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

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey	**Hydrographic**
Project	**OPR-J977-DE-08**
Contract No	**DG133C-05-CQ-1078**
Task Order No	**T0005**
Time Frame	**April 2008 -August 2008**

LOCALITY

State	**Louisiana**
General Locality	**Gulf of Mexico**

2008

CHIEF OF PARTY

Jonathan L. Dasler, David Evans and Associates, Inc.

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DATE

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION	REGISTRY No
HYDROGRAPHIC TITLE SHEET	H11833 H11834 H11835 H11836
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 **David Evans and Associates, Inc.**

State Louisiana

General Locality Gulf of Mexico

Sub-Locality Southwest Pass to Blind Bay

Scale 1:10,000 **Date of Survey** April 15, 2008 to August 22, 2008

Instructions dated March 1, 2008 **Project No.** OPR-J977-DE-08

Vessel R/V Taku, R/V Chinook

Chief of party Jonathan L. Dasler, PE (OR) , PLS (OR,CA)

Surveyed by Jonathan Dasler, Jason Creech, Shyla Allen, Michael Hill

Soundings by echo sounder, hand lead, pole RESON 8101, Odom CV100, EdgeTech 4200-FS and Edge Tech 4200 HSL

Graphic record scaled by N/A

Graphic record checked by N/A **Automated Plot** N/A

Verification by

Soundings in Meters at MLLW

REMARKS: All times are UTC.

The purpose of this contract is to detect and map marine debris for the Gulf of Mexico Marine Debris Project and to provide NOAA with modern, accurate hydrographic survey data with which to update the nautical charts of the assigned area.

SUBCONSULTANTS: ZEPHYR MARINE, P.O. Box 1575, Petersberg, AK 99833

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NOAA FORM 77-28 SUPERSEDES FORM C&GS-537

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Acronyms and Abbreviations

AHB	Atlantic Hydrographic Branch
AML	Applied Microsystems, Ltd.
BAG	Bathymetric Attributed Grid
BIN	HYPACK Digital Echogram File
CO-OPS	Center for Operational Oceanographic Products and Services
CUBE	Combined Uncertainty and Bathymetry Estimator
DEA	David Evans and Associates, Inc.
DXF	Drawing Exchange Format
DGPS	Differential Global Positioning System
FEMA	Federal Emergency Management Agency
GOMMDP	Gulf of Mexico Marine Debris Project
GPS	Global Positioning System
HDCS	Hydrographic Data Cleaning System
HIPS	Hydrographic Information Processing System
HSX	HYPACK Hysweep File
HVF	HIPS Vessel File
IMU	Inertial Motion Unit
MBES	Multibeam Echosounder
MDB	Microsoft Access Database File
MLLW	Mean Lower Low Water
NATSUR	Nature of Surface
NATQUA	Nature of Surface Qualifying Terms
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
POS/MV	Position and Orientation System for Marine Vessels
PPS	Pulse per Second
RAW	HYPACK File
R/V	Research Vessel
RPM	Revolutions per Minute
RTK	Real-Time Kinematic
SBDARE	Seabed Area
SSS	Side Scan Sonar
SV	Sound Velocity
SVP	Sound Velocity Profile
TIF	Tagged Image Format
TPU	Total Propagated Uncertainty
UTC	Universal Time Coordinated
XTF	Extended Triton format file extension

OPR-J977-DE-08
Data Acquisition and Processing Report
Louisiana - Gulf of Mexico
April 15, 2008 – August 22, 2008
R/V Taku* and *R/V Chinook
David Evans and Associates, Inc.
Lead Hydrographers: Jonathan L. Dasler, Jason C. Creech

INTRODUCTION

This report applies to surveys H11833, H11834, H11835, and H11836 located in the Gulf of Mexico in the vicinity of the Mississippi River Delta, Louisiana. These surveys are part of the Gulf of Mexico Marine Debris Project (GOMMDP). The contract surveys were performed under OPR-J977-DE-08 as specified in the *Statement of Work* dated March 1, 2008. In general, survey methods meet or exceed requirements as defined in the National Ocean Service (NOS*) Hydrographic Surveys Specifications and Deliverables (April 2007).* Coverage requirements of 200% side scan sonar with concurrent single beam sonar were met with the following exception. In the vicinity of the entrance channel to Southwest Pass (H11833), 200% side scan coverage was not possible due to dredging operations, vessel traffic and other constraints. In this area 100% multibeam echosounder (MBES) data was collected in lieu of 200% side scan sonar data. This modification was approved by the contracting officer's technical representative (COTR). MBES data was acquired meeting object detection coverage requirements.

A. EQUIPMENT

David Evans and Associates, Inc. (DEA) employed the Research Vessel (*R/V*) *Taku* and *R/V Chinook* for data acquisition for this project. Data was acquired in accordance with National Oceanic and Atmospheric Association (NOAA) standards and modern remote sensing techniques.

Data processing took place at DEA's Marine Services office in Vancouver, WA. Instrumentation used to conduct the survey and redundant systems to provide confidence checks, consisted of the equipment listed in Tables 1 and 2.

Table 1. R/V Taku Hardware

Instrument	Manufacturer	Model	S/N	Function
Side scan				
	Edgetech	**4200**		100/400 kHz and 300/600 kHz Digital side scan sonar imagery with towfish heading and depth sensors.
Deck Unit		701-DL	35323	
		4200 FSL	33914	
		4200 HFL	37844	
Towfish		4200 FS	35482	
Single beam				
	Odom	**CV100**		200 kHz Single beam sonar with 9° beam angle.
Deck Unit		SMBB200-9	26003	
Transducer				
Multibeam				
	RESON	**8101**		240 kHz Shallow Water Multibeam sonar with 101 1.5° beams. Firmware 8101-2.09-E34D
Deck Unit	SeaBat 8101	Seabat 8101	16125	
Transducer		8101 ER	4603059	
Attitude and Position				
	Applanix	**POS MV 320 v4**		Integrated Differential Global Positioning System (DGPS) and inertial reference system for position, heading, heave, roll and pitch data
Deck Unit		PCS-29	22024	
IMU		LN200	477	
Port Antenna		Compact Zephyr	12572971	
Starboard Antenna		Compact Zephyr	12579381	
	Trimble	**ProBeacon**		Obtain differential corrections United States Coast Guard differential beacons.
Receiver		25785-00	220014495	
Antenna		24960-00	220014366	
	Trimble	**DSM132**		Secondary positioning system for Quality Assurance/Quality Control (QA/QC)
Receiver		33302-33	0224092892	
Antenna		33580-00	0220361419	
Sound Velocity				
	AML	**SV Plus V2**		Primary sound velocity profiler and unused spare.
Sensor		SV Plus V2	3591	
Sensor		SV Plus V2	3592	
Bottom Samples				
	Wildco	Standard Ponar Grab Sampler		
SSS Cable Payout Meter				
	Measurement Technology Northwest	**LCI-90**	350	Cable payout measurement for layback calculation

Table 2. R/V Chinook

Instrument	Manufacturer	Model	S/N	Function
Side scan				
	Edgetech	**4200**		100/400 kHz and 300/600 kHz Digital side scan sonar imagery with towfish heading and depth sensors.
Deck Unit		701-DL	35324	
Towfish		4200 HFL 4200 FSL 4200 FS	37844 33914 35482	
Single beam				
	Odom	**CV-100**		200 kHz Single beam sonar with 9° beam angle.
Deck Unit			26020	
Transducer		SMBB200-9		
Position				
	Trimble	**SPS750 MAX**		Modular GPS Receiver
Receiver		58904-66	4706K04156	
Antenna		55550-00	30403372	
	Trimble	**DSM132**		Secondary positioning system for Quality Assurance/Quality Control (QA/QC)
Receiver		33302-33	224093932	
Antenna		33580-00	220398290	
	CSI Wireless	**MBX-3S**		Obtain differential corrections United States Coast Guard differential beacons.
Receiver		801-3012-000 (MBX-3S)	0716-1600-0009	
Antenna		801-3003-06A (MGL-3)	0716-3582-0008	
Attitude				
	Trimble	**SPS550H**		Add-on Modular GPS Receiver. When combined with SPS750 precise heading from dual Global Positioning System (GPS) antennas can be output.
Receiver		58801-00	4716K50001	
Antenna		39105-00	60154234	
	TSS	**DMS05**	2220	Provides real-time heave, roll, and pitch.
Sound Velocity				
	AML	**SV Plus V2**		Primary sound velocity profiler and unused spare.
Sensor		SV Plus V2	3591	
Sensor		SV Plus V2	3592	
SSS Cable Payout Meter				
	Measurement Technology Northwest	**LCI-90**	553	Cable payout measurement for layback calculation

A1. Survey Vessels

A1.a R/V Taku and R/V Chinook

The research vessels *R/V Taku* (Figure 1) and *R/V Chinook* (Figure 2), owned and operated by Zephyr Marine, were the primary survey vessels for this project. Both vessels are 28-foot trailerable aluminum catamaran with a 10.5-foot beam and a draft of 2.0 feet. The vessels are equipped with twin 225 HP outboard motors, a 12-foot pilot house, a hull-mounted single beam transducer, stern mount A-frame, a side scan sonar bow mount for shallow water operations and data acquisition stations. This survey required specialized deployment of the side scan sonar from the bow of the vessels for sonar imaging in shallow water.

Figure 1. *R/V Taku*

Figure 2. *R/V Chinook*

A2. Side Scan Sonar Systems

Daily checks were performed to ensure the side scan sonar was working correctly. Confidence checks to confirm adequate target resolution at the outer limits of the selected range were conducted on a daily basis during acquisition and noted in the acquisition logs. Confidence checks were performed more frequently in deteriorating conditions to confirm detection of features at the outer range limits. An 1 m x 1 m x 1 m cube was deployed as a side scan sonar target at the beginning of the project and periodically throughout the survey to confirm that both sonars were able to detect the cube on the seafloor at all acquired ranges.

A2.a R/V Taku

Side scan sonar imagery was acquired with EdgeTech 4200-FS (100/400 kHz) in deep water and 4200-FSL (300/600 kHz) in shallow water, digital side scan sonars (Figure 3) running in high definition mode at either the 400 kHz or 600 kHz high frequency setting. The sonar was operated at 50-meter range scale on 80-meter *main scheme* lines for each 100% coverage. Imagery was logged on DEA's Triton Isis system in extended Triton format (XTF) (16 bit, 1024 pixels/channel) along with ancillary data including: towfish heading, pitch, roll and depth, ship position and computed towfish position from layback calculations. Side scan data was acquired with the towfish deployed from the bow or stern. A fixed layback distance was manually entered when the towfish was deployed from the bow. When deployed from the stern, layback was computed in the Isis system by using measured tow point offsets and either manual or digital input of cable out and towfish depth. An LCI-90 Cable Payout Meter was used to provide a continuous digital cable length of deployed side scan tow cable to the Isis system. Manual cable out entries were made when the towfish was in the close-to-stern tow configuration.

Figure 3. Edgetech 4200-FSL Side Scan Sonar

Figure 4. Edgetech 4200-FS Side Scan Sonar

A2.b R/V Chinook

Side scan sonar imagery was acquired with EdgeTech 4200-FS (100/400 kHz) and 4200-FSL dual frequency (300/600 kHz) in shallow water and a 4200-FS dual frequency (100/400 kHz) in deep water,) digital side scan sonars (Figure 4) running in high speed mode at either the 400 kHz or 600 kHz high frequency setting. The sonar was operated at 50-meter range scale on 80-meter *main scheme* lines for each 100%

coverage. Imagery was logged on DEA's Triton Isis system in XTF (16 bit, 1024 pixels/channel) along with ancillary data including: towfish heading, pitch, roll and depth, ship position and computed towfish position from layback calculations. Side scan data was acquired with the towfish deployed from the bow or stern. A fixed layback distance was manually entered when the towfish was deployed from the bow. When deployed from the stern layback was computed in the Isis system by using measured tow point offsets and either manual or digital input of cable out and towfish depth. An LCI-90 Cable Payout Meter was used to provide a continuous digital cable length of deployed side scan tow cable to the Isis system. Manual cable out entries were made when the towfish was in the close-to-stern tow configuration.

A3. Single Beam Systems

Draft checks were observed twice daily (beginning and end of day) to monitor vessel loading and fuel consumption. Weekly bar checks were performed to ensure that the sonars were functioning properly and static draft was accurately documented. Odom software was used to perform the test and the bar check was digitally recorded in HYPACK.

Both survey platforms were outfit with Odom single beam echosounders that were operated concurrently with side scan sonar during survey operations. All single beam data were logged in HYPACK (RAW) and HYPACK Digital Echogram (BIN) file formats.

A3.a R/V Taku

An Odom CV100 with a 9° transducer and 200 kHz operating frequency was deployed on the *R/V Chinook*. The transducer was hull-mounted amidships on the starboard sponson.

A3.b R/V Chinook

An Odom CV100 with a 9° transducer and 200 kHz operating frequency was deployed on the *R/V Chinook*. The transducer was hull-mounted amidships on the starboard sponson.

A4. Multibeam System

Weekly leadline checks were performed when utilizing the multibeam to ensure that the sonar was functioning properly and static draft was accurately documented. The leadline was constructed by attaching a mushroom anchor to a metric reel fiberglass tape enabling depths to be read to 5 mm.

A4.a R/V Taku

A Reson 8101 multibeam sonar was installed on the *R/V Taku* and used during item investigations of side scan sonar contacts. The multibeam echosounder was pole-mounted, which facilitated easy removal from the water when not in use to prevent damage to the sonar. The multibeam data were logged in XTF format on the Triton Isis acquisition system. The Reson 8101 series operates at 240 kHz producing a 150° swath of 101 uniform beams with a beam width of 1.5° x 1.5°.

A4.b R/V Chinook

No multibeam data were acquired from R/V Chinook.

A5. Position, Heading and Motion Reference System

A5.a R/V Taku

A position and orientation system for marine vessels (POS/MV), Applanix POS/MV 320 v4 integrated Differential Global Positioning System (DGPS) and inertial reference system was used to measure attitude, heading and position for the survey. The system was comprised of an inertial motion unit (IMU), dual GPS antennas, and a data processor. Position, heading, and motion data were output to Isis acquisition system using the real-time ethernet option at 25 Hz. Motion and position data were output to the HYPACK backup acquisition system over a serial connection with motion data output at 38,400 baud and 25 Hz; and position and heading at 9,600 baud and 1 Hz.

The POS/MV provided time synchronization of sonar instruments and logging computers using a combination of outputs from the POS/MV v4. The Reson processor and HYPACK logging computer were provided both a pulse per second (PPS) and a National Marine Electronics Association (NMEA) global positioning timing message (UTC) to achieve synchronization with the POS/MV. The EdgeTech 4200 side scan sonar deck unit was provided a NMEA ZDA message for time synchronization. The Isis logging computer synchronized its time using the proprietary Trimble Universal Time Coordinated (UTC) message provided by the POS/MV. All messages contain time strings and cause the clocks of the computers and sonars to synchronize to the time contained within the message. Time offsets between instruments and computers, relative to times contained in POS/MV network packets, are typically sub-millisecond.

A Trimble DSM132 was installed as a redundant, secondary positioning system.

A Trimble ProBeacon receiver provided U.S. Coast Guard beacon corrected differential GPS positions using English Turn, Louisiana (broadcast site ID 814 at 293 kHz) for both the primary and secondary positioning systems.

A weekly comparison between positions from the POS/MV and the DSM132 was observed and documented while the vessel was stationary in port. Logged position data was imported into Excel and a difference computed.

A5.b R/V Chinook

Three instruments were used to provide geographic positioning, heading and motion compensation for *R/V Chinook*; a Trimble SPS750 (primary position) combined with a Trimble SPS550 (heading) and a TSS DMS05 HPR (heave, pitch and roll) motion compensator.

A Trimble DSM132 was installed as a redundant, secondary positioning system.

A CSI MBX-3S provided U.S. Coast Guard beacon corrected differential GPS positions using English Turn, Louisiana (broadcast site ID 814 at 293 kHz).

The DMS05 HPR data was output, for logging in HYPACK, at 25 Hz and 38,400 baud. The instrument was configured in "Fully Aided" mode to minimize heave-settling times. This was accomplished using position and speed inputs from the Trimble SPS750 data stream and heading inputs from the Trimble 550H heading sensor. Typical heave settling times were measured as less than 20 seconds in the "Fully Aided" mode. Turns between survey lines were programmed to provide sufficient "run-in" time to allow the heave to settle prior to start of data logging.

Time synchronization of all data was accomplished by using Isis to set the data-logging PC clock to UTC via the NMEA data stream. HYPACK was configured to use the data-logging PC clock for data time tags. Since both applications were running on the same PC, all data were time correlated and logged using UTC times.

A weekly comparison between positions from the DSM132 and the SPS750 was observed and documented while the vessel was stationary in port. Logged position data were imported into Excel and a difference was computed.

A6. Sound Velocity Measurement System

The sensors had been calibrated prior to the start and at the end of the survey. Factory calibration results are included in the Separates II of the Descriptive Reports for the survey. The two probes were lowered together and compared weekly to verify optimum performance.

A6.a R/V Taku

An Applied Microsystems, Ltd. (AML) SV Plus V2 sound velocity sensor was used to take multiple daily sound speed readings during single beam and multibeam operations.

A6.b R/V Chinook

An AML SV Plus V2 sound velocity sensor was used to take multiple daily sound speed readings during single beam and multibeam operations.

A7. Acquisition Systems

The software and version numbers used throughout the survey are listed in Table 3 below.

Table 3. Acquisition and Processing Software

SOFTWARE				
	Company	**Program Name**	**Version**	**Date**
Acquisition				
	Triton Imaging, Inc	Isis	7.1.428.52	04/14/08
	HYPACK, Inc.	HYPACK /HYSWEEP	8.0.0.10	04/14/08
	EdgeTech	Discover	5.30	04/14/08
	Applanix	MV-POSView	3.4.0.0	04/14/08
	Trimble	ProBeacon	1991 DOS	04/14/08
	DEA	Digital LineLog	1.0.6	04/14/08
Processing				
	Caris	HIPS	6.1/SP1/ HF 7	04/14/08
	Caris	Notebook	3.0/HF 2	04/14/08
	Caris	Bathy DataBASE	2.1/HF 2	04/14/08
	Triton Imaging, Inc	Isis Sonar Office Suite	7.1.428.53	04/14/08
	HYPACK, Inc.	HYPACK Lite	8.0.0.10	04/14/08
	ESRI	ArcGIS	9.2	04/14/08
	DEA	SVP Convert	0.0.9	04/19/08
Other				
	Microsoft	Word	2003	
		Excel	2003	
		Access	2003	

Caris HIPS Hotfix and Service Pack upgrades were installed throughout the project as part of the routine software maintenance process. HIPS 6.1/Service Pack 2/Hotfix 1 was the version installed on all DEA workstations at the time this document was prepared.

A7.a R/V Taku

The acquisition stations installed and integrated on the *R/V Taku* by DEA consisted of a Triton Isis side scan and multibeam sonar data acquisition system and a HYPACK vessel navigation and single beam acquisition system (Table 3). During acquisition, data were logged locally on acquisition PCs and then transferred to the external USB drives at the end of each survey day.

A7.b R/V Chinook

The acquisition stations installed and integrated on the *R/V Chinook* by DEA consisted of a Triton Isis side scan and multibeam sonar data acquisition system and a HYPACK vessel navigation and single beam acquisition system (Table 3). During acquisition, data were logged locally on acquisition PCs and then transferred to the external USB drives at the end of each survey day.

A8. Survey Methodology

A8.a Mobilization

Mobilization, sensor installation, and calibration occurred from March 31, 2008 through April 14, 2008 in Red Pass, Louisiana. Surveys of *R/V Taku* and *R/V Chinook* were performed while the vessel was at the DEA's Portland office. A total station was used to survey the vessel's sensor mounting points and prominent structural features. Values from the survey were used to calculate sensor offsets and accuracies used in the Hydrographic Information Processing System Vessel File (HVF). Calibration tests were performed to allow adjustments such as transducer mounting offsets (pitch, roll, yaw), and navigation latency.

A8.b Survey Coverage

The Mississippi River Delta area (OPR-J977-DE-08) was surveyed with line orientations appropriate for each of the survey boundaries. The side scan sonars were operated at 50-meter range scale with a survey line spacing of 80 meters to attain each 100% side scan coverage and allow for a 10-meter offline tolerance. Single beam echosounder data was acquired concurrently with side scan sonar operations. Shallow water multibeam coverage was acquired with the *R/V Taku* over the most significant side scan sonar contacts in order to develop least depths for the features.

A8.c Side Scan Sonar Operations

The primary purpose of this survey was to detect and map marine debris for the GOMMDP. Side scan and single beam data were acquired concurrently from both the *R/V Taku* and the *R/V Chinook*. Preplanned HYPACK line files were created for each survey sheet at 80-meter spacing for each 100% coverage.

The vessels were staffed with a vessel operator and a senior hydrographer. The lead hydrographer rotated between the two vessels to assist in side scan bow deployments, oversee acquisition, and quality assurance. The hydrographer's tasks included: analyzing the digital sonogram, maintaining a digital acquisition log to document required accuracies were being obtained and track sonar contacts, daily confidence checks, and other survey activities. All acquisition occurred during daylight hours with the vessel leaving port in the morning and returning in the evening.

Side scan imagery was collected using the sonar's high frequency (400 or 600 kHz) setting in the high definition mode at a range of 50 meters for all main scheme data acquisition. At a 50-meter range scale using the high definition mode, the EdgeTech 4200 series has a ping rate of 15 Hz. In accordance with the NOS *Hydrographic Surveys Specifications and Deliverables* (*April 2007*), vessel speed was monitored to ensure 3 pings per meter to ensure detection of a 1 meter x 1 meter x 1 meter object on the seafloor. The survey vessel maintained a speed under 8.5 knots throughout the side scan survey, which allowed for a minimum of 3.4 pings per meter.

In addition, the operator monitored coverage displays and towfish height, attempting to maintain within 8% to 20 % of the range when not limited to the extremely shallow waters within the survey area. The minimum height was not always obtainable due to the shallow operating depths.

Retaining full 50-meter swath coverage when the altitude dropped below 4-meters (in-shore limit was the 4-foot depth curve) was approved by the NOAA COTR for this project. When weather or sea conditions degraded side scan sonar imagery, operations were suspended.

Data was transferred to DEA's Portland office where side scan sonar mosaics were created to illustrate completeness of coverage and any detected data holidays were filled by running additional survey lines. Least depths on the most significant contacts were acquired with shallow water multibeam. A discussion of new items can be found in the Descriptive Report for each survey.

A8.d Single Beam Sonar Operations

Single beam sonar operations occurred concurrently with side scan sonar acquisition. The sonar operator monitored the single beam echosounder digital echogram, which was displayed and logged on the Hypack acquisition computer. A traditional paper trace was not recorded during this survey as the full water column return was digitally recorded.

A8.e Multibeam Operations

Multibeam investigations occurred after 200% side scan coverage was achieved and a list of the most significant contacts requiring investigations was compiled. The list of contacts was compiled after examining parameters such as contact height, level of significance, depth of the contact, navigational significance, and potential of being marine debris. Contacts which were identified as pipelines elevated from the seafloor were not investigated with mulibeam sonar, but were submitted to the Atlantic Hydrographic Branch (AHB) and Navigation manager. Further discussion of contacts and multibeam development can be found in the Descriptive Report for each survey.

The multibeam sonar was pole mounted on the starboard side of the *R/V Taku* and operated at a recorded ping rate of 20 Hz during all data acquisition. The multibeam sonar was able to meet the object detection requirement of detection of a one meter cube in depths of 20 meters or less and detection of objects equal to five percent of depth in water deeper than 20 meters. Based on a sonar update rate of 20 Hz and an average vessel speed of 5.5 knots, the bottom coverage averaged 7.1 beam footprints per meter. The multibeam sonar was operated at different range scales throughout the survey by adjusting the depth range to obtain the best coverage in varying depths of water. Table 4 lists the typical sonar settings for the multibeam investigations.

Table 4. Reson 8101 Sonar Settings

8101 Parameter	Value
Range:	Variable, depth dependent
Gain:	Variable, depth and bottom type dependent
Power:	Variable, depth and bottom type dependent
Spreading	30 dB
Absorption:	70 dB/km
Ping Rate	20 p/s
Pulse Width:	Variable

A8.f Bottom Sampling

A total of 80 bottom sediment grab samples were obtained within the four surveys. The samples were collected across a 2,000-meter grid. Samples were obtained with a Ponar grab sampler, which collects a sample size up to 8.2 liters with a typical penetration depth of 3.5 inches. Position, depth, date, time, unique identifier, description and photograph were recorded for each sample. Each sample was described in accordance with IHO S-57 requirements for Seabed Area (SBDARE) features with attribution of COLOUR, Nature of Surface Qualifying terms (NATQUA), and Nature of Surface (NATSUR).

A9. Quality Assurance

All data were processed at DEA's Marine Services office in Vancouver, WA. Two days following acquisition a DEA hydrographer performed a review of the side scan sonar imagery, logging additional contacts if any were detected. A completed list of both online and post-survey review contacts was then compiled.

During item investigations the multibeam data were reviewed and processed to ensure optimal system performance and that a valid least depth was found for each item (Figure 5).

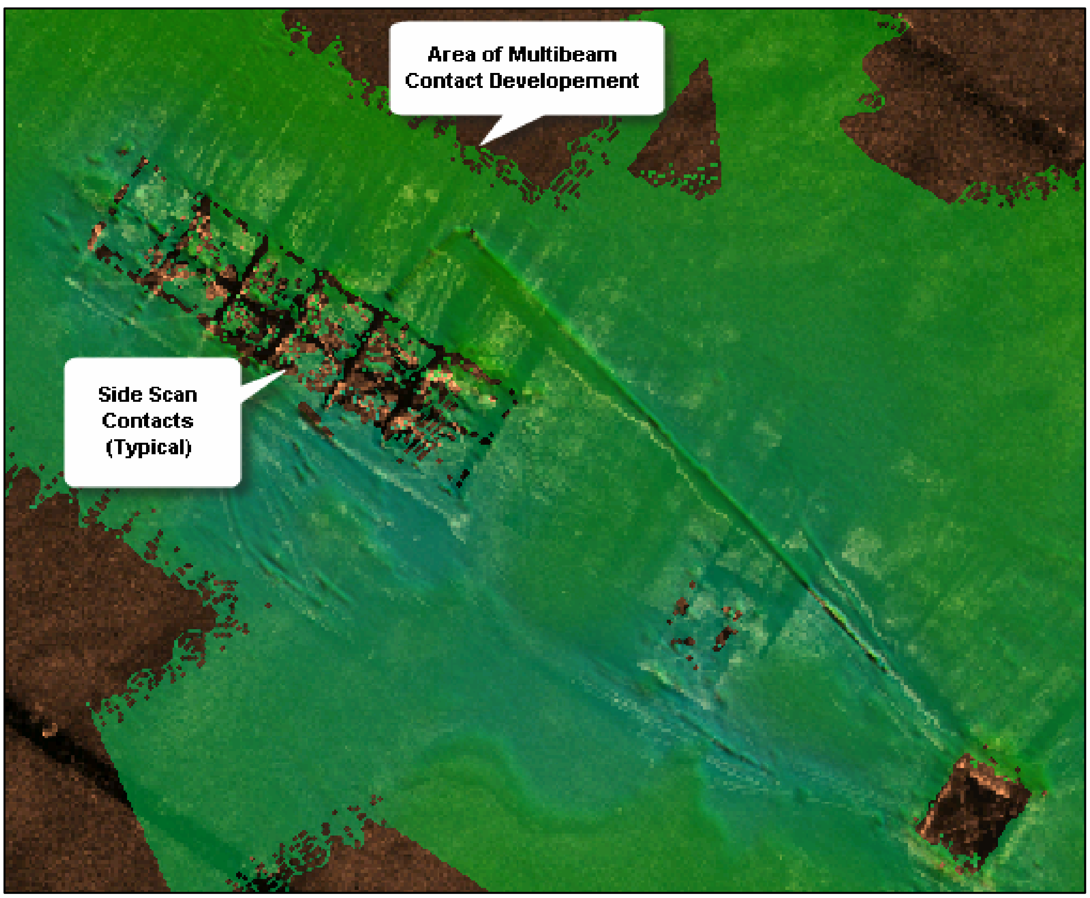

Figure 5. Graphic of side scan mosaic overlaid with contacts and multibeam swath coverage

B. QUALITY CONTROL

B1. Data Acquisition

B1.a Side Scan Sonar

Triton ISIS acquisition software was used to record side scan sonar data in XTF format. Adjustments to towfish height were made as necessary during data acquisition and logged in ISIS to ensure the best image quality. Layback values and changes were recorded in the daily acquisition log. Typical windows for monitoring raw sensor information included a waterfall display for the sonar imagery, graphs of vessel motions and a sonar signal voltage display. Data were displayed on a 30-inch LCD flat panel monitor mounted vertically at the acquisition station. The large format display allowed for increased time to analyze contacts prior to the display scrolling from view. Contacts were selected in real-time and during post-processing.

B1.b Single Beam *R/V Taku*

Odom CV100 single beam echosounder data were acquired on the *R/V Taku* throughout side scan sonar operations. All single beam data were recorded in HYPACK in “RAW” format. A digital echogram and sonar signal voltage were displayed in HYPACK and recorded in the HYPACK BIN format.

A draft correction of 0.5 meters was entered into the ODOM CV-100 echosounder and applied to the data during acquisition.

An incorrect Depth Index constant was applied during the first day of acquisition on the *R/V Taku*. This value accounts for the difference between the physical transducer face and the electronic phase center. A corrector value of 0.5 centimeters was applied during post-processing in CARIS as a “Z” value offset for the transducer in the HVF for day number 117.

B1.c Single Beam *R/V Chinook*

ODOM CV-100 single beam echosounder data were acquired on *R/V Chinook* throughout side scan sonar operations. All single beam data were recorded in HYPACK in “RAW” format. A digital echogram and sonar signal voltage were displayed in HYPACK and recorded in the HYPACK BIN format.

A draft correction of 0.5 meters was entered into the ODOM CV-100 echosounder and applied to the data during acquisition.

B1.d Multibeam

Multibeam echosounder data were only collected in order to develop side scan contacts deemed navigationally significant. During acquisition, data were monitored in real-time using the 2-D and 3-D data display windows in ISIS and the Reson SeaBat 8101. Typical windows for monitoring raw sensor information included a waterfall display for the sonar imagery, graphs of vessel motions, signal voltage display, and side scan. Vessel navigation was monitored with HYPACK. Raw soundings, attitude, heading and position data were recorded in ISIS XTF format and also in HYPACK Hysweep file (HSX) format, as a supplementary backup. Adjustments to the sonar, including changes in range and gain were made, as necessary, during acquisition to ensure the best bathymetric data quality. Additionally, vessel speed was adjusted in accordance with the NOS *Hydrographic Surveys Specifications and Deliverables (April 2007)* to ensure the required along track coverage.

B2. Methodology Used to Maintain Data Integrity

The acquisition system and survey protocols were designed with some redundancy to demonstrate that the required accuracy was being achieved during the survey and provide a backup to primary systems. Data integrity was monitored throughout the survey through system comparisons. Two positioning systems were used to provide real-time monitoring of position data. Position confidence checks, single beam bar checks, and mulitbeam bar checks were conducted weekly to confirm required accuracy was being maintained. Weekly checks of the sound speed instrumentation were conducted by deploying both profilers in tandem. Sound speed profiles were computed for each sensor and compared to confirm instrumentation was functioning within survey tolerances.

Contacts were classified as significant if their height was greater than one meter in deeper areas, greater than 0.5 meters in shallow or navigationally significant areas, or were observed as baring features. When possible towfish altitude was maintained at 8% to 20% of the range, but in many cases this standard could not be met due to the extremely shallow waters within the survey area. To aid the hydrographer a table listing slant range and towfish altitude for one meter contacts at 50-meter range scale was posted at the acquisition station.

In order to manage the high volume of side scan sonar contacts DEA created a custom database that would meet the debris project's weekly reporting requirements as well as meet the contract tracking requirements of the NOS *Hydrographic Surveys Specifications and Deliverables (April 2007)*. The database was maintained and stored in Microsoft Access using the Microsoft Access Database File (MDB) format. Contacts were added into the database on a daily basis with the import of contacts occurring upon completion of the side scan review and contact identification. The use of the MDB format allowed direct geographic display of contacts and spatial queries within ESRI ArcGIS where contacts were correlated and compared to the chart and other survey data. The database had an export feature, which created reports in the Federal Emergency Management Agency (FEMA) format, which were uploaded to the GOMMDP SharePoint on a sheet by sheet basis after internal review and vetting.

Flow diagrams of the single beam, shallow water multibeam, and side scan sonar data acquisition and processing pipelines are presented in Figures 6, 7 and 8, respectively. These diagrams graphically illustrate the data pipeline and processing workflow from acquisition to deliverable production.

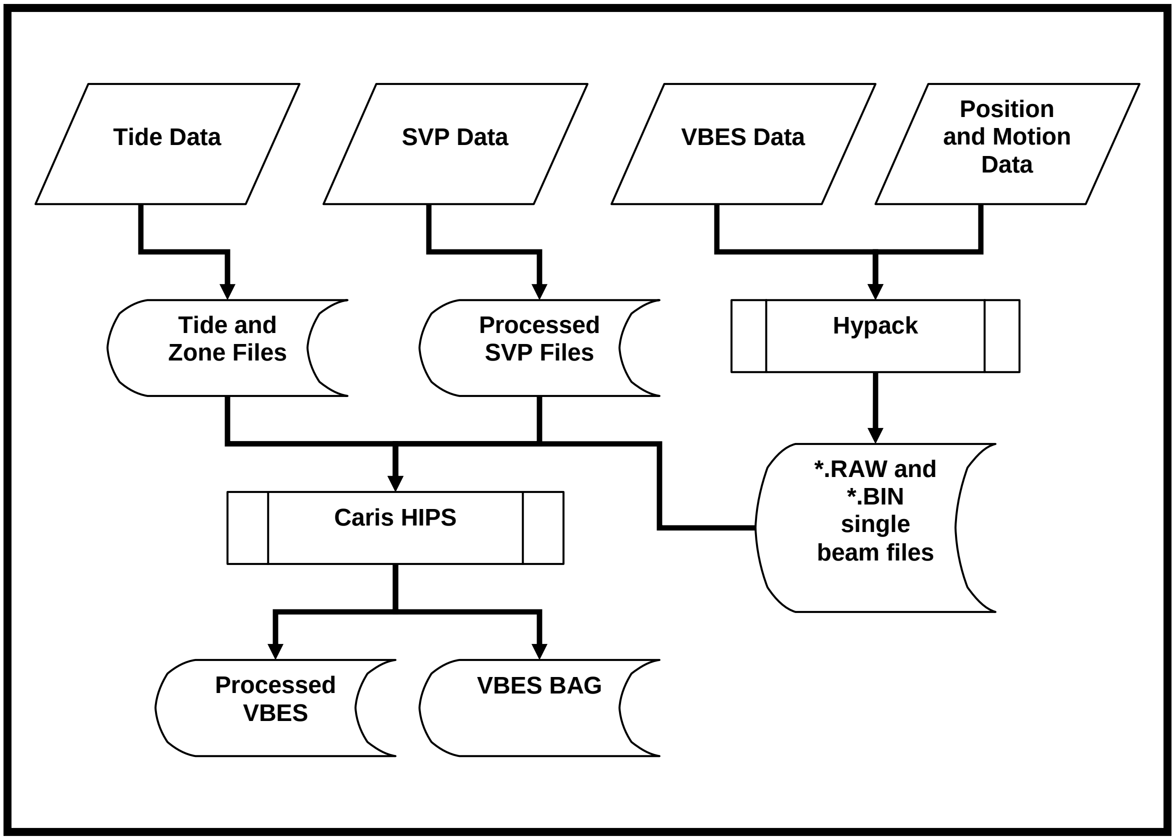

Figure 6. Flowchart of single beam data acquisition and processing pipeline.

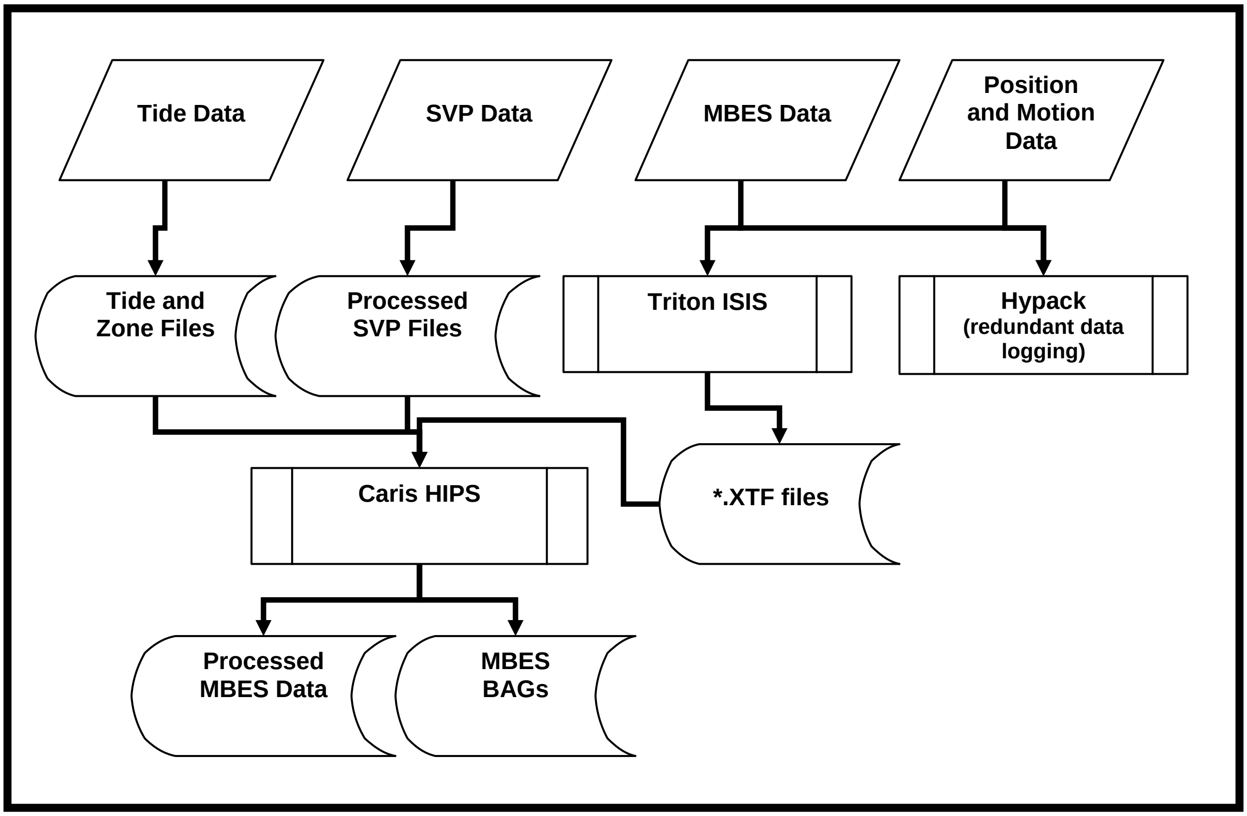

Figure 7. Flowchart of multibeam data acquisition and processing pipeline

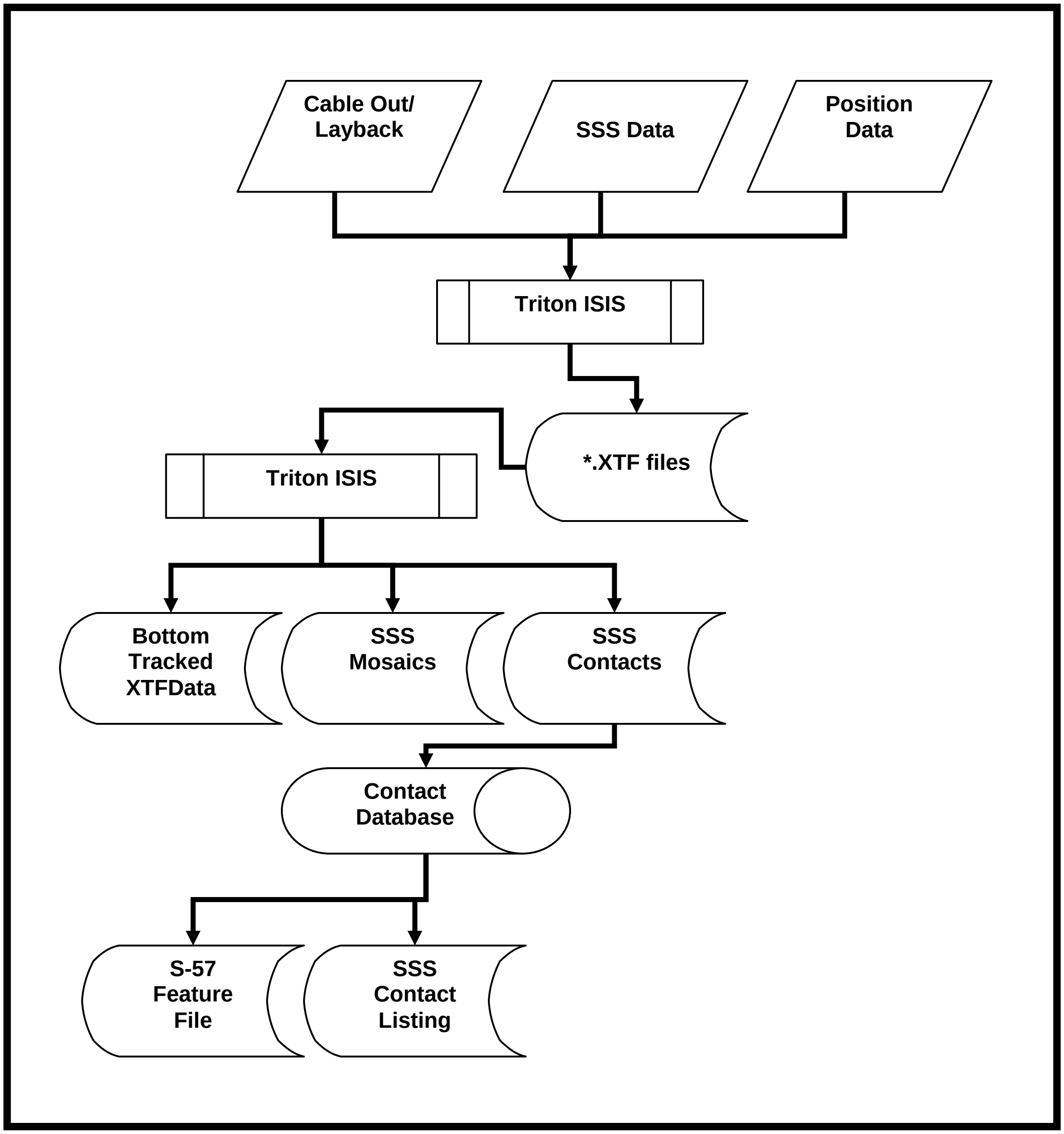

Figure 8. Flowchart of side scan sonar data acquisition and processing pipeline

At the end of each survey day, the data was copied from the vessel acquisition system to external hard-drives. The hard drives were taken to the field office where a back-up, on-site archive was made. Daily, except Sundays, a high capacity hard drive containing raw data was sent to DEA's Vancouver office. As a safeguard, DEA maintained at least three complete copies of the dataset during field operations.

B2.a HIPS Conversion

Multibeam data were converted from XTF format to CARIS Hydrographic Data Cleaning System (HDCS) format using HIPS conversion wizard (XTF converter 6.1.1.4 through 6.1.2.0) with the sensor navigation and ship gyro datagrams selected at conversion. No data were rejected based on quality flags during conversion. The CARIS output window was reviewed for failures during conversion.

Single beam data were converted from RAW format to CARIS HDCS format using HIPS conversion wizard (Hypack converter 6.1.1.0 through 6.1.2.0) with navigation from the primary navigation device (*R/V Chinook*: sensor 5, *R/V Taku*: sensor 4). No data were rejected based on quality flags during conversion. The CARIS output window was reviewed for failures during conversion.

Side scan sonar data were processed in Triton Isis.

B2.b Vessel Files

Three HVF's were created for the systems used during the survey with two additional HVF's created for importing side scan data into Caris SIPS, as listed in Table 5. The vessel file contains all offsets and system biases for the survey vessels and its systems, as well as, error estimates for latency, sensor offset measurements, attitude and navigation measurements and draft measurements. The side scan sonar vessel files were created to meet delivery requirements only and were not used during data processing.

Table 5. HIPS Vessel Files

HIPS Vessel File	Survey Vessel	Echosounder Used
J977-DE-08_MBES_Taku.hvf	*R/V Taku*	Reson 8101
J977-DE-08_SSS_Chinook.hvf	*R/V Chinook*	Edgetech 4200
J977-DE-08_SSS_Taku.hvf	*R/V Taku*	Edgetech 4200
J977-DE-08_VBES_Chinook.hvf	*R/V Chinook*	ODOM CV-100
J977-DE-08_VBES_Taku.hvf	*R/V Taku*	ODOM CV-100

Sensor offset values were calculated from the vessel surveys.

Draft (water line) was measured twice daily (start and end of operations), averaged and entered into the HVF as a correction for the applied water line value. Dynamic draft (settlement and squat) values were calculated through the use of Real-Time Kinematic (RTK) GPS observations.

Best estimates for total propagated uncertainty (TPU) values were entered into the vessel file based on current knowledge of the TPU Combined Uncertainty and Bathymetry Estimator (TPU/CUBE) processing model. Manufacturers' published values were entered into the sensor accuracy fields. Other values were either calculated or estimated. All other error estimates are read from the HVF and Device Model file. Table 6 represents HVF TPU values for each vessel.

Table 6. Hydrographic Vessel File TPU Values

Manufacture Accuracy Values for Total Propagation Uncertainty Computation
HIPS Vessel File (HVF)

All values given as 1 sigma

	TAKU		Chiook
VESSEL	TAKU	VESSEL	Chiook
Motion Sensor	POS/MV	Motion Sensor	TSS DMS05
POSITION SYSTEM	POS/MV Model 320 V3	POSITION SYSTEM	SPS750
Gyro/Heading		***Gyro/Heading***	
Gyro (deg)	0.02	Gyro (deg)	0.2
Heave		***Heave***	
Heave% Amp	5	Heave% Amp	5
Heave (m)	0.05	Heave (m)	0.05
Roll and Pitch		***Roll and Pitch***	
Roll (deg)	0.02	Roll (deg)	0.04
Pitch (deg)	0.02	Pitch (deg)	0.04
GPS Sensor		***GPS Sensor***	
Pos. Navigation (m)	0.7	Pos. Navigation (m)	0.34
Latency		***Latency***	
Timing Trans (s)	0.01	Timing Trans (s)	0.01
Nav Timing (s)	0.01	Nav Timing (s)	0.01
Gyro Timing (s)	0.01	Gyro Timing (s)	0.01
Heave Timing (s)	0.01	Heave Timing (s)	0.01
Pitch Timing (s)	0.01	Pitch Timing (s)	0.01
Roll Timing (s)	0.01	Roll Timing (s)	0.01
Measurement		***Measurement***	
Offset X (m)	0.003	Offset X (m)	0.003
Offset Y (m)	0.003	Offset Y (m)	0.003
Offset Z (m)	0.003	Offset Z (m)	0.003
Speed		***Speed***	
Vessel Speed (m/s)	0.03	Vessel Speed (m/s)	0.36
Draft and Loading		***Draft and Loading***	
Loading	0.03	Loading	0.033
Draft (m)	0.05	Draft (m)	0.016
DeltaDraft (m)	0.01	DeltaDraft (m)	0.03

Physical Alignment Errors

All values given as 1 sigma

	TAKU		Chinook
VESSEL	TAKU	VESSEL	Chinook
POSITION SYSTEM	POS/MV Model 320 V3	POSITION SYSTEM	SPS750
Alignment		***Alignment***	
MRU alignStdev gyro	0	MRU alignStdev gyro	0
MRU align roll/pitch	0	MRU align roll/pitch	0

Manufacture Accuracy Values for Total Propagation Uncertainty Computation in CARIS HIPS
Survey Specific Parameters (These values from Specifications and Deliverables)

All values given as 1 sigma

Tide Value	
Tide Value Measured	0.05
Tided Value Zoning	0.1
Sound Speed Values	
Sound Speed Measure	0.25
Surface Sound Speed	0.25

B2.c Static Draft

The static draft marks were surveyed as part of the vessel's frame of reference on the starboard side of each vessel directly abeam of the single beam and multibeam transducers. Draft readings were observed twice per day and the average draft was used for the day.

B2.d Sound Velocity

The individual sound velocity profiles were concatenated into CARIS SV format files, each representing one day of data collection. The individual day files were also concatenated into a single sheet CARIS SV format file. They were analyzed for errors or issues caused by sensor aeration then applied to the data sets. The sheet wide SV file was applied to the MB data using the "nearest in distance and time within 2 hours" option. The individual day SV files were applied to the SB data using the "nearest in distance and time within 4 hours" option.

B3. Preliminary Side Scan Processing

Side scan imagery was corrected for layback, slant range and speed as well as re-bottom tracked in ISIS. The data processor reviewed acquisition logs for contacts and performed a second review of side scan data. Using Triton Target Pro utility, the processor generated Isis targets for each contact. Contacts were designated as significant or insignificant based on shadow length. All contacts and processing comments were imported into the MDB, which was used to track and manage contacts for each survey. Any line that did not meet the quality criteria was rejected and re-acquired.

Once imported into the contact database least depths of the significant contacts were estimated using the tide corrected single beam depth collected at the time of contact acquisition and the contact height. Preliminary tides were used to reduce single beam depths and compute estimated least depth by subtracting contact height based on side scan image shadow analysis. The estimated least depth values were input into the "EST_LEAST_DEPTH" fields of the contact database and reported in the periodic GOMMDP submissions.

B4. Preliminary Bathymetric Processing

Single beam data were reviewed in CARIS and erroneous depths were rejected and sound velocity profiles and tides were applied.

Below is the list of correctors and filters applied to the bathymetric data in CARIS. Several of the steps are interim processes (such as the water levels) and were re-applied as needed. The TPE was re-computed for the multibeam data as needed to reflect changes in the correctors.

1. Apply zoned, water levels
2. Apply concatenated sound speed profiles for each day
   - "Nearest in distance and time within 2 hours (MBES) or 4 hours (VBES)"
3. Merge vessel offsets

4. Compute TPU
   - Tide Value Measured 0.05 m
   - Tide Value Zoning 0.10 m
   - Sound Speed Measured 0.25 m/s
   - Surface Sound Speed 0.25 m/s
5. Filters applied based on the following criteria:
   - Reject soundings with poor quality flags (0 for Reson)
   - Reject TPU greater than the horizontal and vertical error limits specified in the NOS *Hydrographic Surveys Specifications and Deliverables (April 2007)*.
   - Reject based on depth threshold (if needed)
6. "Designate" critical soundings and mark baring features as "Examined"
7. Side scan contacts overlaid on multibeam.
   - If the side scan contact was confirmed by the multibeam investigation, the multibeam least depth was marked as "Designated"
   - If the side scan contact was disproved by multibeam investigation, a sounding in the vicinity of the side scan contact was marked as "Examined" to signify review of investigation area.
8. Add data to field sheet
   - Two-meter "Uncertainty" weighted surface for single beam
   - 50-centimeter "CUBE" weighted surface for multibeam

Verified zoned tides were applied to the data prior to depth editing or CUBE creation. Tide data were compiled and applied to the survey data through the use of a HIPS zone definition file (ZDF) which was built for each survey. These file are included with the HIPS deliverables. Further discussion of tide gauges and zoning regimes can be found in each Descriptive Report for each survey as well as the *OPR-J977-DE-08 Horizontal and Vertical Control Report*.

All bathymetric data were reviewed in HIPS subset mode. Subset tiles were used to track the progress of processing activities. In addition, data processors reviewed sounding data and CUBE surfaces for motion artifacts or systematic biases. All crosslines were manually reviewed to ensure high internal consistency between the datasets.

Side scan mosaics and contacts were displayed in the background in HIPS and reviewed for multibeam coverage. In addition, contact least depths were queried in subset editor and entered into the contact database with additional multibeam information such as ping, beam and time. Designated soundings were also created for each contact least depths. Contacts over the same feature were correlated in the database by entering contact identification numbers of matching contacts into the "Correlate" field of the database. If the multibeam investigation resulted in the disproval of the side scan contact a sounding was selected in the vicinity of the side scan contact and flagged as "Examined". This designation serves two purposes; to mark the processing of an investigation as complete and to simplify later quality review of each investigation.

In areas of multibeam and single beam overlap, data were reviewed together in HIPS subset mode to ensure that data visually fit together and no systematic biases or artifacts were induced into the data.

B5. Final Side Scan Processing

Final review and editing of the side scan data were performed in DEA's Vancouver office using Triton Isis and Delphmap software. The data processor performed an additional review of all imagery for contacts (third review), created Tagged Image Format (TIF) images of all contacts and generated 100% and 200% side scan mosaics at 50-centimeter resolution. During mosaic creation in Delphmap, each 100% coverage was broken into several sections to facilitate reprocessing a mosaic if necessary without having to generate a new mosaic for the entire sheet. Each of the TIF images were merged using Lizardtech GeoExpress 6.1. A single TIF image per 100% coverage was created for submittal.

Side scan images were imported into ESRI ArcView and reviewed for data gaps and holidays and for problematic data that would warrant reprocessing the data or resurvey of an area. After review of the mosaics, side scan sonar fill plans were generated and sent to the survey vessel.

B6. Final Bathymetric Processing

Upon the completion of editing multibeam data in HIPS, finalized CUBE surfaces were generated using the "greater of the two" option for the final uncertainty value. An uncertainty weighted grid was generated for the single beam data due to the sparse nature of single beam data. Depths and contours were generated from the surfaces and used for chart comparison purposes, but are not included with the deliverables. Bathymetric Attributed Grids (BAGs) for each CUBE surface were exported from HIPS for submittal.

Designated soundings and side scan contact on baring features were used as a starting point for S-57 feature creation. Designated soundings that were determined to be obstructions or wrecks were imported into the S-57 feature files and attributed. In addition, S-57 objects were created for all baring features such as oil production platforms and piles. In cases where a number of potential S-57 features resided in close proximity to one another only the most significant feature within 3mm at survey scale, 30 meters, was submitted. Significance was determined in the following order of importance; submerged feature, tallest baring feature. The most significant feature was then submitted as an S-57 feature with ancillary features residing within a 30 meter radius being noted in the INFORM field of the most significant feature. Many of the items included in the S-57 feature file have already been submitted as Dangers to Navigtion (DtoNs).

The feature file also includes bottom samples (SBDARE) and required meta-objects (M_COVR and M_QUAL).

C. CORRECTIONS TO ECHO SOUNDINGS

C1. Static Draft

With the vessel out of the water, markings were surveyed and painted on the hulls of the *R/V Taku* and *R/V Chinook* providing a means to monitor vessel draft. At the start of the project the approximate draft of the single beam transducer was 0.50 meters. This value was entered into the single beam sonar and used throughout the survey enabling the output of a depth relative to the approximate vessel waterline, therefore enabling quick review of depths at time of acquisition. Static draft readings were recorded at the start and end of each survey day, while the ship was alongside the pier and where an accurate draft reading could be obtained. The vessel's fuel and ballast levels were maintained to control the vessel draft and an average of the start and end of day draft values was calculated daily and entered into a draft tracking sheet. The average draft value best approximates the true draft value during acquisition, due to loading changes from fuel consumption during transit to and from the survey area at the start and end of each day. Ultimately the daily draft values were used to calculate the daily draft relative to the 0.50-meter value that was used during acquisition. These differences relative to the assumed 0.50-meter single beam draft were entered into the waterline field in the Caris HVF for that vessel.

C2. Dynamic Draft

C2.a R/V Taku

A settlement and squat test using RTK GPS observations for the *R/V Taku* was performed on April 21, 2008 (Day Numbers 112). Data from these measurements are displayed graphically in Figure 9.

The settlement and squat values were obtained by computing three-minute GPS height averages at different ship speeds, measured in knots and revolutions per minute (RPM) during transects. Each transect was run twice at each RPM interval with the second transect run at a heading, opposite of the first.

After running a series of 1000 RPM transects, ship speeds at increments of 200 RPMs were observed from 1,000 RPM to 3,000 RPM a with additional transects run at 4,000 RPM. GPS height recorded at 1 Hz. With the vessel at rest, static RTK height observations were recorded between each RPM interval in order to have a baseline GPS height value not affected by tide changes during the test. Three-minute running averages of GPS height were calculated to remove any heave bias from the calculations. Each transect was run for approximately three minutes resulting in one average GPS height measurement per transect. Dynamic draft correctors were then calculated from the difference between the GPS height and an interpolated static GPS height (to account for changing tide) at the time of the average height value. The average speed for each RPM interval and the average dynamic draft corrector were entered into the HIPS vessel file.

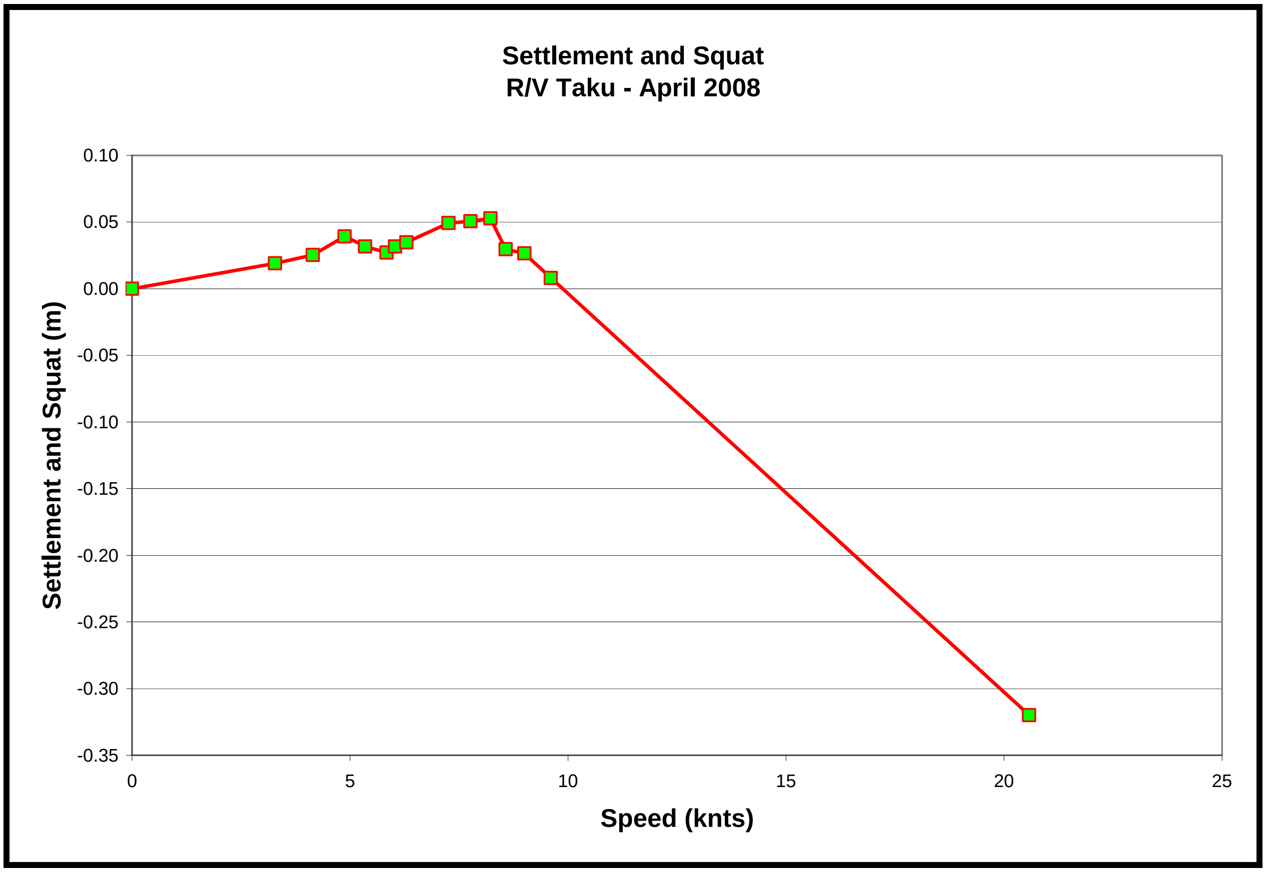

Figure 9. Settlement and squat of *R/V Taku*

C2.b R/V Chinook

A settlement and squat test using RTK GPS observations for the *R/V Chinook* was performed in the vicinity of the survey area on April 10, 2008 (Day Numbers 102). Data from these measurements are displayed graphically in Figure 10.

The settlement and squat values were obtained by computing three-minute GPS height averages at different ship speeds, measured in knots and RPM during transects. Each transect was run twice at each RPM interval with the second transect run at a heading, opposite of the first.

After running a series of 1000 RPM transects, ship speeds at increments of 200 RPMs were observed from 1,000 RPM to 3,000 RPM a with additional transects run at 4,000 RPM. GPS height recorded at 1 Hz. With the vessel at rest, static RTK height observations were recorded between each RPM interval in order to have a baseline GPS height value not affected by tide changes during the test. Three-minute running averages of GPS height were calculated to remove any heave bias from the calculations. Each transect was run for approximately three minutes resulting in one average GPS height measurement per transect. Dynamic draft correctors were then calculated from the difference between the GPS height and an interpolated static GPS height (to account for changing tide) at the time of the average height value. The average speed for each RPM interval and the average dynamic draft corrector were entered into the HIPS vessel file.

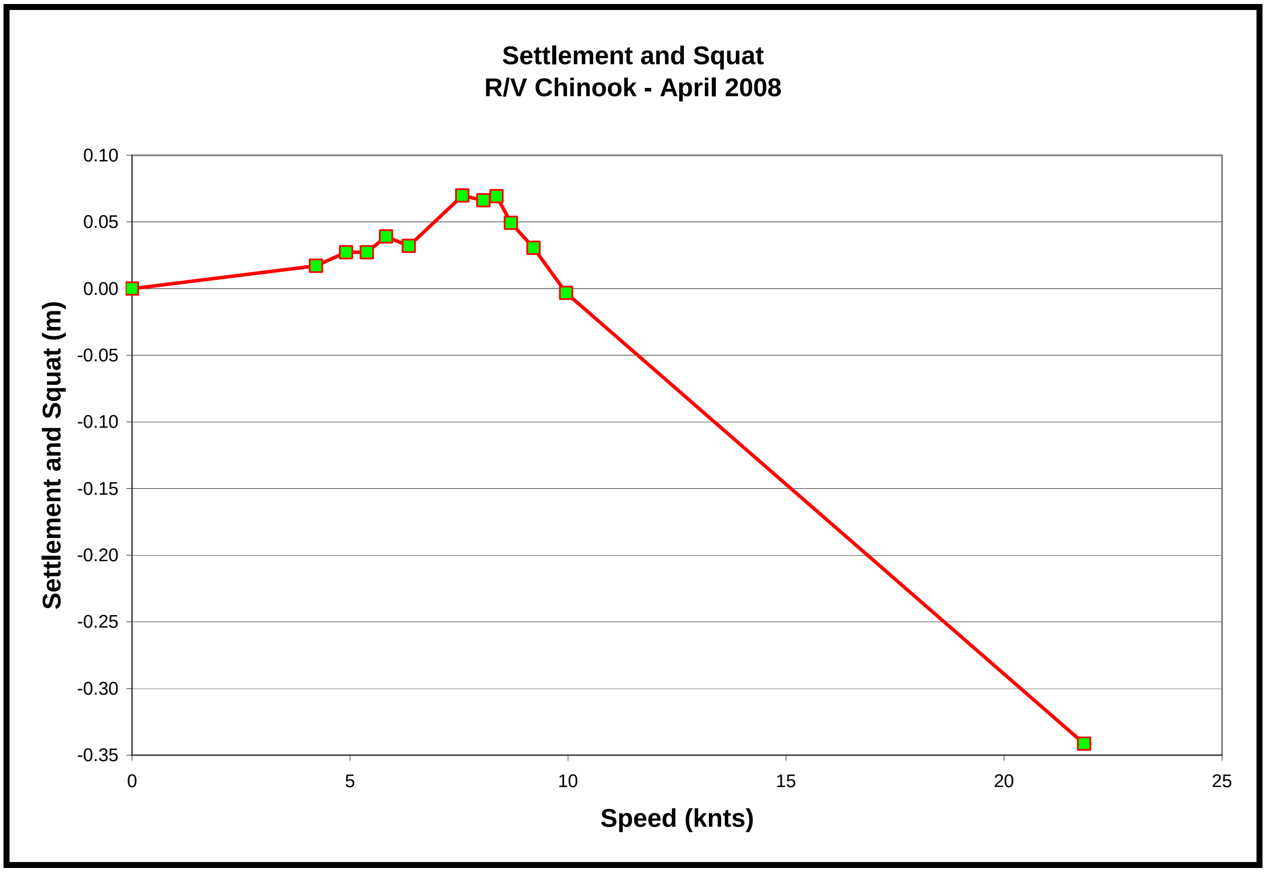

Figure 10. Settlement and squat of the *R/V Chinook*

C3. Bar Checks

Bar checks were performed for each sonar if they were used to acquire data anytime within a particular week. Tabulated leadline comparisons may be found in the *Bar Comparison* log included in Separate 1 *Acquisition and Processing Logs* of the Descriptive Reports.

A bar check was used to validate the single beam echosounders performance. While the vessels was alongside its berth in the marina, a bar check was recorded and compared to the depth output by the echosounder after adjusting it for the draft offset. The average difference between the bar check and single beam measurements for the *R/V Taku* was 0.000 meters with a standard deviation of 0.018 meters. The average difference between the bar check and single beam measurements for the *R/V Chinook* was -0.001 meters with a standard deviation of 0.014 meters.

In addition, bar checks were performed for the multibeam each week. An XTF file was logged as the bar check depth was read. The file was then loaded into HIPS and a depth was picked from the nadir beams. Bar check observations were recorded in the leadline comparison log. The average difference between leadline and multibeam was 0.020 meters with a standard deviation of 0.031 meters.

C4. Heave, Roll and Pitch Corrections

An Applanix POS/MV 320 v4 integrated DGPS and inertial reference system was used for the motion sensor aboard the *R/V Taku*. The POS/MV 320 is a six-degree of freedom motion unit, with a stated accuracy of 0.05 meters or 5% for heave, 0.02 degrees for roll and pitch and heading. Real-time displays of the vessel motion accuracy were monitored throughout the survey with the POS/MV controller program.

A TSS DMS-05 was used for HPR motion sensing aboard the *R/V Chinook*. The DMS-05 has a stated accuracy of 0.05 meters or 5% for heave and 0.04 degrees for pitch and roll. Heading was obtained using the Trimble SPS750(Max)/SPS550H GPS receiver combination which has an accuracy of 0.05 degrees RMS. Real-time displays of the vessel motion were monitored throughout the survey in Triton ISIS and HYPACK.

If any of the vessel motion accuracy degraded to greater than 0.05 degrees, survey operations would be suspended until the inertial unit was able to regain the higher degree of accuracy.

Manufacturer reported accuracies as published on the Caris HIPS TPE website (http://www.caris.com/tpe/) were entered into the HIPS HVF and used for TPE computations. A schematic of the vessel and sensor set-up is shown in Figures 11 and 12.

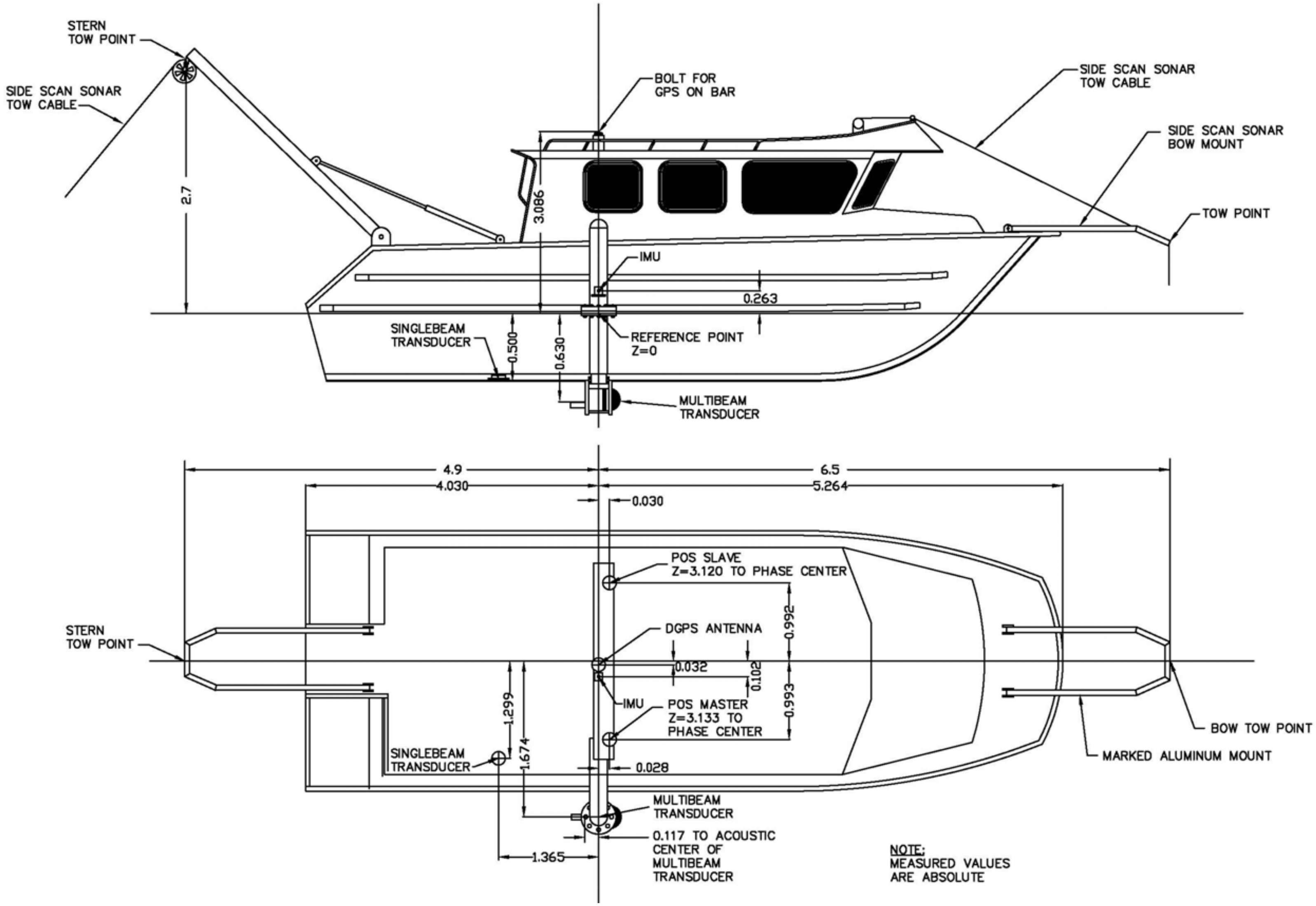

Figure 11. Schematic of *R/V Taku* and sensor setup

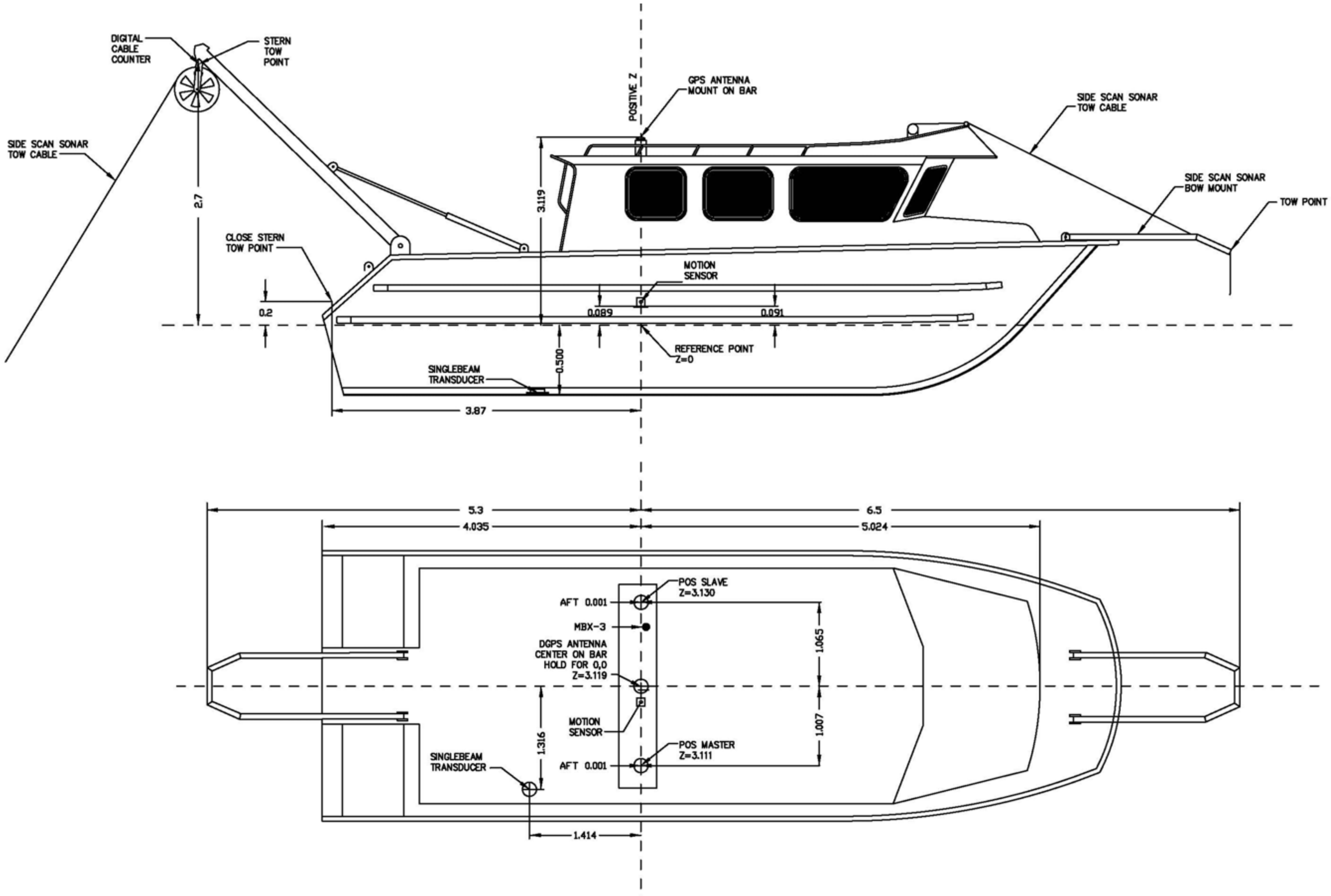

Figure 12. Schematic of the *R/V Chinook* and sensor setup

Installation bias was applied to all the data and stored in a Caris HIPS vessel file specific to bathymetry type. System offsets and biases for relative to single beam acquisition were stored in Caris vessel files J977-DE-08_VBES_Taku.hvf and J977-DE-08_VBES_Chinook.hvf.Offsets and biases for the multibeam acquisition system, including the results obtained from the patch test at the start of the survey, were stored in the Caris "J977-DE-08_MBES_Taku.hvf" vessel configuration file.

C5. Patch Tests

A patch test was conducted prior to performing multibeam item investigations to measure alignment offsets between the *R/V Taku's* IMU sensor and multibeam transducer, and to verify delay times applied to the time-tagged sensor data. The patch test consisted of a series of lines run in a specific pattern, which were then used in pairs to analyze roll, pitch and heading alignment bias angles, as well as, latency in the time-tagging of the sensor data. The initial patch test was conducted in Red Pass, Louisiana in accordance with *NOS Hydrographic Surveys Specifications and Deliverables (April 2007)* on Day Number 118. Additional tests were performed periodically (DN 178, 212, 220 and 235) to verify the adequacy of the system biases.

A precise timing latency test was performed by running reciprocal lines over a flat bottom, in a water depth of approximately 20 meters. Sea conditions were slightly rough during the test in order to amplify the effects of latency and make the error conspicuous during data review. The lines were then opened in the HIPS calibration editor (after applying tide and Sound Velocity Profile (SVP) corrections) and a slice of along track data was evaluated in the outer swath of the line. Incremental changes to the roll time offset were made to evaluate the performance of the precise timing setup and to determine if a latency correction was needed. No latency was found in the system. These lines were also used to evaluate the roll bias.

Roll alignment was determined by evaluating a line acquired with heavy wake from a passing boat. The pitch test consisted of a set of reciprocal lines over a mound in Red Pass. Yaw was determined by running parallel lines over the same area. Acquisition speeds varied based on the test and ranged from 1.5 knots to 7.0 knots.

Selected pairs of lines were then analyzed in the HIPS Calibration editor to measure the angular sensor bias values. Visual inspection of the data confirmed each adjustment. Two sets of lines were run and analyzed for each of the mounting biases. The second set was used to confirm the results of the data. Multiple patch tests were performed during the project in order to account for minor changes caused by deployment and installation. Bias correction values for each patch test are displayed in Table 7.

Table 7. Biases applied when using the POS/MV for pitch and roll.

Date	Latency	Pitch	Roll	Yaw
04/27/08	0.00s	-0.70°	1.80°	-2.70°
06/26/08	0.00s	-1.20°	1.95°	-2.5°
07/30/08	0.00s	-1.10°	1.93°	-2.5°
08/07/08	0.00s	-1.10°	2.45°	-2.5°
08/22/08	0.00s	-0.70°	2.24°	-2.5°

C6. Tide and Water Level Corrections

The primary water level station for this project was Pilot Station East, LA (876-0922). A subordinate gauge was installed at Devon Energy Facility, North Pass, LA (876-0417). NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) preliminary zoning files tied to Pilot Station East, LA (876-0922) were adjusted using the DEA installed subordinate gauges as the reference station. Minor modifications were made to zone boundaries of both zone files by moving the vertices of several zones so that adjacent zones had vertices that matched exactly in order to remove some very small slivers from the file and by extending the boundaries of CGM243 and CMG244 (approximately 225 meters eastward) so the zones fully encompassed the survey area. New time and range correctors were calculated relative to the subordinate gauge at Devon Energy Facility by back zoning from Pilot Station East, SW Pass to transfer relative to Devon Energy Facility.

Time correctors were calculated by adjusting the average time corrector (ATC) for zones which surrounded the subordinate gauge to zero minutes. The Devon gauge did not fall within a zone polygon so an assumption was made that the Devon gauge should be back applied from zone CGM 247 which junctions with the entrance to North Pass. Similarly, range correctors were adjusted to 1.00 for zone CGM 247. From this ATCs were calculated for each remaining zone relative to the subordinate gauge by calculating the difference between the ATC relative to 876-0922 for the zone in question. Range correctors were calculated by dividing the range corrector for the zone in question by the range corrector of the zone CGM 247.

A HIPS ZDF was used to apply zoned tides to the multibeam data. The zoning file relative to Pilot Station East, LA (876-0922) used CO-OPS preliminary zoning values with the only modifications being minor edits to some of the vertices. The Devon Energy Facility, North Pass, LA (876-0417) zoning file used the same vertices as Pilot Station East but with zoning values adjusted relative to the subordinate gauge. See the Descriptive Report for each survey for discussion of the water level data and zoning scheme that was used.

The primary and subordinate stations experienced no down time during periods of hydrographic survey.

C7. Sound Velocity Correction

Manual sound velocity casts were taken periodically throughout each survey day. A cast was typically taken onsite prior to starting acquisition and then approximately every two hours during the survey.

A sound velocity cast was taken by lowering the AML Smart sensor to the bottom while the vessel was holding station. A HYPACK target was taken to record the time and position of the cast which would later be entered into the HIPS sound velocity file. The sampling period was increased if large changes in sound speed were observed between casts. During concurrent single beam and side scan acquisition, casts were taken more frequently if refraction artifacts were visible in the side scan sonar record. During multibeam item investigations, casts were taken in the vicinity of each investigation. At least one deep cast (extending to 95% of depth) was taken per day.

After each cast the sound speed data was reviewed for outliers or anomalies such as a sharp thermocline or halocline which could impact data quality. In addition to these periodic comparisons, weekly check casts were taken to verify proper performance of the AML sensor. For this check both AML sensors were deployed simultaneously. Corrections for the speed of sound through the water column were computed for each sensor and imported into an Excel file where sound speed profiles were created and overlaid for comparison. Each sensor had been calibrated prior to the start and at the end of the survey. Factory calibration results are included in the Separates Section II *Sound Speed Data* of the Descriptive Reports for this project.

The sound speed correction was applied to each line using the nearest distance in time option in the HIPS SVP correct routine. All casts were concatenated into a daily HIPS SVP file for each survey day. Time, position and sound speed for each profile were included in the HIPS file.

D. LETTER OF APPROVAL

DAVID EVANS AND ASSOCIATES INC.

LETTER OF APPROVAL

OPR-J977-DE-08
Data Acquisition and Processing Report

This report and the accompanying data are respectfully submitted.

Field operations contributing to the accomplishment of OPR-J977-DE-08 were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and associated data have been closely reviewed and are considered complete and adequate as per the Statement of Work.

Digitally signed by Jon Dasler
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Jonathan L. Dasler, PE (OR), PLS (OR, CA)
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August 2008

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