CUBE surface.

While examining the data in subset mode soundings were designated wherever the CUBE surface did not adequately depict the shoalest point of a feature. Soundings were designated when they met or exceeded the criteria for designation set forth in the Specifications and Deliverables (June 2006). Designation ensured they were carried through to the finalized BASE surfaces.

A statistical analysis of the sounding data was conducted via the CARIS Quality Control Report (QCR) routine. Tie lines were run in each sheet and were compared with lines acquired from the main-scheme lines where applicable. The Quality Control Reports are located in Separate 4.

Sounding data that passed the required quality assurance checks were used in the final BASE surfaces via CARIS HIPS. Due to the high volumes of data, some of the near shore sheets were sub-divided into smaller overlapping FieldSheets. For each of these FieldSheets a series of BASE surfaces (CUBE surface) were created at different resolutions (0.5m, 1m, 2m & 5m). These surfaces were then finalized in CARIS with the specified parameters in Sections 5.2.3 and 5.5.4 of the June 2006 Specs to produce the final surfaces. To ensure sufficient overlap between these surfaces the follow parameters were used:

- Depth Threshold: 0 to 17 meters resolution = 0.5m
- Depth Threshold: 15 to 33 meters resolution = 1m
- Depth Threshold: 30 to 65 meters resolution = 2m
- Depth Threshold: 60 to Max depth resolution = 5m

Note: It should be noted that these resolutions may vary on a sheet by sheet basis due to extreme slopes, but are noted in the Descriptive Reports.

For the final product a single FieldSheet that covered the entire sheet was created and the finalized surfaces for each resolution were combined. Refer to Fugro Pelagos Inc. Document titled “2006-NOAAProcessingProcedures”.

Features that were awash or above the waterline were manually tide corrected in Excel and imported in to CARIS Notebook, edited where necessary, and exported as S57 Feature Files.

In addition to traditional shoreline verification, item investigations were conducted on LIDAR objects that required further action in order to be proven or disproved. A 25 ft. skiff (owned and operated by Quicksilver Inc.), referred to as DP Skiff, was used to perform the shoreline verification and item investigations. The DP skiff could generally safely navigate in any area where it could maintain 1-2 meters of under-keel clearance, except in locations of heavy swells near shore. The skiff was equipped with a CSI GBX-PRO DGPS receiver, WinFrog v3.4.0 data acquisition system (operated on a Panasonic laptop), laser range finder and a Sony digital camera. The LIDAR Smooth Sheet data, RSD source data, and NOAA charts were displayed as a layer in WINFROG for reference. All soundings on submerged features were collected by the Quicksilver. The DP skiff was utilized to mark locations of exposed rocks. A West Marine Single Beam Echosounder was used to aid the hydrographer on the skiff in locating the shoalest point of targets near the surf zone or areas of limited visibility. Detached Positions (DPs) and their corresponding hydrographer’s remarks were digitally recorded in Winfrog and digital photographs were taken for features when feasible.

ArcMap v9.1 with the Shoreline Correlator add-on, written by the Fugro Pelagos Inc. GIS department, aided in the processing of the investigation results. The Correlator utilized the Winfrog Log files to create an individual DP form for all acquired DPs. The Correlator was mapped to the Winfrog log, tide, photos, NOAA Chart (largest scale available), LIDAR data, smooth sheet soundings and multibeam coverage files to calculate and display the desired information for each DP. Figure 1 shows an example of a DP form produced from the Correlator.

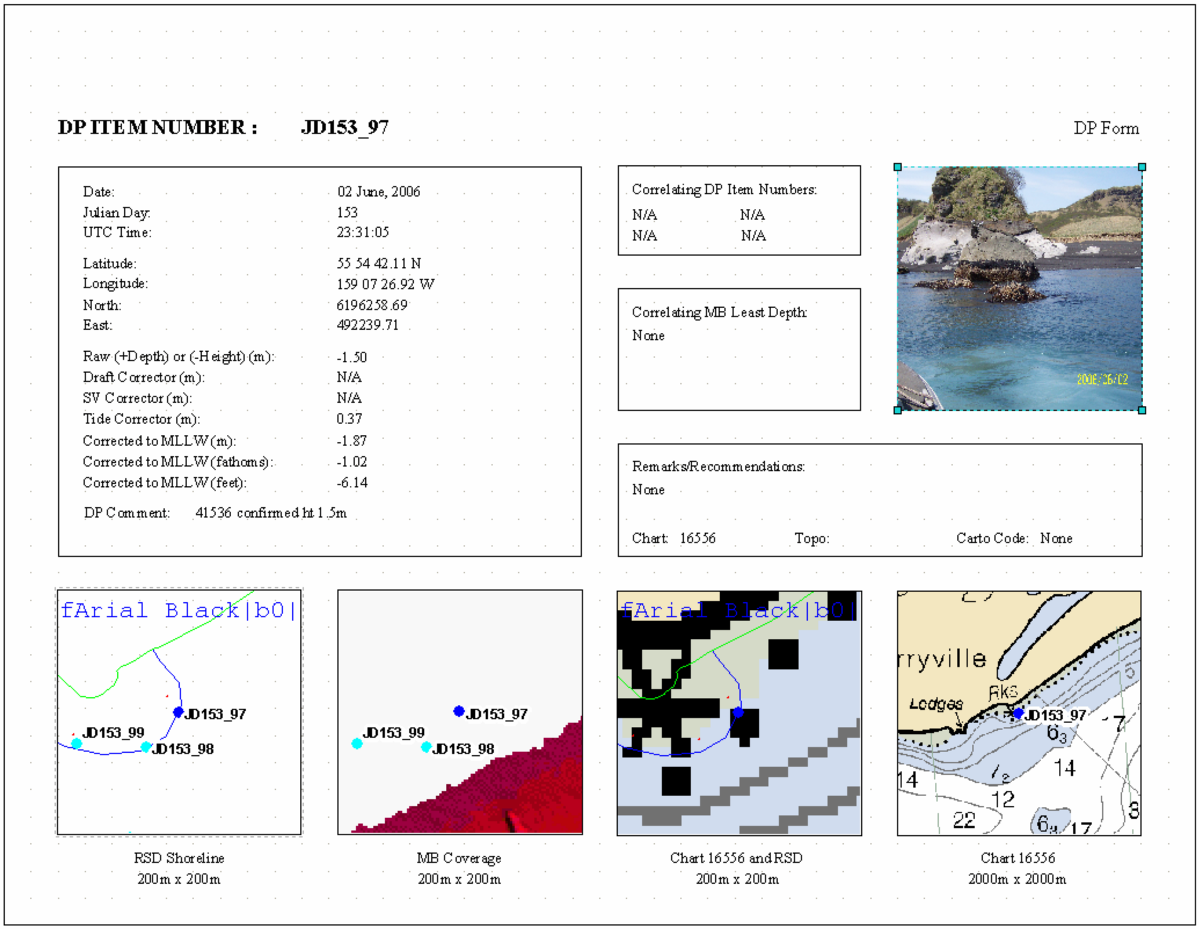


Figure 1 - DP Correlator Sheet

Features awash or above the waterline were manually tide corrected in Excel and then imported in to CARIS Notebook 2.2 (w/SP1) for editing where necessary. Notebook was also used to convert all shoreline and bottom sample data to CARIS HOB format and export to S57 format.

Event files in Winfrog LOG format containing the results from the DP skiff shoreline verification were taken in to Excel, corrected with verified tides, and exported to text file. They were then imported in to Notebook as point features using the object import utility and items were assigned the appropriate S57 object acronym and attributes.

Shape files provided by NOAA containing the RSD shoreline features were also imported using the object import utility as line features.

In Notebook, the combined data was reviewed and edited where necessary utilizing all available data, including multibeam coverage and raster charts. Changes to a sheet's source RSD Data were noted in the Descriptive Report for that sheet, as well as significant deviations or disapprovals of previously charted features. When complete an S57 Feature File was exported.

C - Corrections to Soundings

SOUND VELOCITY PROFILES

Sound velocity casts were performed nominally every two to three hours. The AML Smart Probes used to determine sound velocities for the surveys sampled at a rate of eight-velocity and pressure observation pairs a second. For each cast, the probes were held at the surface for two minutes to achieve temperature equilibrium. The probes were then lowered and raised slowly (no greater then 1 meter per second) to maintain equilibrium. Between casts, the sound velocity sensors were stored in a barrel of fresh water to minimize salt-water corrosion and to hold them at ambient water temperatures. Refer to Appendix III for Calibration Reports.

SETTLEMENT CURVE

The squat settlement test for the R/V Quicksilver was conducted outside Cushing Bay (Mitrofania Island), AK June 10, 2006 (Julian Day 161).

To perform the squat settlement test, the R/V Quicksilver logged dual frequency (L1/L2) data on the POS MV. The squat settlement tests were performed by first establishing a 500 meter line in the direction of the current. The survey vessel occupied the south end of the line for two minutes while logging L1/L2 GPS data. The line was then run heading north at an engine rate of 850 RPM and then south at 850 RPM, stopping at the south end of the line to obtain an additional two minutes of 'static' L1/L2 GPS data. Again, the survey vessel occupied the south end of the line and the scenario repeated at incrementing engine RPM's.

All measurements were corrected for heave, pitch, roll and reduced to the vessel's common reference point (CRP) and subsequently to the multibeam transducer. Static measurements observed at the end of lines were used to compute a tide curve for tidal corrections. A settlement curve for the Quicksilver, with the Reson 8101 installed, was then computed.

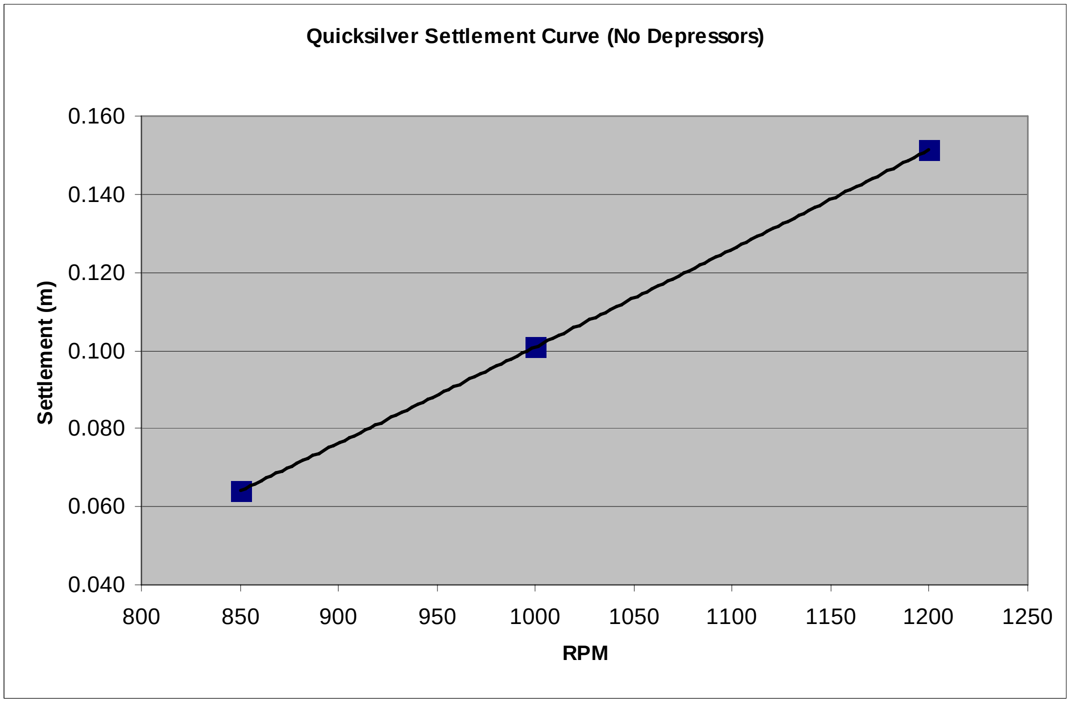


Figure 2 - R/V Quicksilver Settlement Curve (No Depressors)

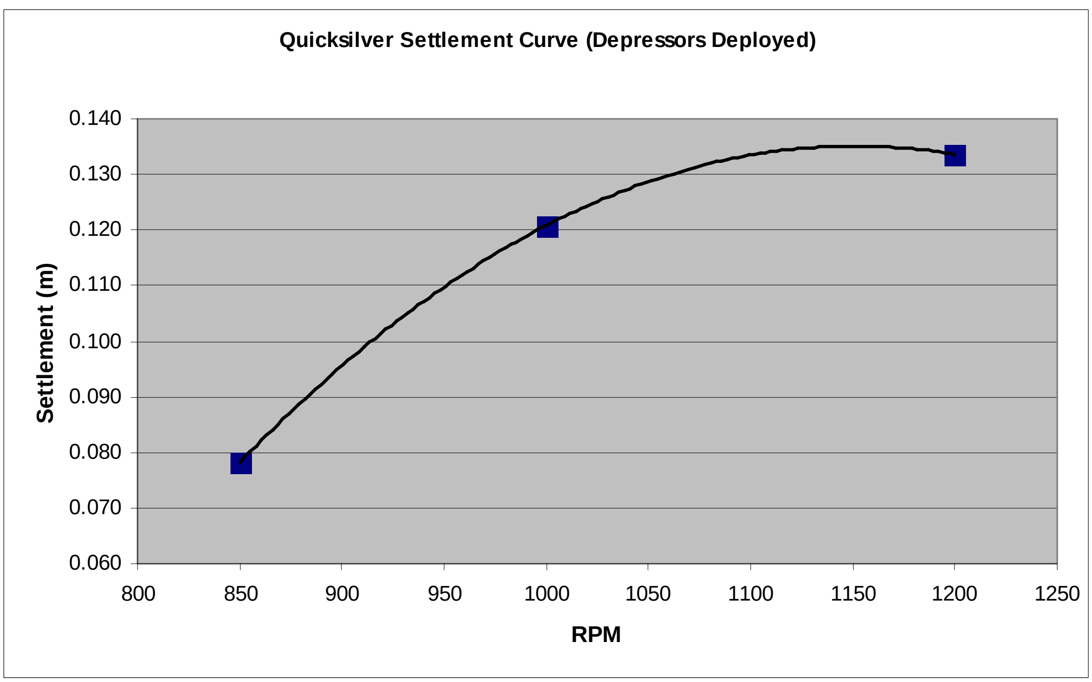


Figure 3 - R/V Quicksilver Settlement Curve (with Depressors Deployed)

The results of the squat settlement test for the Reson 8101 are shown below.

Table 1 - R/V Quicksilver Squat Settlement Results

QUICKSILVER-8101 CALCULATED SETTLEMENT		
RPM	DEPRESSORS UP	DEPRESSORS DOWN
850	0.06	0.08
1000	0.10	0.12
1200	0.15	0.13

Note: Vessel RPM and speed was noted on the survey line logs (refer to Separate 1). Corrections to soundings were loaded using the delta draft function in CARIS based on engine RPM. Speed was noted but not used for squat settlement corrections.

The squat settlement test for the R/V Ocean Pioneer was conducted outside Cushing Bay (Mitrofania Island), AK on July 12, 2006 (Julian Day 193).

To perform the squat settlement test, the R/V Ocean Pioneer logged dual frequency data on the POS MV. The squat settlement tests were performed by first establishing a 1000 meter line in the direction of the current. The survey vessel occupied the south end of the line for two minutes while logging L1/L2 GPS data. The line was then run heading north at an engine rate of 6 Kts (speed was measured using the GPS system) and then south at 6 Kts, stopping at the south end of the line to obtain an additional two minutes of ‘static’ L1/L2 GPS data. Again, the survey vessel occupied the south end of the line and the scenario repeated at incrementing engine speeds. Speed was measured by the GPS system.

All measurements were corrected for heave, pitch, roll and reduced to the vessel’s common reference point (CRP) and subsequently to the multibeam transducer. Static measurements observed at the end of lines were used to compute a tide curve for tidal corrections. A settlement curve for the Ocean Pioneer, with the Reson 8111 installed, was then computed.

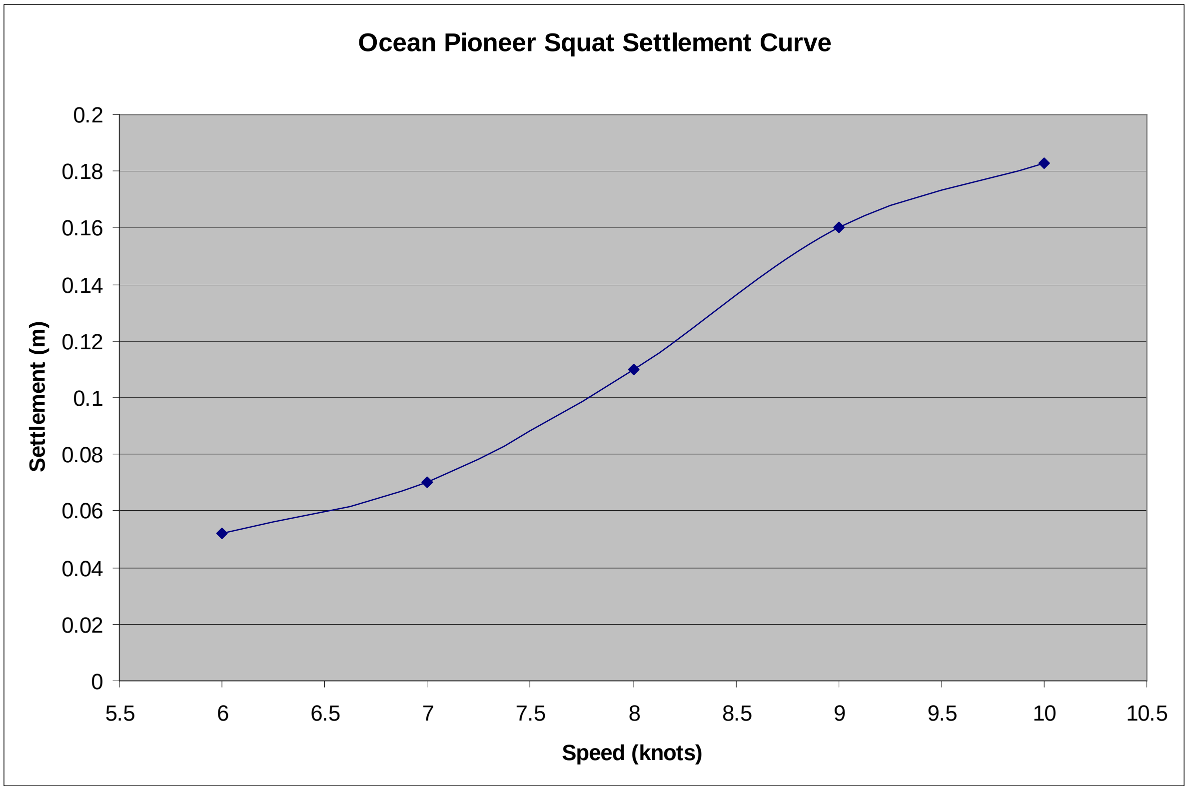


Figure 4 - R/V Ocean Pioneer Settlement Curve

The results of the squat settlement test for the Reson 8111 are shown below.

Table 2 - R/V Ocean Pioneer Squat Settlement Results

OCEAN PIONEER-8111 CALCULATED SETTLEMENT	
SPEED	
6.0	0.05
7.0	0.07
8.0	0.11
9.0	0.16
10.0	0.18

Note: Vessel speed was noted on the survey line logs (refer to Separate 1).

STATIC DRAFT

Static draft was measured from tabs on both sides of the vessels, the average was taken, and then the correction to the common reference point was applied. The table below shows the draft values for the R/V Quicksilver used in data processing.

Table 3 - Draft Measurements for the R/V Quicksilver (8101)

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)
2	153	6/2/2006	00:00	-0.42
3	154	6/3/2006	06:19	-0.48
4	154	6/3/2006	15:30	-0.46
5	155	6/4/2006	03:00	-0.46
6	155	6/4/2006	15:15	-0.43
7	156	6/5/2006	03:52	-0.40
8	156	6/5/2006	15:09	-0.42
9	157	6/6/2006	03:19	-0.41
10	157	6/6/2006	15:56	-0.46
11	158	6/7/2006	08:33	-0.46
12	158	6/7/2006	15:04	-0.44
13	159	6/8/2006	02:58	-0.43
14	159	6/8/2006	16:11	-0.43
15	161	6/10/2006	15:20	-0.42
16	162	6/11/2006	03:50	-0.45
17	162	6/11/2006	15:10	-0.45
18	163	6/12/2006	03:21	-0.42
19	163	6/12/2006	15:29	-0.43
20	164	6/13/2006	03:00	-0.44
21	164	6/13/2006	15:10	-0.45
22	165	6/14/2006	03:24	-0.47
23	165	6/14/2006	15:05	-0.44
24	166	6/15/2006	03:23	-0.43
25	166	6/15/2006	15:35	-0.43
26	167	6/16/2006	03:05	-0.40

The table below shows the draft values for the R/V Ocean Pioneer used in data processing.

Table 4 - Draft Measurements for the R/V Ocean Pioneer (8111)

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)	COMMENTS
1	153	6/2/2006	18:41	-2.27	Perryville
2	154	6/3/2006	16:49	-2.33	Perryville
3	155	6/4/2006	15:12	-2.39	Perryville
4	156	6/5/2006	15:29	-2.32	Perryville
5	157	6/6/2006	16:10	-2.38	Perryville
6	158	6/7/2006	15:25	-2.39	Perryville
7	159	6/8/2006	15:25	-2.36	Perryville
8	162	6/11/2006	15:00	-2.34	Perryville
9	163	6/12/2006	15:39	-2.37	Perryville
10	164	6/13/2006	15:18	-2.36	Perryville
11	165	6/14/2006	15:22	-2.37	Perryville
12	166	6/15/2006	15:03	-2.37	Perryville
13	167	6/16/2006	15:16	-2.38	Perryville
14	168	6/17/2006	15:00	-2.41	interpolated
15	169	6/18/2006	15:00	-2.44	interpolated
16	170	6/19/2006	15:00	-2.46	interpolated
17	171	6/20/2006	01:32	-2.49	Mitrofania Island
18	172	6/21/2006	18:14	-2.39	Choppy, Not used
19	174	6/23/2006	18:45	-2.30	AS in Chignik, Take on water
20	175	6/24/2006	15:00	-2.29	interpolated
21	176	6/25/2006	15:00	-2.28	interpolated
22	177	6/26/2006	15:00	-2.27	interpolated
23	178	6/27/2006	15:00	-2.26	interpolated
24	179	6/28/2006	15:00	-2.25	interpolated
25	181	6/30/2006	15:00	-2.24	interpolated
26	182	7/1/2006	15:00	-2.23	interpolated
27	183	7/2/2006	15:00	-2.22	interpolated
28	184	7/3/2006	15:00	-2.21	interpolated
29	185	7/4/2006	15:00	-2.20	interpolated
30	186	7/5/2006	15:00	-2.19	interpolated
31	187	7/6/2006	06:24	-2.18	Sosbee Bay
32	190	7/9/2006	22:39	-2.18	Along side in Chignik
33	191	7/10/2006	n/a	n/a	Take on fresh water, WOW
34	192	7/11/2006	n/a	n/a	WOW
35	193	7/12/2006	15:00	-2.23	Along side in Chignik
36	194	7/13/2006	2:00	-2.57	Sosbee Bay
37	196	7/15/2006	22:30	-2.55	J03-Calm

DRAFT #	JULIAN DAY	DATE (UTC)	TIME (UTC)	DEPTH (m)	COMMENTS
38	197	7/16/2006	22:30	-2.53	interpolated
39	198	7/17/2006	20:03	-2.51	Cushing Bay (after ballast)
40	199	7/18/2006	n/a	n/a	WOW
41	200	7/19/2006	n/a	n/a	WOW
42	201	7/20/2006	14:45	-2.46	Cushing Bay
48	207	7/26/2006	18:42	-2.44	Cushing Bay

Note that when long periods of offshore activity in rough weather prevented accurate static draft measurements, interpolated values were used for the time period between "good" measurements taken in calm water. All measurements met specifications.

TIDES

All sounding data were reduced to MLLW initially using unverified tidal data from one tide station located on Mitrofania Island, AK. Tidal data for a twenty-four hour period, UTC (Alaska Daylight Time to UTC was +8 hours), was assembled by JOA and emailed to the Ocean Pioneer at the end of every Julian Day. A cumulative file in a CARIS format was updated each day by appending the new data. Refer to the OPR-P182-KR-06 Horizontal and Vertical Control Report for any additional tidal information.

On September 9, 2006, JOA issued verified tidal data and final zoning for OPR-P182-KR-06. The tidal zoning was modified by JOA, providing a simpler zoning scheme from those issued in the Statement of Work (for additional information, refer to JOA's Final Technical Report). From September 20, 2006 to September 22, 2006 all sounding data were re-merged using CARIS HIPS and SIPS tide routine. Verified tidal data were used for the final Navigation Base Surfaces and S57 Feature files.

VESSEL ATTITUDE: HEADING, HEAVE, PITCH, AND ROLL

Vessel heading and dynamic motion were measured by the Applanix POS MV 320 V4.The system calculated heading by inversing between two Trimble GPS generated antenna positions. An accelerometer block (the IMU), which measured vessel attitude, was mounted directly over the multibeam transducer on each vessel. The operational accuracy specifications for this system, as documented by the manufacturer, are as follows:

Table 5 - POS MV Specifications

POS MV Accuracy	
Pitch and Roll	0.035°
Heading	0.05°
Heave	5% or 5-cm over 20 seconds

CALIBRATIONS

Multibeam

A patch test was conducted to identify alignment errors (timing, pitch, heading and roll) between the motion sensor and the multibeam transducer.

On June 5, 2006, while conducting near shore work the Quicksilver struck a submerged object. Review of the data on June 7, 2006 revealed a shift in sonar to IMU alignment parameters. An additional patch test was conducted that night to obtain new parameters. It was apparent that the new alignment parameters were static, and valid after 08:08 on June 5 (the time of the incident).

An additional patch test was also conducted for the Ocean Pioneer for quality control and testing purposes, but the derived values were not entered into the vessel configuration file, hence, not used in processing since they were in agreement. Patch test calibration values used to correct all soundings for the survey were as follows:

Table 6 - Patch Test Results for Quicksilver Reson 8101

Patch Test Results for Quicksilver Reson 8101 June 2nd, 2006 (2006-153)		
Test	**CARIS Session**	**Mean Correction**
Navigation Timing Error	n/a	0.00 seconds
Pitch Offset	Patch_153_Pitch	0.40°
Azimuth Offset	Patch_153_Yaw	1.30°
Roll Offset	Patch_153_Roll	-0.30°

Table 7 - Patch Test Results for Quicksilver Reson 8101

Patch Test Results for Quicksilver Reson 8101 June 5th, 2006 (2006-156)		
Test	**CARIS Session**	**Mean Correction**
Navigation Timing Error	Patch_156_Nav	0.00 seconds
Pitch Offset	Patch_156_Pitch	-0.20°
Azimuth Offset	Patch_156_Yaw	1.40°
Roll Offset	Patch_156_Roll	0.76°

Table 8- Patch Test Results for the Ocean Pioneer Reson 8111

Patch Test Results for Ocean Pioneer Reson 8111 June 2nd, 2006 (2006-153)		
Test	**CARIS Session**	**Mean Correction**
Navigation Timing Error	n/a	0.00 seconds
Pitch Offset	Patch_153_Pitch	0.20°
Azimuth Offset	Patch_153_Yaw	0.00°
Roll Offset	Patch_153_Roll	0.45°

Additional Sounding Techniques

The West Marine Single Beam Echosounder could not be accurately compensated for skiff motion. It was used primarily to aid the hydrographer on the skiff in locating the shoalest point of targets near the surf zone or areas of limited visibility. No soundings from this sounder were used in the BASE surfaces or the S57 Feature Files. Calibration of the sounder was conducted by comparison to leadline readings and Multibeam data from the R/V Quicksilver in flat areas in depths up to 3 fathoms.

Specifications of the West Marine Single Beam Echosounder are as follows:

Table 9 – MD100 Series Specifications

Depth Capability:	1 – 300 meters or 3 – 400 feet
Display Window Size:	4.4 X 4.4 X 1”
Operating Frequency:	200kHz
Transducer:	DST52 Depth Transducer
Power Input Range:	10-17 VDC

Hand lead lines are simple, accurate and are not subject to breakdown. It is however, awkward to use and inconvenient in bad weather. Additionally, it is difficult to determine if the sounding obtained was the shoalest point of the feature, if the feature cannot be visually seen.

The actual measurement tool utilized for this survey was not a traditional lead line with the standardized markings, but a strong cloth/vinyl tape measure on a winding reel. A round 3-pound lead ball was affixed to the end of the tape which was shortened so that the bottom of the ball was the zero point at touchdown. This was then checked and confirmed using a standard marked survey rod. Additional QC of the lead line measurements was conducted by comparison to actual swath bathymetry where applicable.

Note: All lead line measurements were recorded directly to the water line and corrected for tide.

D - Approval Sheet

Approval Sheet

For

H11517, H11518, H11519, H11520, H11521, H11522, H11523, H11524, H11525 & H11526

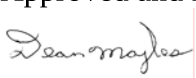
Standard field surveying and processing procedures were followed in producing this survey in accordance with the following documents:

> OPR-P182-KR-06 statement of work and hydrographic manual;
> Fugro Pelagos, Inc. Acquisition Procedures (2006- NOAAAcquisitionProcedures);
> Fugro Pelagos, Inc. Processing Procedures (2006-NOAAProcessingProcedures);
> Technical Report for Tides, 9459016 Mitrofania Report Complete 2006

The data were reviewed daily during acquisition and processing.

This report has been reviewed and approved. All records are forwarded for final review and processing to the Chief, Pacific Hydrographic Branch.

Approved and forwarded,



Dean Moyles,
Lead Hydrographer
Fugro Pelagos, Inc. Survey Party

Appendix I – Equipment List and Software Versions

Equipment

Table 10 - Equipment List

System	Manufacturer	Model	Serial No.
Multibeam Sounder	Reson	SeaBat 8101 Processor	12945
		SeaBat 8101 Transducer	1600001
		8101 Firmware Dry: 8010-2-07-2D4D	
		Wet: 8101-1-06-2F6B	
Multibeam Sounder	Reson	SeaBat 8111 Processor	23279
		SeaBat 8111 Transducer Array	Transmit/Receive
			0100050/0700016
		8111 Firmware Dry: 8111-2.07-996C Wet: 8111-1.00CA00	
POS MV	Applanix	Firmware: 3.22	2354
POS MV	Applanix	IMU	231
POS MV	Applanix	Firmware: 3.22	2161
POS MV	Applanix	IMU	78
POS MV	Applanix	Firmware: 3.22	2143
POS MV	Applanix	IMU	135
GPS Antenna	Trimble	L1/L2	12697293
GPS Antenna	Trimble	L1/L2	12561441
GPS Antenna	Trimble	L1/L2	12561441
GPS Antenna	Trimble	L1/L2	12561426
GPS Antenna	Trimble	L1/L2	60008160
GPS Antenna	Trimble	L1/L2	60001924
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4821-SV&P
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4820-SV&P
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4966-SV&P
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4431-SV&P
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4655-SV&P
Smart Sensor	Applied Microsystems Ltd.	Smart Sound Velocity and Pressure	4703-SV&P
RTCM	CSI Inc.	CSI MBX-3	9841-2496-0002
RTCM	CSI Inc.	CSI-MBX-3	9833-2166-0001
RTCM	CSI Inc.	CSI MBX-3	9932-4356-0001
RTCM	CSI Inc.	CSI-MBX-3	0042-7227-0001
RTCM	CSI Inc.	CSI MBX-3	9827-1866-0001
RTCM	CSI Inc.	CSI-MBX-3	9834-2211-0001
DGPS	CSI Inc.	GBX PRO	0031-6753-0001
L1 Base Station	Fugro Pelagos	Novatel OEM 4 L1 GPS Card	450017
L1 Base Station	Fugro Pelagos	Novatel L1 GPS Antenna	16175
Telemetry Radio	Teledesign	TS4000	012130
Telemetry Radio	Teledesign	TS4000	012144
Telemetry Radio	Teledesign	TS4000	012160
Telemetry Radio	Teledesign	TS4000	012184
Digital Camera	Kodak	Kodak	CX6445
Laptop	Dell	Latitude	03J010-12961-24R-7366
Single Beam	West Marine	MD100	6-1-D-02-0399
Control Station	Novatel	DL-4	NYB05140001
Control Station	Novatel	DL-4	NYB05140009
Control Station	Novatel	DL-4	NYB06140004

System	Manufacturer	Model	Serial No.
Automatic Level	Omni	PM3624	K10788

Software

Triton Isis V 7.0.413.9
Delph Map V 3.1.413.9
Winfrog V 3.6.0
CARIS Hips/Sips V 6.0 (w/ Service Pack 2, Hotfix 1-6)
CARIS GIS V 4.4a (w/ Service Pack 5, Hotfix 1-19)
CARIS Notebook V 2.2 (w/ Service Pack 1)
MapInfo Professional V 5.0
AutoDesk Map R 5.0
Fugro MBSurvey Tools V1.0
Fugro File Convert V 1.0
Fugro Correlator for ArcMap V 1.0
ESRI Arc Map V 9.1
Applanix POS MV V4 Controller V 3.3.1.0
Applanix POSConv v1.4
Applanix POSPac 4.3

Appendix II – Vessel Descriptions

R/V Quicksilver

The R/V Quicksilver (Figure 5) was modified to accommodate a survey crew and acquisition hardware. The keel was cut just aft of mid-ship and a Reson 8101 multibeam sonar was installed. A conical cowling protected the sonar head forward and aft by a crescent shaped skid (Figure 6). The accelerometer package for a POS MV was mounted in the hull of the vessel just over the 8101 multibeam transducer head.

Two Trimble L1/L2 antennas were mounted above the 8101 and accelerometer for positioning and heading (Figure 7). The two POS MV antennas were offset 0.6m either side of the central antenna. The port side antenna (L1/L2) functioned as the POS MV master antenna; the starboard side antenna functioned as the POS MV secondary.

The AML Smart Probe SV&P sensors and the CTD were deployed from an A-Frame on the stern using a small hydraulic winch.

The Quicksilver was fitted with depressors. These devices are simply weighted, bird shaped pieces of steel that hang in the water on either side of the vessel. The depressors' primary function was to reduce vessel roll. The Quicksilver was operated with the depressors deployed or stowed depending on weather conditions. The status of the depressors was noted on all survey line logs, and appropriate corrections made for dynamic draft in CARIS.

Offset values were derived from a total station survey and applied to the data in CARIS HIPS as specified in the HIPS vessel file (HVF). Vessel offsets used are shown in the following table. Note that the HVF does not contain navigation offsets because the position provided by the POS MV is already corrected to the CRP.

Table 11 - Vessel Offsets (Quicksilver)

Quicksilver Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POS MV	0.000	0.00	0.00
CRP	Reson 8101 Transducer	0.009	-0.195	0.617
CRP	GPS1 – Master Antenna	-0.543	-0.028	-4.744
CRP	GPS3 – Slave Antenna	0.669	0.002	-4.733
CRP	Draft Measuring Point, Port	-2.306	0.247	-1.863
CRP	Draft Measuring Point, Starboard	2.316	0.247	-1.812

Note: All units are meters.
CRP is the top-center of the IMU.
Axis used: X positive toward Starboard
Y positive toward Bow
Z positive in to the water

Table 12 - Vessel Specifications (Quicksilver)

Survey Launch	R/V Quicksilver
Official Number	947419
Owner	Marcus Ballweber
Year Built	1989
Length	32 ft
Beam	15.5 ft
Draft	3 ft
Gross Ton	28
Net Ton	15
Mechanical Power	860 hp
Electrical	5kW

Figure 5 - R/V Quicksilver

Figure 6 - Hull Mounted Reson 8101 (Quicksilver)

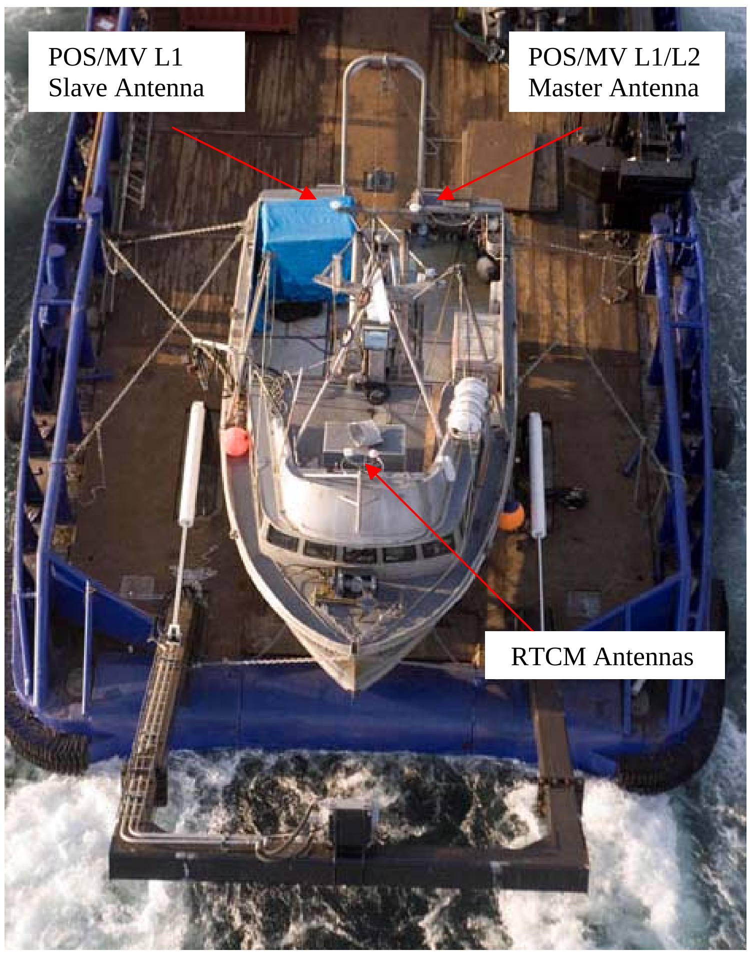


Figure 7 - Differential and POS MV Antennas (Quicksilver)

R/V Ocean Pioneer

The R/V Ocean Pioneer (Figure 8) accommodated a survey crew, acquisition hardware and processing equipment. The Reson 8111 multibeam sonar was installed just aft of mid-ship in a false keel (figure 9), and protected forward and aft by a conical cowling. The accelerometer package for a POS MV was mounted on the lower deck of the vessel just above the 8111 multibeam transducer head.

Two Trimble L1/L2 GPS antennas were mounted on arms extending from the ships mast for positioning and heading. The two POS MV antennas were separated 2.8m port and starboard. The port antenna functioned as the POS MV master antenna; the starboard antenna functioned as the POS MV secondary.

The AML Smart Probe SV&P sensors and the CTD were deployed from a davit located mid-ship on the port side using a hydraulic winch.

Offset values were applied to the data in CARIS HDCS as specified in the HIPS vessel file (HVF). Vessel offsets used are shown in the following table. Note that the HVF does not contain navigation offsets because the position provided by the POS MV is already corrected to the CRP.

Table 13 - Vessel Offsets (Ocean Pioneer)

Ocean Pioneer Vessel Offsets				
From	**To**	**X**	**Y**	**Z**
CRP	IMU – POS MV	0.000	0.000	0.000
CRP	Reson - 8111 Transducer	-0.319	0.191	2.003
CRP	GPS 1 - Master Antenna	-1.572	18.020	14.138
CRP	GPS 3 - Slave Antenna	1.255	19.938	14.077
CRP	Draft Measuring Point, Port	-6.703	-2.350	5.274
CRP	Draft Measuring Point, Starboard	6.234	-2.087	5.178

Note: All units are meters.
CRP is the top-center of the IMU.
Axis used: X positive toward Starboard
Y positive toward Bow
Z positive in to the water

Table 14 - Vessel Specifications (Ocean Pioneer)

Survey Launch	Ocean Pioneer
Number	557401
Owner	Stabbert Maritime
Year Built	1974
Length	205 ft
Beam	40 ft
Draft	17 ft
Engines	(2) Alco 12-251 (5600 Hp)
Electrical Power	(2) 3406 CAT (212KW)

Figure 8 - R/V Ocean Pioneer

Figure 9 – Reson 8111 Mount

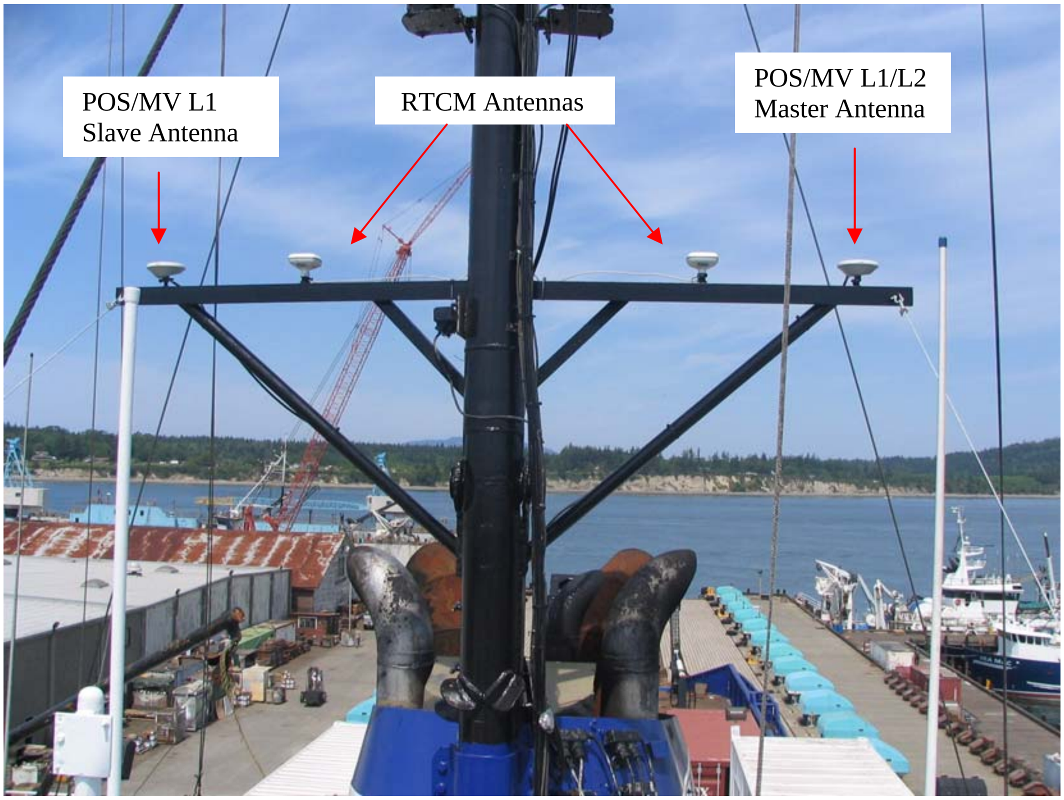


Figure 10 - POS MV & RTCM Antennas (Ocean Pioneer)

DP Skiff

The DP Skiff, was 25 ft in length and was equipped with a CSI GBX-PRO DGPS receiver, WinFrog v3.6.0 data acquisition system (operated on a Dell laptop), laser range finder and a Kodak digital camera. NOAA nautical charts & LIDAR Smooth Sheets were displayed as a layer in WINFROG for reference. The DP skiff was utilized to mark locations of exposed rocks. A West Marine Single Beam Echosounder was used to aid the hydrographer on the skiff in locating the shoalest point of targets near the surf zone or areas of limited visibility.

Figure 11 – DP Skiff

Appendix III – Calibration Reports

4431-BGR121767.pdf
4655-BGR600674.pdf
4703- BGR121840.pdf
4820-BGR121772.pdf
4821-BGR121773.pdf
4966-BGR602089.pdf