

H11540

NOAA FORM 76-35A

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

DESCRIPTIVE REPORT

Type of Survey Hydrographic/Lidar

Field No. N/A

Registry No. H11540

LOCALITY

State Alaska

General Locality Approaches to Sitka

Sublocality Walker Channel to Necker Bay

.....
2006
.....

CHIEF OF PARTY

..... Darren Stephenson

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DATE

<p style="text-align: center;">U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION</p> <p style="text-align: center;">HYDROGRAPHIC TITLE SHEET</p>	<p>REGISTRY No</p> <p style="text-align: center;">H11540</p>
<p>INSTRUCTIONS – The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the Office.</p>	<p>FIELD No: N/A</p>
<p>State <u>Alaska</u></p> <p>General Locality <u>Approaches to Sitka</u></p> <p>Sub-Locality <u>Walker Channel to Necker Bay</u></p> <p>Scale <u>1:10,000</u> Date of Survey <u>June 15 to September 11, 2006</u></p> <p>Instructions dated <u>2/8/2006</u> Project No. <u>OPR-O112-KRL-06</u></p> <p>Vessel <u>Tenix LADS Aircraft, VH -LCL</u></p> <p>Chief of party <u>D.J. Stephenson</u></p> <p>Surveyed by <u>Tenix LADS Personnel</u></p> <p>Soundings by <u>Laser Airborne Depth Sounder</u></p> <p>SAR by <u>Toshi Wozumi</u> Compilation by <u>Peter Holmberg</u></p> <p>Soundings compiled in <u>Fathoms</u></p>	
<p>REMARKS: <u>All times are UTC. UTM Projection 8</u></p> <p><u>The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Revisions and end notes in red were generated during office processing. Page numbering may be interrupted or non sequential.</u></p>	

DESCRIPTIVE REPORT TO ACCOMPANY**HYDROGRAPHIC SURVEY H11540****SCALE 1:10,000, SURVEYED IN 2006****TENIX LADS AIRCRAFT, VH-LCL****TENIX LADS, INC. (TLI)****MARK SINCLAIR, HYDROGRAPHER****PROJECT¹****Project Number:** OPR-O112-KRL-06**Original:** DG 133C-03-CQ-0011**Date of Instructions:** February 8, 2006**Task Order:** T0009**Date of Supplemental Instructions:**

- Site visit by NOAA on September 12–13, 2006 to TLI to discuss the data delivery under the new Specifications and Deliverables.
- E-mail from Toshi Uozumi confirming the delivery of features for examination can be exclusively submitted within the S-57 feature file.

Sheet Number: AU**Registry Number:** H11540**PURPOSE**

To provide NOAA with modern, accurate hydrographic survey data with which to update the nautical charts of the assigned area.

A. AREA SURVEYED

Between June 14 and September 11, 2006 the LADS Mk II aircraft forward deployed to Sitka from the project OPR-P133-KRL-06 operating base of Kodiak on six occasions. During this period, fourteen survey sorties were flown under Task Order 9 OPR-O112-KRL-06 Approaches to Sitka – Sitka Sound. Survey operations covered three survey areas. This Descriptive Report describes Sheet AU, which covers the Approaches to Sitka, Walker Channel to Necker Bay area (see Figure 1).

Environmental factors such as wind strength and direction, cloud cover, high ground and water clarity influenced the area of data acquisition on a daily basis. See section B.2 Quality.

The planned and actual linear miles sounded for the areas are provided at Appendix III. The sheet limits are as follows for Sheet AU:

	Latitude (N)	Longitude (W)
NW corner	56.68089959° 135.29030382	°
NE corner	56.73064856° 135.20528674	°
SE corner	56.66285047° 135.07460588	°
SW corner	56.61319013° 135.15964278	°

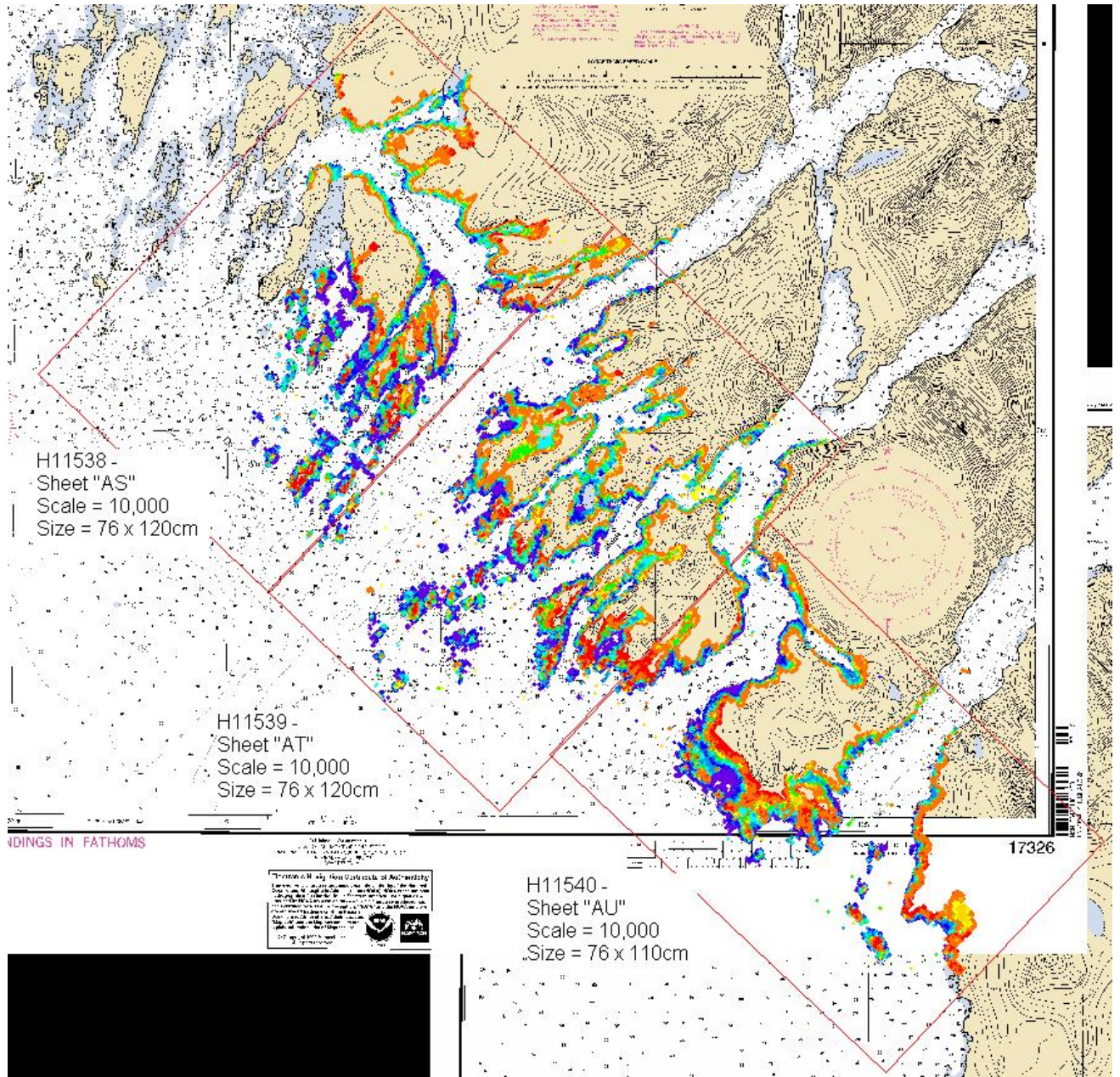


Figure 1 - Task Order 9 OPR-O112-KRL-06

B. ACQUISITION AND PROCESSING

Refer to the Data Acquisition and Processing Report for a detailed description of the equipment, processing and quality control procedures. A general description and items specific to this survey are discussed in the following sections.

B.1 EQUIPMENT

Data collection was conducted using the LADS Mk II Airborne System, data processing using the LADS Mk II Ground System and data visualization, quality control and final products using CARIS HIPS and SIPS 6.0.2 and CARIS BASE Editor 2.0.

A prototype Digital Imagery Capture system was installed at the commencement of this survey, which allowed digital images from the downward looking video to be captured, georeferenced and combined into an orthophoto mosaic.

B.1.1 Airborne System

The LADS Mk II Airborne System (AS) consists of a Dash 8-200 series aircraft, which has a transit speed of 250 knots at altitudes of up to 25,000m and an endurance of up to eight hours. Survey operations are conducted from heights between 1,200 and 2,200m at ground speeds between 140 and 175 knots. The aircraft is fitted with a Nd: YAG laser which is eye safe in accordance with ANSI Z136.1-2000, American National Standard for Safe Use of Lasers. The laser operates at 900 Hertz from a stabilized platform to provide a number of different spot spacings.

Green laser pulses are scanned beneath the aircraft in a rectangular pattern. The pulses are reflected from the land, sea surface, within the water column and from the seabed. The height of the aircraft is determined by the infrared laser return, which is supplemented by the inertial height from the Attitude and Heading Reference System and GPS height. Real-time positioning is obtained by an Ashtech GG24 GPS receiver providing autonomous GPS or combined with Wide Area DGPS provided by the Fugro Omnistar to provide a differentially corrected position where coverage is available. Ashtech Z12 GPS receivers are also provided as part of the Airborne System and Ground Systems to log KGPS data on the aircraft and at a locally established GPS base station. For more details on the airborne system refer to the Data Acquisition and Processing Report.

B.1.2 Ground System

The LADS Mk II Ground System (GS) 'Gandalf' was used to conduct data processing in the field. Gandalf consists of a portable Compaq Alpha ES40 Series 3 processor server with 1 GB EEC RAM, 764 GB disk space, digital linear tape (DLT) drives and magazines, digital audio tape (DAT) drive, CD ROM drive and is networked to up to 12 Compaq 1.5 GHz PCs and a HP 800ps Design Jet Plotter, printers and QC workstations. Quality control checks and editing of the data were conducted on GS 'Katrina' at the Biloxi office upon completion of the data collection phase of the survey.

The GS supports survey planning, data processing, quality control and data export. The GS component also includes a KGPS base station, which provides independent post-processed position and height data. A comprehensive description of the GS is provided in the Data Acquisition and Processing Report.

B.2 QUALITY

B.2.1 Data Density

The survey area was illuminated at 4x4m laser spot spacing with main lines of sounding spaced at 80m, which provided the required 200% coverage.

At the sea surface the footprint of the laser beam is approximately 2.5m in diameter. As the beam passes through the water column it slowly diverges due to scattering. It should be noted that at 4x4m laser spot spacing there is a gap of 1 to 1.5m between the illuminated area of adjacent soundings at the sea surface. There is a possibility that small objects in shallow water along the coastline may fall between consecutive 4x4m soundings and not be detected.

B.2.2 Water Clarity

The water clarity in the survey area varied significantly during the period of data collection and this required careful management to achieve the best possible results. Water clarity varied from extremely poor to good. Many secchi disk observations were taken throughout the survey area during operations to correlate water clarity with laser performance and manage optimal times of data collection. On occasions the water clarity was extremely poor and on other occasions the water clarity had significantly improved.

B.2.3 Data Management

The database is identified as follows:

Database Name	General Locality	Sheet(s)
06_5rakof	Walker Channel to Necker Bay	AU

A detailed table of survey line numbers is presented in the Data Acquisition and Processing Report.

B.2.4 Data Acquisition

Survey operations were conducted when suitable weather conditions prevailed, water clarity was good and when adverse weather conditions prevented survey operations for project P133. After the first two forward deployments, consideration was also given to planning forward deployments at spring tides, to obtain better coverage on exposed off-lying rocks at low tide. The first survey sortie was flown on June 26, 2006.

The poor water quality observed during the first forward deployment resulted in only one survey flight being conducted. A decision was made that the water clarity needed time to improve and secchi disk observations had to be taken in order to properly manage water clarity and data collection.

The second forward deployment was conducted during the period of July 5-10 when five survey sorties were flown and good data collected.

The third forward deployment was conducted during the period of August 8-12 when two survey sorties were flown. The data was not as good as the previous forward deployment, but adequate data was still collected. However, poor weather minimized progress during this forward deployment.

The fourth forward deployment was conducted during the spring tide period of August 20-26 in order to obtain coverage over exposed off-lying rocks. Three survey sorties were flown, but no data was collected on the first sortie due to low cloud coverage. The second survey sortie was flown at low water spring tide and good data was collected. No sorties were conducted for three days due to poor weather. The third survey sortie was flown, but no data was collected due to continuing low cloud coverage and poor water quality.

The fifth forward deployment was conducted during the period August 29 - September 2. Good progress had been made in the P133 project area so the aircraft forward deployed to Sitka, enabling the surveyors to better monitor the weather. No flight occurred for the first four days due to poor weather. One sortie was flown on the fifth day, but only marginal data was collected.

The sixth and final forward deployment was conducted during the period September 5-9. The first sortie was flown to complete the inshore mainlines. The second sortie was cut short due to poor weather. The following day saw no flight due to poor weather. The third and fourth sorties were flown over low water spring tides and good data was collected.

Survey operations were plagued by very poor weather and extremely variable water clarity, which led to the data acquisition timeline being extended by four weeks. Compared with previous years' surveys in SE Alaska, lidar seabed coverage for OPR-O112-KRL-06 was marginal. Despite flying many additional sorties, doing twice as many forward deployments than were planned, the overall result of the survey was, for the most part adequate, but in some locations sub-standard. This was completely due to variable poor water clarity throughout the survey area despite considerable efforts to manage the water clarity.

For a summary of data acquisition statistics refer to Appendix III Final Progress Sketch.

B.2.5 Sea Conditions - Sea State, Waves, Swell, White Water

The sea state ranged from 1 to 4 on the Beaufort Scale throughout the survey, but was generally between states 1 and 2 inshore and 3 and 4 offshore in the exposed area. This did not affect data quality except where significant white water occurred around rocks in exposed areas such as Slate Islands. In the exposed areas long streaks of white foam on the sea surface were present at times. White water creates saturated surface pulses, which result in no return from the seabed. Gaps were kept to a minimum by collecting data in the offshore areas during calm conditions.

Calm seas were experienced on occasions in the sheltered areas such as Walker Channel and Necker Bay. Under such calm conditions the sea may become glassy which degrades the sea surface model.

Long period swell was not significant during the survey, however an allowance has been made in the assessment of vertical accuracy.

B.2.6 Kelp

Kelp is one of the factors that increases the complexity of a particular survey area. It is one of the reasons why 200% coverage is recommended in Alaskan waters. Kelp reduces the survey coverage achieved by lidar. Kelp also increases the amount of data processing that is required and the amount of boatwork that is recommended in section D.1.4 Additional Boatwork Inside Lidar Area. Large areas of kelp exist throughout the survey area.

Kelp areas can be recognized in the data by the following indicators:

- Mid-water column pulses, frequently with low amplitude and poorly defined leading edges on the waveform.
- Returns from the seabed are highly attenuated.
- Soundings in shallow water are very sparse.
- Soundings do not correlate with overlapping data from adjacent lines.

Kelp limits the penetration of the laser. This reduces the laser coverage of the seabed in kelp areas. Data processing takes much longer in these areas, as more points need to be assessed and reviewed by the surveyors validating, checking, conducting quality control and approving the data.

Kelp areas appear as data gaps in the BASE surface. In such areas of partial bottom coverage, unsurveyed polygon areas (WEDKLP) have been defined in the S-57 features file at the boundaries of data gaps attributed to kelp. Where kelp is present, but doesn't affect a large area of data coverage, kelp point objects have been defined in the S-57 features file (US511540.000).

Rocks detected by the system in kelp areas may be difficult to discriminate as rock or kelp returns. When it is uncertain if the return is from rock or kelp, a decision whether the feature has 'least depth found' (LDF) by lidar is provided in section D.1.5 Chart Comparison Spreadsheet. If it is determined that the LDF on a significant feature has not been surveyed by lidar due to the presence of kelp, the item will appear as a feature for examination in the ChartComp.hob file.

B.2.7 Gap and Feature Tagging

During data processing on the GS, the operators have the ability to assign S-57 and user-defined tags to gaps and features in the data. This enables accurate delineation and attribution of unsurveyed polygons for the S-57 features file (US511540.000).

The following user-defined tags were used to delineate the seaward extent of gaps in the lidar seabed coverage, typically at a 20m interval:

GK	Bathymetry data gap due to kelp.
GW	Bathymetry data gap due to white water – not a rock awash feature.
GS	Bathymetry / topography data gap due to the secondary exclusion zone.
GT	Bathymetry data gap due to turbidity.
GLS	Bathymetry data gap due to glassy seas.
GTR	Topography data gap due to the detection of foliage in spruce trees.

A data gap due to the secondary exclusion zone occurs at the land / sea interface where the waveform return from the seabed is mixed with the waveform return from the sea surface. Neither the seabed nor a drying sounding can be determined so a gap exists in this shallow area. In most cases, the gap is filled by flying alternate lines at a different tidal state.

A data gap due to glassy seas occurs in extremely calm conditions where the laser returns at nadir become saturated driving the gains down. A gap will occur if there is no data from adjacent lines to cover the area.

A data gap due to trees occurs where spruce trees grow along the MHW line and a bare earth lidar return is not possible due to the foliage. Where this occurs the operator will tag the first foliage return and this is then exported and the MHW line interpolated.

The following tags were used in the GS for features that require further examination:

FEK	Feature for examination in kelp, as the least depth has not been determined.
FERK	Feature for examination of a submerged rock, as the least depth has not been determined, or a higher density of data is required to adequately define the feature.
FERA	Feature for examination of a rock awash, as the feature has not been surveyed adequately due to the presence of white water.
FEDR	Feature for examination of a drying rock, as a higher density of data is required to adequately define the potentially drying feature.
FE	Feature for examination, generally in deep water, as the least depth has not been found due to poor water clarity.

The tags associated with features requiring further examination have been compiled in the Investigations.hob file and each given certain priority and a suggested examination method for the undertaking of additional boatwork.

In most cases the least depth has deemed not to be found on a feature and it requires further examination by boat to determine the least depth.

B.2.8 Nature of the Seabed

The seabed in the vicinity of Walker Channel to Necker Bay is very complex. The area exhibits many islands, islets, drying rocks and rocks awash. The seabed is similarly undulating. Along most coastlines, especially inshore, the seabed slope gradient is high.

B.2.9 Topography

The LADS Mk II system can measure topographic heights up to 50m elevation, subject to the depth / topographic logging window selected. For this survey, a 20m topographic height logging window was selected. As a result, the coastline was surveyed and elevations up to 20m were measured. Above 20 m elevation, no coverage has been achieved. Large spruce trees were detected along most of the coastline and on some of the inshore islands. It was evident that many of the topographic returns were from foliage in these areas and in many cases there was no laser penetration to the ground. Returns from foliage were removed from the data. In general, this was achieved by deleting returns greater than 5m above the water line. In many steep spruce tree covered locations, the removal of data above 5m elevation resulted in the absence of topographic data for deriving the MHW line. In these locations the operator assigned 'tree gap' tags, and digital orthophoto mosaic was used to extrapolate the mean high water line.

The maximum topographic heights achieved in this area are limited by the topographic logging window and by spruce tree foliage. This can be seen as gaps in the BASE surface, indicating areas of no coverage in the center of islands and along the coastline. As a result of the restricted topographic window & spruce trees, some islands will extend higher than the surveyed data range.

B.2.10 Datums

Upon the completion of each flight, the GPS data logged on the aircraft and at the base station was processed to determine the post-processed KGPS position and height of the aircraft. This data is used in the calculation of the sea surface datum.

B.2.11 Wind

Survey operations were conducted in wind strengths of up to 20 knots during the survey. In general the wind strength during the time of survey was around 10 knots from the SW.

B.2.12 Cloud

Low cloud coverage and rain was a significant factor during the survey. The wind direction affected the cloud base in the survey area. For example, in southerly or easterly conditions a

low cloud base was experienced . The effects of low cloud coverage were managed as follows:

- a. Limited weather forecasts were available for the survey area. Real-time weather conditions were monitored using real-time satellite imagery, radar data and aviation reports. The actual weather was confirmed by contacting the control tower at Sitka, and local pilot weather reports were often provided.
- b. Two Internet sites proved to be invaluable for forecasting the weather. An aviation site, <http://adds.aviationweather.gov> provided METAR data, actual wind speed and direction, cloud base and satellite cloud data. The observations were updated every twenty minutes. A NOAA weather site, <http://pafc.arh.noaa.gov> provided aviation and general weather.

B.2.13 Effects of High Ground

For this survey the high ground was a significant issue and the majority of the inshore survey lines were flown at 2,200m . Low cloud coverage was often prevalent along the inshore terrain. During these periods of adverse inshore weather, lines were flown offshore between 1,200m and 1,600m, below the low cloud coverage.

B.2.14 Receiver Gain

Changes in gain levels in the Airborne System automatically accommodate for changes in the sea surface, water column and seabed conditions. In some areas, after long over-land passages, low gain levels were initialized when passing back over the water. Where this has been identified in the data, these lines were reflown from the opposite direction to improve the coverage. In some inshore areas reciprocal lines could not be flown due to the proximity of high ground at the start / end of the line. This adversely affected seabed coverage along some coastlines.

B.2.15 Raw Laser Waveforms

The raw laser waveform returns from the areas that were covered with kelp are considerably attenuated. In order to detect the seabed in such areas, the threshold in the GS was lowered to detect pulses with low signal-to-noise ratios. This enabled the seabed to be detected, but also resulted in increased data validation times.

B.2.16 Data Processing

The collected data was copied using the Airborne System following each sortie in Sitka, and the data was processed at the operating site in Kodiak on return from each forward deployment. During the final two forward deployments to Sitka, a portable ground system known as 'Bilbo' was set up to enable copying of data and additional survey planning. Final validation, checking, approving, reports and products were conducted at this site and Biloxi, MS. The quality control of the data was done independently in Adelaide, South Australia.

B.2.17 Progress Sketches

Progress sketches were provided to NOAA on a bi-weekly basis, the final progress sketch can be found in Appendix III.

B.3 DATA FORMATS

Data is provided in the following formats:

- Digital S-57 feature file.
- Caris BASE surface.
- Caris compatible data - LADS soundings and waveforms, which can be imported into Caris HIPS.
- Tidal data provided in ASCII, .xls and .csv formats.
- Digital georeferenced image in .tif / .tfw format.

Refer to the Data Acquisition and Processing Report for specific details.

B.4 BENCHMARKS

The depth benchmark area from the 2003 lidar survey in Chatham and Sumner Straits was used to check the performance of the LADS Mk II system for the H11540 survey. These benchmarks were surveyed to assess the LADS Mk II system accuracy.

Center coordinates for the benchmark area is as follows:

South Kruzof Island Benchmark Line

Benchmark Name	Nominal Depth	Easting (NAD 83)	Northing (NAD 83)
BM_1	9m	459 200	6 318 725

The South Kruzof Island benchmark line was attempted during each sortie. A total number of 7 benchmark lines were compared during the survey. The tidal model in use for the comparison of the South Kruzof Island benchmark was the same as the tidal model used to reduce the benchmarks during the 2003 survey. Benchmark comparisons were conducted after the application of verified tides. Comparison summaries are provided in the Separates.

The LADS data is compared against the gridded benchmark surface in the GS and statistics are generated, which include the number of points compared, the mean depth difference (MDD) and the standard deviation (SD) between the data sets. The benchmark comparison function compares the data against the benchmark surface, and as this data is unedited, it may contain noise normally removed during the validation process. These noisy outliers are flagged as the shoalest and deepest differences.

B.4.1 Benchmark Comparison Mean Depth Difference (MDD) and Standard Deviation (SD)

The average of the mean depth differences and standard deviations for all benchmark runs is as follows:

South Kruzof Island Benchmark

GS ID	BM Name	Nominal Depth	MDD	SD
1	BM_1 9m		-0.05 +/- 0.15	0.19 +/- 0.02

These results are within expected tolerances and show that the LADS Mk II depth performance was within specifications. These results indicate that the LADS Mk II system operated correctly during the survey.

B.5 CROSSLINES

No specific crosslines were planned due to the number of additional runs flown perpendicular to main survey lines. These additional runs were flown to achieve better coverage around off-lying rocks and adjacent to long stretches of coastline. These lines were used for the crossline comparisons. Areas were selected where common data existed and ideally, where the seabed was reasonably flat. This minimized the apparent differences in depths due to minor positional differences in steeper areas of seabed.

Four crosslines were identified as meeting the above criteria. They were all sounded at 4x4m laser spot spacing, throughout the survey area as follows:

Line 1013.0.1	1 crossline intersection	Yamani Cove.
Line 1106.0.1	1 crossline intersection	Along the NW coast of Necker Bay.
Line 1110.0.1	3 crossline intersections	Along exposed coast of Baranof Island.
Line 1116.0.1	3 crossline intersections	Through Walker Channel and into Crawfish Inlet.

B.5.1 Crossline Comparison Mean Depth Difference (MDD) and Standard Deviations (SD)

The mean depth difference and standard deviation for each crossline comparison is as follows:

Run No.	Comparisons	Average MDD	Average SD
1013.0.1 583		-0.01	0.17
1106.0.1 508		0.16	0.16
1110.0.1	3033	-0.13 +/- 0.11	0.19 +/- 0.01
1116.0.1	3357	0.10 +/- 0.10	0.26 +/- 0.04

The sparse data coverage throughout the survey area resulted in limited crossline comparisons being conducted. However, following analysis of overlap between lines during data processing, it has been deemed that there were no gross errors in the data.

The limited results above are consistent with IHO Order-1 depth accuracy.

B.6 POSITION CHECKS

Two independent positioning systems were used during the survey. Real-time positions were determined by autonomous GPS. Post-processed KGPS positions were also determined relative to a local GPS base station that was established on the rooftop of the AERO Services building at the Sitka Airport. The post-processed KGPS positions were applied to each sounding during post-processing and the height used in the topographic datum filter.

Position checks were conducted prior to, during and following data collection as follows:

- a. **DGPS Site Confirmation.** A 24-hour certification was conducted of the local GPS base station established on the roof of AERO Services building at the Sitka Airport on August 7-8, 2006. The results reveal that the local GPS base station is free from site specific problems such as multipath and obstructions.
- b. **Static Position Check.** Prior to commencing data collection, the coordinates of the aircraft GPS antenna were determined relative to four NGS-CORS Base Stations in the SE Alaska area. Data was then logged by each LADS Mk II positioning system, enabling the positions to be checked against the NGS-CORS coordinated position. The accuracy of the post-processed KGPS solution during the static position check was 0.042m (95 % confidence). The results and details of the static position check are enclosed in the Vertical and Horizontal Control Report.
- c. **Dynamic Position Check.** During each sortie GPS data was logged on the aircraft and at the local GPS base station. This provided a check between the real-time and post-processed GPS positions. The mean difference between the real-time and post-processed positions was 2.038m, with an average standard deviation of 0.264m. Details are provided in the Vertical and Horizontal Control Report.
- d. **Navigation Position Check.** Navigation checks were also conducted over a coordinated point on the roof of the Butler building at Sitka Airport. This enabled the known position of the structure to be checked against the image on the downward looking video. This provided a gross error check of position. The mean error was 1.72m with a standard deviation of 3.51m. Details are provided in the Vertical and Horizontal Control Report.
- e. **Position Confidence.** The position quality was also monitored by checking a post-processed position confidence (C3), which is determined from the AS platform error, GPS error and residual errors between the actual GPS positions and aircraft position, as determined from the line of best fit. No position anomalies were detected.

The position checks were within the expected tolerances and showed that the positioning systems were functioning correctly.

B.7 CORRECTIONS TO SOUNDINGS

Refer to the Data Acquisition and Processing Report for a description of corrections to soundings. There were no deviations from the corrections described therein.

C. VERTICAL AND HORIZONTAL CONTROL

Refer to the Vertical and Horizontal Control Report for a detailed description of the vertical and horizontal control used during this survey. A summary of vertical and horizontal control for the survey follows.

C.1 VERTICAL CONTROL

Vertical control for the survey was based on the Mean Lower Low Water tidal datum (MLLW). The operating National Water Level Observation Network (NW LON) station at Sitka, AK (9451600) served as vertical control for the LADS depth benchmark areas and for the survey area.

Station details are as follows:

		WGS84	
Gauge	Location	Latitude	Longitude
9451600	Sitka Sound Seafood Dock	57° 03.1' N	135° 20.5' W

C.2 ZONING

NOAA supplied tide zones that cover the extent of the survey area, with time and range correctors relative to the Sitka tide station. These are as follows:

Tide Zone	GS Identifier	Time Corrector	Range Corrector	Reference Station
PAC294	TA1	+0 minutes	x 1.00	9451600
PAC294A	TA2	+0 minutes	x 0.99	9451600
PAC294B	TA3	+0 minutes	x 0.97	9451600
SEA200	TA4	+0 minutes	x 1.00	9451600

An analysis of crosslines and overlaps of the mainlines of sounding concluded that preliminary tide zoning was adequate. Therefore, the preliminary tide zoning correctors have been considered to be the final zoning correctors for the survey.

The verified tides supplied by NOAA were independently checked by John Oswald and Associates. Once the data was checked, a fifth degree polynomial was applied to the tidal data and this data was then supplied to Tenix LADS Inc. for the application of tides.

For final tide application, the time and amplitude correctors were applied to the tidal data delivered by John Oswald and Associates. Soundings were then reduced to MLLW using these corrected tides.

The derived value at the Sitka tide station for the difference between MLLW and MHW is 2.791m. From the final zoning a range factor 0.986 was used for H11540, Sheet AU to determine a MHW line of 2.75m.

C.3 HORIZONTAL CONTROL

Data collection and processing were conducted on the Airborne and Ground Systems in World Geodetic System (WGS84) on Universal Transverse Mercator (Northern Hemisphere) projection UTM (N) in Zone 8, Central Meridian 135 ° W. All units are in meters. This data was post-processed and all soundings are relative to the North American Datum 1983 (NAD83).

C.3.1 LADS Local GPS Base Station – Sitka

Real-time positions were determined using an Ashtech GG24 GPS receiver operating in autonomous GPS mode. A local GPS base station was coordinated by John Oswald and Associates on the roof of AERO Services at Sitka Airport on April 24, 2004 in order to post-process KGPS positioning off-line.

The derived NAD83 coordinates for the local GPS base station, are:

NAD 83		UTM (N) Zone 8		
Latitude (N)	Longitude (W)	Easting (m)	Northing (m)	Ellipsoidal Height (m)
57° 03' 11.8702"	135° 22' 00.3931"	477 751.069	6 323 378.511	16.210

Post-processed KGPS positions were determined off-line using data logged at the local GPS base station and on the aircraft. This data was processed through Ashtech PNAV software to calculate both a DGPS and KGPS position solution. The post-processed KGPS positions were then imported into the GIS and applied to all soundings. This provided increased sounding position accuracy and horizontal redundancy.

The local GPS base station site was checked for obstructions and multipath over a 24 hour period on August 07 and August 08, 2006. The results outlined in the Vertical and Horizontal Control Report reveal that the local GPS base station site is free from site specific problems such as multipath and obstructions.

On June 25, 2006 static position checks of the LADS Mk II positioning systems were undertaken. The results outlined in the Vertical and Horizontal Control Report revealed no gross errors and that all positioning systems functioned correctly.

During each sortie, GPS data was logged both on the aircraft and at the local GPS base station, which enabled a post-processed KGPS position solution to be determined. These positions were then compared to the position determined by the real-time positioning system. This dynamic positioning check provided quality control of the positioning systems and the positional differences were within tolerance for the survey. These differences are tabulated in the Vertical and Horizontal Control Report.

Navigation position checks were attempted over the Butler building during each sortie when suitable weather conditions prevailed. Following each sortie the logged aircraft position was processed against the downward looking video record to determine the difference in position at the time of overflight. This provided a gross error check on the aircraft positioning. The tabulated results are presented in the Vertical and Horizontal Control Report and revealed that the positioning systems functioned to within expectations.

D. RESULTS AND RECOMMENDATIONS

The results for the H11540 survey are submitted separately to this Descriptive Report as the S-57 feature file, BASE surface, CARIS .hob files, orthophoto mosaic, chart comparison spreadsheet, etc. on the USB hard drive. Refer to Appendix II of the Data Acquisition and Processing Report for a list of all the applicable results files from H11540.

Below is a table listing the S-57 feature objects found in the S-57 feature file (US511540.000):

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Spatial Attribute	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Comments
Coastline	COALNE	L	The high water line. Where depth equals 0 relative to MHW.	Quality of position (QUAPOS)	Category of Coastline (CATCOA)				The spatial attribute QUAPOS is used when coastline is interpolated from tags or the georeferenced orthophoto mosaic.
Depth Contour	DEPCNT L		The approximate location of the line of equal depth. Also referred to as a depth curve.		Value of depth contour (VALDCO)				Tenix will only be responsible for defining the 0m curve.
Land Area	LNDARE P		The solid portion of the Earth's surface, as opposed to sea, water.						Used for defining islet point features
Land Elevation	LNDELV P		The vertical distance of a point or level measured from a specified vertical datum.		Elevation (ELEVAT)				Used for defining islet heights related to MLLW.
Underwater / Awash Rock	UWTROC P		A concreted mass of stony material or coral which dries, is awash or is below the water surface.		Water level effect (WATLEV)	Quality of sounding measurement (QUASOU)	Technique of sounding measurement (TECSOU)	Value of sounding (VALSOU)	
Weed / Kelp	WEDKLP P,	A	Usually large, blade-shaped or vine-like brown algae.		Category of weed/kelp (CATWED)				Polygon limits defined using the "GK" tags exported from the GS
Unsurveyed Areas	UNSARE A		Unsurveyed area.		Information (INFORM)				Define gaps in data coverage within polyline. INFORM has been identified as either Turbidity, Secondary exclusion zone, Glassy seas
Shoreline Construction	SLCONS L		A fixed artificial structure between the water and the land.		Category of shoreline construction (CATSLC)				
Sand Waves	SNDWAV P,	A	A large mobile wave-like sediment feature in shallow water and composed of sand						
<i>Meta Objects</i>									
Coverage	M_COVR	A	A geographical area that describes the coverage and the extent of spatial objects.		Category of coverage (CATCOV)				M_COVR: CATCOV = 1 polygons define the extents of good LIDAR data coverage.
Quality of Data	M_QUAL A		An area within which a uniform assessment of the quality of the data exists.		Category of zone of confidence in data (CATZOC)				

Table 1: S-57 attribution for the S-57 feature file (US511540.000)

Recommendations for registry number H11540 are divided into 2 components:

Recommended charting action, primarily for MCD.

Recommended further boatwork to sufficiently junction with lidar seabed coverage and examine uncertain lidar features.

Recommendations for charting action for registry number H11540 are provided in sections D.1.1 to D.1.6 below. The Chart Comparison Spreadsheet has historically been one of the sources for the lidar features for examination list. In order to provide just one list of features for examination to field units, the Chart Comparison Spreadsheet has had some minor adjustments for this survey (H11540_V1_ChartComp.xls). All features that appear in the chart comparison, but have not accurately had least depth determined by lidar, appear in the features for examination file. Where the least depth has not been found by lidar, no recommended charting action has been specified. Instead, a vessel-based verification method is suggested. The determination of least depth is at the discretion of the ships conducting junctioning / investigations and their results should be reported for charting action to MCD in due course.

Recommendations for ship junctioning and investigations are provided in sections D.2.1 to D.2.5 below. In order to minimize the historical double handling of reporting uncertain lidar soundings on features, the features for examination are now contained exclusively in the CARIS .hob file (Investigations.hob). The features for examination have been prioritized with respect to multibeam junctioning, investigating features in 'unsurveyed' foul areas and within the NALL.

D.1 RECOMMENDED CHARTING ACTION

H11540 LADS survey deliverables were compared to:

ENC US5AK3SM Edition 1, compiled from Raster Chart 17328 7th Edition. ENC update application date May 1, 2006, at scale 1:40,000.

This chart was downloaded from the NOAA Office of Coast Survey – NOAA Electronic Navigational Charts download website on December 15, 2006.
(<http://chartmaker.ncd.noaa.gov/mcd/ENC/download.htm>)

Recommendations for charting action are described in sections D.1.4 to D.1.6.

D.1.1 Dangers to Navigation

- Item number 1 is a possible 13.6m shoal located at the entrance to a small bay on Baranof Island. This feature is approximately 300m offshore and 100m NW of an islet. Sparse lidar coverage exists over the feature and requires further investigation by boat to determine the least depth.
- Item number 2 is a possible 16.4m shoal located in the vicinity of a charted 35m . Lying approximately 250m off the coast of Baranof Island at the entrance to Necker Bay. Sparse

lidar coverage exists over the feature and requires further investigation by boat to determine the extent and least depth.

- Item number 3 is a possible 12.1m shoal located approximately 150m SE of an islet and 1000m W of the coast of Baranof Island. Sparse lidar coverage exists over the feature and requires further investigation by boat to determine the extent and least depth.
- Item number 4 is a possible 3.0m rock located at the seaward extent of a large coastal kelp area. This feature is located approximately 100m NW of an islet and 1000m W of the coast of Baranof Island. This feature requires verification by boat.
- Item number 5 is a possible 12.8m shoal located adjacent to a charted 42m approximately 250m NW of an islet at the entrance to Necker Bay. Sparse lidar coverage exists over the feature and requires further investigation by boat to determine the extent and least depth.
- Item number 6 is a possible 11.9m shoal located adjacent to a charted 25.6m approximately 200m NW of an islet at the entrance to Necker Bay. This feature requires further investigation by boat to determine the extent and least depth of the feature.
- Item number 7 is a possible 15.9m shoal located at a charted 21.9m approximately 70m N of an islet in the Guibert Islets. This feature requires further investigation by boat to determine the extent and least depth of the feature.
- Item number 8 is a possible 14.0m shoal located adjacent to a charted 35m approximately 200m S of an islet in the Guibert Islets at the entrance to Necker Bay. This feature requires further examination by boat to determine the extent and least depth of the feature.
- Item number 9 is a possible 15.1m shoal located approximately 200m NW of an islet in the Guibert Islets at the entrance to Necker Bay. This feature requires further investigation by boat to determine the extent and least depth of the feature.
- Item number 10 is a 13.4m shoal located adjacent to a charted 35m approximately 300m SW of an islet in the Guibert Islets.
- Item number 11 is a 9.7m shoal located at the SW extent of a bank extending from an islet. This shoal is approximately 200m SW of an islet in the Guibert Islets at the entrance to Necker Bay.
- Item number 12 is a possible 6.8m Rock in kelp located adjacent to a charted 31m, approximately 150m NW of an islet in the Guibert Islets group at the entrance to Necker Bay. This feature requires further examination by boat if possible to determine the extent and least depth of the feature.
- Item number 13 is a possible 7.6m Rock in kelp located adjacent to a charted 31m approximately 100m SE of a headland adjacent to Yamani Cove on the north coast at the entrance to Necker Bay. This feature requires further investigation by boat if possible to determine the extent and least depth of the feature.
- Item number 14 is a 6.7m Rock located adjacent to a charted 14.6m located in Yamani Cove in a channel between Yamani Island and Baranof Island. Kelp areas exist to the north of this feature.

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- Item number 15 is a possible 9.8m shoal located on a charted 23.7m, approximately 100m SW of a group of islets seaward of Ya mani Island at the north coast of the entrance to Necker Bay. This feature requires further examination by boat to determine the extent and least depth of the feature.
 - Item number 16 is a possible 6.3m shoal located adjacent to a charted 21.9m, approximately 350m SW of Ya mani Island at the approach to the north coast entrance to Necker Bay. This feature requires further investigation by boat to determine the extent and least depth.
 - Item number 17 is a possible rock awash which is likely a doubtful sounding and requires verification by vessel. This feature is located approximately 250m SW of Ya mani Island at the approach along the north coast to Necker Bay.
 - Item number 18 is a 11.5m Rk located 100m S of the southern most islet in the Slate Islets and 50m S of two drying rocks at the northern entrance to Necker Bay.
 - Item number 19 is a possible 12.6m Rk located at the seaward extent of a kelp area 100m SW of the Slate Islets. This feature requires further examination by boat to define the feature and obtain least depth.
 - Item number 20 is a possible 10.3m Rk in kelp located adjacent to a charted 27.4m, approximately 50m W of the Slate Islets. This feature requires further examination by boat if possible to define the extent and least depth of the feature.
 - Item number 21 is a possible 9.2m Rk in kelp located in a bay inshore of the Slate Islets and 200m offshore of Baranof Island. This feature requires further examination to define the extent and least depth.
 - Item number 22 is a possible 12.3m Rk in kelp located on a charted 25.6m, in a channel between two islets in the Slate Islets. This feature is 100m SW of a charted islet which was not detected by lidar or seen on the downward looking video. This feature requires further investigation by boat to determine the extent and least depth.
 - Item number 23 is a 15.4m Rk located on a charted 27.4m located between islets in the northern part of the Slate Islets group.
 - Item number 24 is a possible 7.7m Rk in a kelp area. This is an extensive kelp area with dimensions of 50m x 70m and is a possible hazard during junctioning by boat. This possible rock in kelp is located in a sheltered channel between the Slate Islets and Baranof Island. This feature requires further examination if possible.
 - Item number 25 is a possible 15.2m shoal located approximately 250m NW of the northern islet of the Slate Islets. This feature requires further investigation to determine the extent of the feature; however, less water is unlikely.
 - Item number 26 is a possible 4.9m Rk in kelp located on a charted 20.1m. This feature is located between two northern islets of the Slate Islets leading into a sheltered channel between the Slate Islets and Baranof Island. This feature requires further examination if possible to determine the extent and least depth.
 - Item number 27 is a possible 16.1m shoal located approximately 300m W of Aspid Cape at the southern entrance to Walker Channel.

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- Item number 28 is a possible 10.6m shoal located on a charted 18.2m at the upper reaches of Jamboree Bay. This feature requires further examination to determine the extent and least depth of the shoal.
 - Item number 29 is a possible 10.6m Rk in kelp located approximately 130m off the east coast of Walker Channel at the north entrance to Jamboree Bay. This feature requires further investigation to determine the extent and least depth.
 - Item number 30 is a possible 10.7m Rk in kelp at the seaward extent of a large kelp area, approximately 70m NW of an islet in the middle of Walker Channel. This feature requires further examination if possible to determine the extent and least depth.
 - Item number 31 is a 10.0m shoal located amongst kelp approximately 250m NW of an islet in the middle of Walker Channel.
 - Item number 32 is a possible 15.2m shoal located on a charted 23.7m between an islet and 150m off Baranof Island approaching the entrance to Crawfish Inlet. This feature requires further investigation to determine the extent of the feature; however, less water is unlikely.
 - Item number 33 is a possible 6.1m Rk in kelp located approximately 150m off the NE coast of Walker Channel at the mouth of a sheltered bay. This feature requires further investigation if possible to determine the extent and least depth.
 - Item number 34 is a 12.8m Rk located amongst kelp adjacent to a charted 33m. This feature is located approximately 100m off the NE coast of Walker Channel.
 - Item number 35 is a possible 6.8m Rk in a large kelp area approximately 70m off the NE coast of Walker Channel at the entrance to a sheltered bay. This feature requires further examination if possible to determine the extent and least depth.
 - Item number 36 is most likely a rock awash in kelp located on a charted 4m between an islet and Baranof Island in a shallow sheltered bay.
 - Item number 37 is a possible 11.7m shoal located 100m off the NW coast of Walker Channel at the approach to a sheltered bay. This feature requires further investigation by boat to determine the extent of the feature; however, less water is unlikely.
 - Item number 38 is a 7.6m shoal located between a charted 20.1m and 31m at the entrance to a small bay approximately 200m off the NW coast of Walker Channel.
 - Item number 39 is a possible 10.6m shoal located on a charted 25.6m approximately 150m W of the NW headland approaching the entrance to Walker Channel. Other possible shoals are in the vicinity and this feature requires further investigation to determine the extent and least depth.
 - Item number 40 is a possible 15.2m shoal located 700m SW of Yamanai Island, SE of the Slate Islets at the approaches to Necker Bay. This feature requires further investigation to determine the extent and least depth.
 - Item number 41 is a possible 9.6m shoal located 300m E of the SE coast of Beauchamp Island in Walker Channel. This feature requires further investigation to determine the extent and least depth.

D.1.2 AWOIS

No AWOIS were assigned to this Task Order.

D.1.3 Aids To Navigation

No Aids to Navigation were seen or detected in the survey area for H11540.

D.1.4 Charted Depths and Features

Registry number H11540 covers part of NOAA chart 17328 covering the SE coast of Beauchamp Island, the peninsular on Baranof Island between Walker Channel and Necker Bay and the Guibert Islets. From the Source Diagram, the area covered by survey area H11540 was covered by NOS surveys between 1900 and 1939, presumably by leadline. Partial bottom coverage was achieved. The chart in this area was inadequately surveyed, with only the coastline and a number of rocks and islets along the coast portrayed.

The area surveyed is represented by the BASE surface and S-57 feature file in considerably more detail than is currently shown on the chart. The following general recommendations are relevant:

- a. **Coastline.** The charted coastline agrees very well with the surveyed coastline for the larger islands and islets. The surveyed coastline differs from the charted position by up to 100m in some parts of the survey area. It is recommended that the coastline on the chart be amended to match the LADS surveyed and extrapolated MHWL.
- b. **Inshore Islets.** A large number of islets have been surveyed close to the coastline. Many of these are not shown on the chart, as the charted coastline is highly generalized. It is recommended that the chart be amended to match the LADS survey deliverables. Where significant these islets are detailed in the Chart Comparison Spreadsheet in section D.1.6.
- c. **Rocks.** Many rocks and drying rocks have been surveyed along the coastline, which are not presently shown on the chart. It is recommended that the chart be amended to match the LADS survey deliverables. Where significant, these rocks are detailed in the Chart Comparison Spreadsheet in section D.1.6.

D.1.5 Chart Comparison

In addition to the general recommendations above, some 244 significant differences between the chart and the LADS survey have also been identified. Specific recommendations for these differences are described in section D.1.6 Chart Comparison Spreadsheet. An expanded version of the spreadsheet is included digitally on the USB hard drive (H11540_V1_ChartComp.xls). A CARIS .hob file containing just the chart comparison items has also been compiled and is provided as part of survey deliverables (ChartComp.hob). The attribution methodology for this file is presented in the table below.

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Attribute 1	Attribute 2	Attribute 3	Attribute 4
Nautical publication information	M_NPUB P		Used to relate additional nautical information or publications to the data.	INFORM (used for storing a unique chart comparison ID)	NINFOM (used for storing the charting recommendation)	PUBREF (used for storing a reference to a Feature for Investigation)	PICREP (used for storing a link to waveform screenshots)

Table 2: S-57 attribution for the CARIS ChartComp.hob file

The chart comparison was conducted by reviewing the chart, the LADS survey deliverables and the digital orthophoto mosaic. For each item identified, screen dumps of the Local Area Display and Raw Waveform Display were extracted from the LADS Mk II Ground System.

These have been reviewed in order to make the following assessments:

- a. Type of Feature
- b. Kelp Area
- c. Least Depth Found
- d. Charting Recommendation
- e. Remarks

When the least depth has been adequately surveyed by lidar, the Least Depth Found Column is populated with a 'Y' for yes. The charting recommendation for a feature that has an adequately surveyed least depth will be either 'Insert' for a new feature, 'Replace' for an amendment to an existing charted feature or 'Remove' for a disproved charted feature.

When the least depth has NOT been found by lidar (populated with an 'N'), the chart comparison number has been used as the identifier within the S-57 file that contains the features for examination. If a chart comparison item had previously been identified as a feature for examination during data processing, a reference is made in the 'Remarks' column to the S-57 feature for examination item. For all chart comparison items that have not had least depth surveyed adequately, a suggested boatwork examination method acronym has been assigned. The description of these is provided in Section D.2.4 Recommended Examination Method of Features Requiring Further Investigation.

Each chart comparison was categorized as follows:

1. New shoal found
2. Charted shoal disproved / not found

The fields in the Chart Comparison Spreadsheet have been developed from experience learned and feedback received from previous lidar surveys in Alaska, witnessing survey operations in NOAA ship Rainier, from meetings at PHB and UNH and the 2007 NOAA Field Procedures

Workshop. They have been designed for ease of use and to minimize double handling of data and transcription. Continued feedback is welcomed in order to develop these formats to achieve further efficiencies in data handling.

D.1.6 Chart Comparison Spreadsheet

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks	
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)						
1	AU1	1				-4.10	56° 38' 18.4801"	135° 7' 58.489"	Islet	Y	Y	Insert	All items covered by 4x4m laser spot spacing at 200% lidar coverage.	
2	AU4	1				-3.32	56° 38' 36.5359"	135° 7' 40.1333"	Drying Rk	Y	Y	Insert		
3	AU5	1				0.75	56° 38' 43.0213"	135° 7' 40.0202"	Rk	Y	N	VV		Possible Rk in kelp.
4	AU6	1				0.62	56° 38' 44.7598"	135° 7' 44.1106"	Rk	Y	N	VV		Possible Rk in kelp.
5	AU7	1				0.53	56° 38' 46.3585"	135° 7' 36.3824"	Rk Awash	Y	N	VV		Possible Rk Awash in kelp.
6	AU8	2	Islet	56° 38' 49"	135° 7' 56"	0.37	56° 38' 50.3099"	135° 7' 55.898"	Rk Awash	Y	N	VV		Possible Rk Awash in kelp.
7 A	U9	2	Drying Rk	56° 38' 46"	135° 8' 14"	-3.60	56° 38' 46.0511"	135° 8' 13.6604"	Islet	Y	Y	Replace		
8	AU10	1				0.09	56° 38' 48.1186"	135° 8' 9.8426"	Rk Awash	Y	N	VV		Possible Rk Awash in kelp.
9	AU11	1				-4.70	56° 38' 48.2903"	135° 8' 18.015"	Islet	N	Y	Insert		
10	AU12	2	Islet	56° 38' 39"	135° 7' 50"							Remove		Not detected by lidar, not observed in downward looking video.
11	AU13	1				-0.77	56° 38' 38.8493"	135° 7' 58.6693"	Drying Rk	Y	Y	Insert		
12	AU14	1				13.57	56° 38' 36.2659"	135° 8' 9.2609"	Rk	N	N	JV		Refer to FEAU17. See Danger to Navigation Report. Item 1.
13	AU15	1				13.51	56° 38' 48.9746"	135° 8' 49.4927"	Rk	Y	Y	Insert		
14 A	U17	2	Drying Rk	56° 39' 11"	135° 9' 2"							Remove		Not detected by lidar, not observed in downward looking video.

Shoal Categories
 1-New Shoal Found
 2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
15	A U18	2	Drying Rk	56° 39' 17"	135° 8' 51"							Remove	Not detected by lidar, not observed in downward looking video.
16	AU19	2	48	56° 39' 19"	135° 8' 57"	23.87	56° 39' 18.9547"	135° 8' 55.3574"	Slope	N	Y	Remove	
17	A U20	2	Drying Rk	56° 39' 28"	135° 8' 47"							Remove	Not detected by lidar, not observed in downward looking video.
18	AU21	2	35	56° 39' 40"	135° 9' 1"	16.44	56° 39' 37.0235"	135° 9' 0.1836"	Rk	N	N	JV	Refer to FEAU23. See Danger to Navigation Report. Item 2.
19	AU22	2	27.4	56° 39' 40"	135° 8' 49"	8.54	56° 39' 40.3866"	135° 8' 46.8398"	Rk	Y	N	BV	Possible Rk in Kelp.
20	AU23	1				-1.07	56° 39' 0.099"	135° 7' 52.8524"	Drying Rk	N	Y	Insert	
21	AU24	1				-3.28	56° 39' 0.3341"	135° 7' 55.8264"	Drying Rk	N	Y	Insert	
22	AU26	1				-4.00	56° 40' 15.7238"	135° 8' 26.7475"	Islet	Y	Y	Insert	
23	AU27	1				-1.87	56° 40' 17.3449"	135° 8' 28.4536"	Drying Rk	Y	Y	Insert	
24	AU29	1				1.82	56° 41' 11.6102"	135° 7' 58.2773"	Rk	Y	N	VV	Possible Rk in Kelp.
25	AU30	1				12.14	56° 38' 17.831"	135° 9' 28.9328"	Rk	N	N	JV	Refer to FEAU3. See Danger to Navigation Report. Item 3.
26	AU31	1				2.55	56° 38' 23.7782"	135° 9' 54.3848"	Rk	Y	N	VV	Possible Rk in Kelp.
27	AU32	1				-4.60	56° 38' 29.8392"	135° 9' 57.164"	Islet	Y	Y	Insert	
28	AU33	2	8.5	56° 38' 33"	135° 9' 59"	3.03	56° 38' 32.9737"	135° 9' 58.2473"	Rk	Y	N	VV / BV	Possible Rk in Kelp. See Danger to Navigation Report. Item 4.
29	AU34	2	42	56° 38' 33"	135° 10' 14"	12.82	56° 38' 34.22"	135° 10' 7.8866"	Rk	Y	N	JV	Refer to FEKAU3. Possible Rk in Kelp. See Danger to Navigation Report.

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
												Item 5.	
30	AU35	2	25.6	56° 38' 41"	135° 10' 1"	11.87	56° 38' 38.692"	135° 10' 0.1956"	Rk	Y	N	JV	Refer to FEKAU10. Possible Rk in Kelp. See Danger to Navigation Report. Item 6.
31	AU36	2	21.9	56° 38' 56"	135° 10' 18"	15.86	56° 38' 56.4223"	135° 10' 17.5228"	Rk	N	N	JV	See Danger to Navigation Report. Item 7.
32	AU37	2	35	56° 39' 2"	135° 10' 11"	14.05	56° 39' 4.3034"	135° 10' 7.6397"	Rk	N	N	JV	See Danger to Navigation Report. Item 8.
33	AU39	1				15.12	56° 39' 13.8514"	135° 10' 12.0274"	Rk	N	N	JV	Refer to FEAU10. See Danger to Navigation Report. Item 9.
34	AU40	2	42	56° 39' 19"	135° 9' 57"	18.48	56° 39' 21.5917"	135° 9' 58.4338"	Rk	N	N	JV	
35	AU41	2	35	56° 39' 27"	135° 10' 2"	13.38	56° 39' 25.8109"	135° 9' 56.7803"	Rk	N	Y	Replace	See Danger to Navigation Report. Item 10.
36	AU42	1				9.69	56° 39' 31.4399"	135° 9' 58.3178"	Rk	N	Y	Insert	See Danger to Navigation Report. Item 11.
37	AU43	2	31	56° 39' 39"	135° 9' 58"	6.77	56° 39' 40.9428"	135° 9' 54.3485"	Rk	Y	N	BV	Refer to FEKAU69. Possible Rk in Kelp. See Danger to Navigation Report. Item 12.
38	AU44	1				12.43	56° 39' 37.1542"	135° 9' 52.92"	Rk	N	Y	Insert	
39	AU45	1				13.20	56° 39' 44.1403"	135° 9' 53.7635"	Rk	N	Y	Insert	
40	AU46	2	35	56° 41' 15"	135° 9' 2"	15.78			Slope	N	Y	Remove	
41	AU49	1				7.61	56° 41' 1.1335"	135° 9' 43.8761"	Rk	Y	N	BV	Refer to FEKAU61. Possible Rk in Kelp.
42	AU50	2	33	56° 41' 3"	135° 9' 58"	9.81	56° 41' 4.9765"	135° 9' 57.6108"	Rk	Y	N	BV	Possible Rk in Kelp.

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
43	AU51	1				-4.40	56° 41' 5.4269"	135° 10' 5.6885"	Islet	Y	Y	Insert	
44	AU52	1				10.35	56° 40' 58.1408"	135° 10' 8.9879"	Rk	Y	Y	Insert	
45	AU53	2	37	56° 40' 57"	135° 10' 7"	3.02	56° 40' 55.4383"	135° 10' 9.4256"	Rk	Y	N	BV	Possible Rk in Kelp.
46	AU54	1				0.41	56° 40' 48.0328"	135° 10' 31.2845"	Rk Awash	Y	Y	Insert	
47	AU55	1				1.19	56° 40' 43.1436"	135° 10' 30.2362"	Rk	Y	N	VV / BV	Possible Rk in Kelp.
48	AU57	1				0.59	56° 40' 33.1352"	135° 10' 34.6559"	Rk Awash	Y	Y	Insert	
49	AU58	2	31	56° 40' 27"	135° 10' 25"	7.61	56° 40' 25.64"	135° 10' 27.4912"	Rk	Y	N	BV	Refer to FEAU22. Possible Rk in Kelp. See Danger to Navigation Report. Item 13.
50	AU59	1				1.09	56° 40' 25.0813"	135° 10' 36.5005"	Rk	Y	N	VV	Refer to FEKAU45. Possible Rk in Kelp.
51	AU60	2	Islet	56° 40' 25"	135° 10' 41"		0° 0' 0"	0° 0' 0"	Coast	Y	Y	Remove	Surveyed as coastline.
52	AU61	1				-3.70	56° 40' 29.1828"	135° 10' 53.1484"	Islet	Y	Y	Insert	
53	AU62	1				0.85	56° 40' 28.1201"	135° 10' 53.7251"	Rk	Y	N	VV / BV	Possible Rk in Kelp.
54	AU64	2	4	56° 40' 31"	135° 10' 58"	0.21	56° 40' 32.2583"	135° 10' 55.6331"	Rk Awash	Y	Y	Replace	
55	AU65	1				-0.82	56° 40' 34.4053"	135° 11' 2.4576"	Drying Rk	N	Y	Insert	
56	AU67	1				3.97	56° 40' 31.3309"	135° 11' 12.134"	Rk	Y	N	BV	Refer to FEKAU42. Possible Rk in Kelp.
57	AU68	2	5.8	56° 40' 39"	135° 11' 22"	0.52	56° 40' 40.9105"	135° 11' 22.0628"	Rk Awash	N	Y	Replace	
58	AU69	1				0.05	56° 40' 44.5267"	135° 11' 19.2595"	Rk Awash	Y	Y	Insert	

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
59	AU70	2	18.2	56° 40' 34"	135° 11' 20"	10.36	56° 40' 33.7184"	135° 11' 24.8046"	Rk	Y	N	BV	Refer to FEKAU40. Possible Rk in Kelp.
60	AU71	1				0.61	56° 40' 29.6375"	135° 11' 21.8875"	Rk	Y	N	VV	Possible Rk in Kelp.
61	AU72	2	14.6	56° 40' 31"	135° 11' 37"	6.68	56° 40' 31.8331"	135° 11' 33.6041"	Slope	Y	Y	Remove	See Danger to Navigation Report. Item 14.
62	AU76	1				-3.40	56° 40' 24.0856"	135° 11' 54.0546"	Islet	N	Y	Insert	
63	AU77	1				0.55	56° 40' 20.0867"	135° 11' 44.6579"	Rk Awash	N	Y	Insert	
64	AU78	2	5.8	56° 40' 19"	135° 11' 37"				Slope	N	Y	Remove	
65	AU80	1				0.66	56° 40' 17.2621"	135° 11' 32.0777"	Rk	N	Y	Insert	
66	AU81	1				5.52	56° 40' 21.0738"	135° 10' 54.53"	Rk	Y	N	BV	Possible Rk in Kelp.
67 A	U82	2	Drying Rk	56° 40' 20"	135° 11' 5"				Slope	N	Y	Remove	Surveyed as drying shelf.
68	AU84	1				-1.46	56° 40' 21.6178"	135° 11' 9.6353"	Drying Rk	Y	N	VV	Possible Drying Rk in Kelp.
69	AU85	2	4	56° 40' 18"	135° 11' 6"				Slope	N	Y	Remove	
70	AU86	1				4.13	56° 39' 54.6286"	135° 10' 43.0478"	Rk	Y	N	BV	Possible Rk in Kelp.
71	AU87	2	13.7	56° 39' 51"	135° 10' 52"	12.22	56° 39' 51.6895"	135° 10' 51.9344"	Rk	Y	N	JV	Refer to FEAU12. Possible Rk in Kelp.
72	AU88	1				9.87	56° 39' 54.0288"	135° 10' 50.3706"	Rk	Y	N	JV	Refer to FEKAU34. Possible Rk in Kelp.
73 A	U89	2	Drying Rk	56° 39' 58"	135° 10' 50"	-3.70	56° 39' 58.6714"	135° 10' 49.3673"	Islet	Y	Y	Replace	
74	AU93	1				5.42	56° 40' 5.1625"	135° 11' 12.552"	Rk	Y	N	BV	Refer to FEKAU33. Possible Rk in Kelp.
75	AU94	2	18.2	56° 40' 8"	135° 11' 14"				Slope	Y	Y	Remove	
76	AU96	1				-3.60	56° 40' 13.5793"	135° 11' 22.5532"	Islet	Y	Y	Insert	

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
77	AU97	1				-2.61	56° 40' 12.7722"	135° 11' 21.0782"	Drying Rk	Y Y		Insert	
78	A U98	2	Drying Rk	56° 40' 6"	135° 11' 18"				Coast	N Y		Remove	Surveyed as coastline.
79	AU99	2	23.7	56° 39' 50"	135° 11' 10"	9.07	56° 39' 52.286"	135° 11' 11.6614"	Rk	Y N		JV	Possible Rk in Kelp.
80	AU100	1				6.75	56° 39' 47.6881"	135° 11' 11.3579"	Rk	Y N		BV	Possible Rk in Kelp.
81	AU101	1				7.40	56° 39' 45.3823"	135° 11' 6.6494"	Rk	Y N		BV	Refer to FEKAU31. Possible Rk in Kelp.
82	A U102	2	Drying Rk	56° 39' 40"	135° 11' 11"	-4.00	56° 39' 40.4136"	135° 11' 11.1718"	Islet	Y Y		Replace	
83	AU103	1				-3.50	56° 39' 38.4102"	135° 11' 13.9492"	Islet	Y Y		Insert	
84	AU104	2	23.7	56° 39' 36"	135° 11' 19"	9.77	56° 39' 37.1009"	135° 11' 17.2554"	Rk	N N		JV	See Danger to Navigation Report. Item 15.
85	AU105	1				6.37	56° 39' 39.789"	135° 11' 19.1641"	Rk	Y N		BV	Refer to FEKAU24. Possible Rk in Kelp.
86	AU106	1				2.13	56° 39' 41.5181"	135° 11' 23.4823"	Rk	Y N		VV / BV	Refer to FEKAU25. Possible Rk in Kelp.
87	A U107	2	Drying Rk	56° 39' 43"	135° 11' 21"	-8.90	56° 39' 43.659"	135° 11' 20.6574"	Islet	N Y		Replace	
88	AU108	1				-3.60	56° 39' 54.5627"	135° 11' 19.2808"	Islet	Y Y		Insert	
89	AU109	2	21.9	56° 39' 45"	135° 11' 51"	6.28	56° 39' 47.021"	135° 11' 48.2478"	Rk	Y N		BV	Refer to FEAU5. Possible Rk in Kelp. See Danger to Navigation Report. Item 16.
90	AU110	1				0.15	56° 39' 49.0489"	135° 11' 40.9002"	Rk Awash	Y N		VV / BV	Possible Rk in Kelp. See Danger to Navigation Report. Item 17.
91	AU111	1				-3.60	56° 39' 59.9918"	135° 11' 36.5935"	Islet	Y Y		Insert	

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
92	AU112	1				-1.12	56° 40' 1.4603"	135° 11' 36.5694"	Drying Rk	Y Y		Insert	
93	AU113	1				10.08	56° 40' 0.4598"	135° 11' 44.2529"	Rk	Y N		JV	Refer to FEKAU32. Possible Rk in Kelp.
94	AU114	1				8.18	56° 40' 4.3702"	135° 11' 41.8391"	Rk	Y N		BV	Possible Rk in Kelp.
95	AU116	1				13.74	56° 40' 2.7512"	135° 11' 51.5659"	Rk	N N		JV	
96	AU117	1				-3.80	56° 40' 8.7668"	135° 11' 56.391"	Islet	Y Y		Insert	
97	AU118	1				12.55	56° 40' 4.0123"	135° 12' 5.4256"	Rk	N N		JV	Refer to FEKAU28.
98	AU119	1				4.81	56° 40' 7.5076"	135° 12' 3.1442"	Rk	Y N		VV / BV	Possible Rk in Kelp.
99	AU120	1				-0.64	56° 40' 12.1703"	135° 11' 57.3428"	Drying Rk	Y Y		Insert	
100	AU121	1				-2.76	56° 40' 14.8836"	135° 12' 11.1265"	Drying Rk	Y Y		Insert	
101	AU122	2	Islet	56° 40' 17"	135° 12' 12"				Coast	Y Y		Remove	Surveyed as coastline.
102	AU123	2	Islet	56° 40' 15"	135° 12' 16"				Coast	Y Y		Remove	Surveyed as coastline.
103	AU124	2	Rock	56° 40' 17"	135° 12' 25"	-1.04	56° 40' 17.2099"	135° 12' 24.4026"	Drying Rk	Y Y		Replace	
104	AU125	1				-0.81	56° 40' 19.0441"	135° 12' 28.8338"	Drying Rk	Y Y		Insert	
105	AU126	2	Drying Rk	56° 40' 17"	135° 12' 35"	-4.90	56° 40' 18.115"	135° 12' 36.999"	Islet	Y Y		Replace	
106	AU127	1				-4.40	56° 40' 15.852"	135° 12' 40.2408"	Islet	N Y		Insert	
107	AU128	1				-0.90	56° 40' 12.6944"	135° 12' 29.2792"	Drying Rk	Y Y		Insert	
108	AU129	1				-0.42	56° 40' 1.9672"	135° 12' 28.0548"	Rk Awash	Y Y		Insert	

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
109	AU130	2	12.8	56° 40' 2"	135° 12' 40"	9.71	56° 40' 1.2425"	135° 12' 38.0023"	Rk	Y	N	BV	Possible Rk in Kelp.
110	AU131	1				11.14	56° 39' 57.5708"	135° 12' 37.2546"	Rk	Y	N	JV	Refer to FEKAU60. Possible Rk in Kelp.
111	AU132	1				-2.18	56° 39' 48.1518"	135° 12' 45.0756"	Drying Rk	Y	Y	Insert	
112	AU133	1				11.55	56° 39' 46.6297"	135° 12' 48.1061"	Rk	Y	Y	Insert	See Danger to Navigation Report. Item 18.
113	AU134	1				7.41	56° 39' 53.5968"	135° 12' 55.714"	Rk	Y	N	BV	Possible Rk in Kelp.
114	AU135	1				12.94	56° 39' 58.5454"	135° 13' 5.2561"	Rk	N	N	JV	
115	AU136	1				12.57	56° 40' 2.3894"	135° 13' 12.5972"	Rk	N	N	JV	Possible rock in kelp See Danger to Navigation Report. Item 19.
116	AU137	1				-3.60	56° 40' 4.0228"	135° 13' 5.5826"	Islet	Y	Y	Insert	
117	AU138	2	Drying Rk	56° 40' 5"	135° 13' 3"	-7.00	56° 40' 4.9667"	135° 13' 2.2296"	Islet	Y	Y	Replace	
118	AU139	2	Islet	56° 40' 7"	135° 13' 2"	-0.48	56° 40' 6.3887"	135° 12' 59.7906"	Drying Rk	Y	Y	Replace	
119	AU140	1				9.54	56° 40' 9.3194"	135° 13' 16.4219"	Rk	Y	Y	Insert	
120	AU142	2	27.4	56° 40' 14"	135° 13' 26"	10.29	56° 40' 12.6671"	135° 13' 24.6655"	Rk	Y	N	JV	Possible Rk in Kelp. See Danger to Navigation Report. Item 20.
121	AU143	2	23.7	56° 40' 19"	135° 13' 14"	7.57	56° 40' 17.486"	135° 13' 14.524"	Rk	Y	N	BV	Refer to FEKAU7. Possible Rk in Kelp.
122	AU144	1				15.05	56° 40' 18.3936"	135° 13' 27.6625"	Rk	N	Y	Insert	
123	AU145	1				8.77	56° 40' 17.6016"	135° 13' 5.9326"	Rk	Y	N	BV	Refer to FEKAU8. Possible Rk in Kelp.
124	AU146	2	31	56° 40' 30"	135° 13' 11"	19.98	56° 40' 28.33"	135° 13' 9.7889"	Rk	N	N	JV	
125	AU147	2	21.9	56° 40' 28"	135° 13' 0"	8.28	56° 40' 29.6274"	135° 12' 55.7928"	Rk	Y	N	BV	Possible Rk in Kelp.

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks	
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)						
126	AU148	1				-1.19	56° 40' 28.5071"	135° 12' 50.7773"	Drying Rk	Y Y		Insert		
127	AU149	1				9.20	56° 40' 25.6202"	135° 13' 6.1378"	Rk	Y N		BV	Refer to FEKAU14. Possible Rk in Kelp. See Danger to Navigation Report. Item 21.	
128	AU150	1				12.08	56° 40' 36.2338"	135° 13' 1.533"	Rk	N Y		Insert		
129	AU151	1				0.03	56° 40' 43.5796"	135° 12' 56.957"	Rk Awash	Y Y		Insert		
130	AU152	1				-0.15	56° 40' 45.7532"	135° 13' 0.2208"	Rk Awash	Y Y		Insert		
131	AU154	2	16.4	56° 40' 47"	135° 13' 22"	7.63	56° 40' 46.9664"	135° 13' 18.3475"	Rk	Y N		BV	Possible Rk in Kelp.	
132	AU155	2	Islet	56° 40' 29"	135° 13' 37"								Remove	Not detected by lidar, not observed in downward looking video?
133	AU156	2	Drying Rk	56° 40' 41"	135° 13' 31"	-4.30	56° 40' 41.1373"	135° 13' 31.1689"	Islet	Y Y		Replace		
134	AU157	2	10.9	56° 40' 38"	135° 13' 33"	5.15	56° 40' 39.5454"	135° 13' 34.3322"	Rk	Y N		BV		
135	AU158	1				6.90	56° 40' 37.6687"	135° 13' 39.1084"	Rk	Y Y		Insert	Possible Rk in Kelp.	
136	AU159	2	25.6	56° 40' 26"	135° 13' 43"	12.35	56° 40' 26.3838"	135° 13' 42.3102"	Rk	N N		JV	Refer to FEAU1. See Danger to Navigation Report. Item 22.	
137	AU160	1				8.22	56° 40' 31.7881"	135° 13' 53.5562"	Rk	Y N		BV	Possible Rk in Kelp.	
138	AU161	2	25.6	56° 40' 39"	135° 14' 9"	9.30	56° 40' 38.9654"	135° 14' 4.3685"	Rk	Y Y		Replace		
139	AU162	1				-5.00	56° 40' 39.8669"	135° 13' 53.1167"	Islet	Y Y		Insert		
140	AU163	2	27.4	56° 40' 44"	135° 14' 11"	15.40	56° 40' 43.5461"	135° 14' 10.3632"	Rk	N Y		Replace	See Danger to Navigation Report. Item 23.	

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks	
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)						
141	AU164	2	Drying Rk	56° 40' 47"	135° 13' 58"	-4.60	56° 40' 46.101"	135° 13' 58.4515"	Islet	Y	Y	Replace	All items covered by 4x4m laser spot spacing at 200% lidar coverage.	
142	AU165	1				-3.20	56° 40' 44.4176"	135° 13' 56.7678"	Drying Rk	Y	Y	Insert		
143	AU166	1				7.70	56° 40' 47.9726"	135° 13' 51.5978"	Rk	Y	N	BV		Possible Rk in Kelp.
144	AU167	1				7.67	56° 40' 47.1335"	135° 13' 43.2559"	Rk	Y	N	VV / BV		Refer to FEKAU21. Possible Rk in Kelp. See Danger to Navigation Report. Item 24.
145	AU169	2	Islet	56° 40' 56"	135° 13' 39"							Remove		
146	AU170	1				0.49	56° 40' 55.8851"	135° 13' 42.33"	Rk Awash	Y	N	VV		Refer to FEKAU26. Possible Rk Awash in Kelp.
147	AU171	1				9.10	56° 40' 59.0776"	135° 13' 57.6653"	Rk	Y	N	JV		Refer to FEKAU18. Possible Rk in Kelp.
148	AU172	1				-0.67	56° 41' 0.2317"	135° 14' 8.8105"	Drying Rk	Y	Y	Insert		
149	AU173	1				-3.70	56° 41' 2.1397"	135° 14' 12.125"	Islet	Y	Y	Insert		
150	AU174	2	10.8	56° 40' 54"	135° 14' 20"	5.61	56° 40' 54.53"	135° 14' 19.6811"	Rk	Y	N	BV		Refer to FEKAU68. Possible Rk in Kelp.
151	AU175	1				15.16	56° 40' 59.9552"	135° 14' 24.958"	Rk	N	N	JV		See Danger to Navigation Report. Item 25.
152	AU176	1				3.35	56° 41' 3.0638"	135° 14' 14.9633"	Rk	Y	Y	Insert		
153	AU177	1				14.44	56° 41' 6.8338"	135° 14' 15.1573"	Rk	N	N	JV		
154	AU178	2	20.1	56° 41' 3"	135° 14' 5"	4.87	56° 41' 3.1466"	135° 14' 0.8462"	Rk	Y	N	BV		Refer to FEKAU16. Possible Rk in Kelp. See Danger to Navigation Report. Item 26.
155	AU179	2	20.1	56° 41' 16"	135° 14' 7"	4.63	56° 41' 13.295"	135° 14' 4.1896"	Rk	Y	N	BV		Possible Rk in Kelp.

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
156	AU180	2	25.6	56° 41' 19"	135° 13' 59"	18.13	56° 41' 18.1716"	135° 13' 56.7253"	Rk	N	N	JV	
157	AU181	1				-1.54	56° 41' 14.7646"	135° 13' 46.1798"	Drying Rk	Y	Y	Insert	
158	AU182	1				-2.97	56° 41' 17.4005"	135° 13' 42.4852"	Drying Rk	Y	Y	Insert	
159	AU183	1				6.78	56° 41' 19.1897"	135° 13' 45.1016"	Rk	Y	N	BV	Refer to FEKAU62. Possible Rk in Kelp.
160	AU185	1				16.15	56° 41' 26.8278"	135° 13' 58.3255"	Rk	N	Y	Insert	See Danger to Navigation Report. Item 27.
161	AU186	2	Islet	56° 41' 23"	135° 13' 38"							Remove	Surveyed as large 1 islet.
162	AU187	1				-3.09	56° 41' 24.6275"	135° 13' 34.6296"	Drying Rk	Y	Y	Insert	
163	AU188	1				-5.60	56° 41' 26.9034"	135° 13' 35.2369"	Islet	Y	Y	Insert	
164	AU189	1				7.52	56° 41' 27.7609"	135° 13' 39.9979"	Rk	Y	N	BV	Refer to FEKAU63. Possible Rk in Kelp.
165	AU190	1				14.45	56° 41' 33.5702"	135° 13' 37.8221"	Rk	N	Y	Insert	
166	AU191	1				-2.66	56° 41' 31.7904"	135° 13' 30.6077"	Drying Rk	Y	Y	Insert	
167	AU192	1				14.59	56° 41' 35.7572"	135° 13' 31.4882"	Rk	N	Y	Insert	
168	AU193	1				14.02	56° 41' 38.4659"	135° 13' 27.3475"	Rk	N	Y	Insert	
169	AU194	2	Drying Rk	56° 41' 39"	135° 13' 23"					N	N	Remove	Not detected by lidar, not observed in downward looking video
170	AU196	1				9.07	56° 41' 45.1493"	135° 12' 51.9635"	Rk	Y	Y	Insert	
171	AU198	1				-3.60	56° 41' 48.9851"	135° 12' 8.9633"	Islet	Y	Y	Insert	
172	AU200	2	Drying Rk	56° 41' 59"	135° 12' 6"	-4.60	56° 41' 58.8534"	135° 12' 6.0934"	Islet	Y	Y	Replace	
173	AU202	1				12.47	56° 42' 7.7076"	135° 11' 59.5583"	Rk	N	N	JV	Refer to FEKAU51.

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
174	AU204	1				-2.79	56° 42' 9.9662"	135° 11' 58.8905"	Drying Rk	Y Y		Insert	
175	AU205	1				13.12	56° 42' 20.3087"	135° 12' 3.2188"	Rk	N Y		Insert	
176	AU206	1				-4.70	56° 42' 30.5881"	135° 11' 48.9044"	Islet	Y Y		Insert	
177	AU207	2	27.4	56° 42' 28"	135° 11' 56"				Slope	N Y		Remove	
178	AU208	2	Drying Rk	56° 42' 33"	135° 11' 45"					Y N		Remove	Not detected by lidar, not observed in downward looking video.
179	AU209	2	Islet	56° 41' 59"	135° 10' 40"				Coast	N Y		Remove	Surveyed as coastline.
180	AU210	1				13.15	56° 41' 57.5131"	135° 10' 30.2722"	Rk	N N		JV	
181	AU211	2	18.2	56° 41' 54"	135° 10' 21"	10.60	56° 41' 54.515"	135° 10' 18.7842"	Rk	Y N		JV	Refer to FEKAU55. Possible Rk in Kelp. See Danger to Navigation Report. Item 28.
182	AU212	1				0.31	56° 41' 47.0346"	135° 10' 22.6816"	Rk Awash	Y Y		Insert	
183	AU213	2	Rock	56° 41' 48"	135° 10' 10"	0.19	56° 41' 47.0184"	135° 10' 9.1319"	Rk Awash	Y Y		Replace	
184	AU215	2	10.9	56° 42' 3"	135° 10' 21"				Slope	N Y		Remove	
185	AU216	1				10.83	56° 42' 43.4354"	135° 11' 35.8339"	Rk	Y N		JV	Possible Rk in Kelp. See Danger to Navigation Report. Item 29.
186	AU217	2	Islet	56° 43' 8"	135° 11' 50"				Coast	Y Y		Remove	Surveyed as coastline.
187	AU218	1				-2.10	56° 43' 9.5423"	135° 11' 51.5713"	Drying Rk	Y Y		Insert	
188	AU219	2	12.8	56° 43' 17"	135° 11' 58"				Slope	Y Y		Remove	
189	AU220	2	Drying Rk	56° 43' 7"	135° 12' 25"	-6.00	56° 43' 7.3722"	135° 12' 24.7644"	Islet	Y Y		Replace	

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
190	AU221	2	6.4	56° 43' 10"	135° 12' 25"	-0.77	56° 43' 9.3601"	135° 12' 26.456"	Drying Rk	Y Y	Replace		
191	AU222	1				10.75	56° 43' 10.106"	135° 12' 28.7838"	Rk	Y N	JV	Possible Rk in Kelp. See Danger to Navigation Report. Item 30.	
192	AU223	1				10.03	56° 43' 14.4005"	135° 12' 31.1814"	Rk	Y Y	Insert	See Danger to Navigation Report. Item 31.	
193	AU224	1				12.38	56° 43' 12.653"	135° 12' 33.9574"	Rk	Y N	JV	Refer to FEKAU64. Possible Rk in Kelp.	
194	AU225	1				12.90	56° 43' 15.1108"	135° 12' 35.258"	Rk	Y N	JV	Refer to FEKAU66. Possible Rk in Kelp.	
195	AU226	2	23.7	56° 43' 18"	135° 12' 27"	15.17	56° 43' 18.7234"	135° 12' 26.41"	Rk	N N	JV	See Danger to Navigation Report. Item 32.	
196	AU227	1				-4.10	56° 43' 10.1212"	135° 13' 10.5647"	Islet	Y Y	Insert		
197	AU228	1				-1.29	56° 43' 7.6066"	135° 12' 57.4297"	Drying Rk	Y Y	Insert		
198	AU230	2	18.2	56° 42' 57"	135° 12' 53"	13.67	56° 42' 57.8106"	135° 12' 52.231"	Rk	N Y	Replace		
199	AU231	1				14.21	56° 42' 29.6143"	135° 12' 55.1588"	Rk	N N	JV		
200	AU232	1				14.71	56° 42' 28.0156"	135° 12' 57.2782"	Rk	N Y	Insert		
201	AU233	1				6.12	56° 42' 9.2074"	135° 13' 44.5757"	Rk	Y N	BV	Refer to FEKAU44. Possible Rk in Kelp. See Danger to Navigation Report. Item 33.	
202	AU235	1				-4.20	56° 42' 16.3091"	135° 13' 45.021"	Islet	Y Y	Insert		
203	AU236	1				5.10	56° 42' 10.8695"	135° 13' 50.3699"	Rk	Y Y	Insert		
204	AU237	1				-3.50	56° 42' 6.9469"	135° 13' 53.9627"	Islet	Y Y	Insert		
205	AU238	1				-2.61	56° 42' 4.2628"	135° 13' 51.6616"	Drying Rk	Y Y	Insert		

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
206	AU239	1				7.22	56° 42' 2.3882"	135° 13' 53.3388"	Rk	Y	N	BV	Possible Rk in Kelp.
207	AU240	2	33	56° 41' 56"	135° 14' 24"	12.82	56° 41' 57.8346"	135° 14' 26.4685"	Rk	N	Y	Replace	See Danger to Navigation Report. Item 34.
208	AU241	1				6.78	56° 42' 2.0066"	135° 14' 28.4953"	Rk	Y	N	BV	Refer to FEKAU38. Possible Rk in Kelp. See Danger to Navigation Report. Item 35.
209	AU242	1				13.55	56° 42' 0.7538"	135° 14' 32.7894"	Rk	N	Y	Insert	
210	AU243	1				-0.04	56° 42' 1.7035"	135° 14' 18.681"	Rk Awash	Y	Y	Insert	
211	AU244	2	20.1	56° 42' 4"	135° 14' 33"	11.83	56° 42' 3.5744"	135° 14' 33.9976"	Rk	Y	Y	Replace	
212	AU245	1				-0.62	56° 42' 11.331"	135° 14' 31.0898"	Drying Rk	Y	Y	Insert	
213	AU246	1				0.17	56° 42' 19.7338"	135° 14' 24.2459"	Rk Awash	N	Y	Insert	
214	AU247	1				-2.53	56° 42' 20.5038"	135° 14' 22.7609"	Drying Rk	N	Y	Insert	
215	AU249	2	Drying Rk	56° 42' 27"	135° 14' 15"	-6.20	56° 42' 26.1137"	135° 14' 12.872"	Islet	N	Y	Replace	
216	AU250	1				0.66	56° 42' 28.2794"	135° 14' 13.6982"	Rk	N	Y	Insert	
217	AU251	2	8.2	56° 42' 30"	135° 14' 16"	2.51	56° 42' 31.5871"	135° 14' 14.6177"	Rk	N	Y	Replace	
218	AU252	2	4.5	56° 42' 33"	135° 14' 7"	1.93	56° 42' 32.9033"	135° 14' 5.1504"	Rk	N	Y	Replace	
219	AU254	1				-2.26	56° 42' 41.0558"	135° 14' 8.5967"	Drying Rk	Y	Y	Insert	
220	AU257	2	4	56° 42' 24"	135° 14' 26"	0.32	56° 42' 24.1042"	135° 14' 26.0952"	Rk Awash	Y	Y	Replace	See Danger to Navigation Report. Item 36.

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks	
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)						
221	AU258	2	Drying Rk	56° 42' 22"	135° 14' 29"	-3.60	56° 42' 22.2062"	135° 14' 29.1793"	Islet	N	Y	Replace	All items covered by 4x4m laser spot spacing at 200% lidar coverage.	
222	AU259	1				-1.55	56° 42' 21.6086"	135° 14' 28.2055"	Drying Rk	Y	Y	Insert		
223	AU260	1				3.04	56° 42' 18.6689"	135° 14' 32.1295"	Rk	N	Y	Insert		
224	AU261	1				-1.72	56° 42' 17.6728"	135° 14' 37.4302"	Drying Rk	Y	Y	Insert		
225	AU262	2	Islet	56° 42' 15"	135° 14' 52"	-3.18	56° 42' 15.3475"	135° 14' 52.0883"	Drying Rk	Y	Y	Replace		
226	AU263	2	Drying Rk	56° 42' 16"	135° 14' 58"				Drying Shelf	Y	Y	Remove		Surveyed as drying shelf.
227	AU264	2	Drying Rk	56° 42' 15"	135° 14' 56"				Drying Shelf	Y	Y	Remove		Surveyed as drying shelf.
228	AU265	2	Islet	56° 42' 15"	135° 14' 58"				Drying Shelf	N	N	Remove		Surveyed as drying shelf.
229	AU267	1				-1.08	56° 42' 7.8178"	135° 14' 44.2122"	Drying Rk	Y	Y	Insert		
230	AU268	1				11.72	56° 42' 2.1719"	135° 14' 45.3361"	Rk	Y	Y	Insert		
231	AU269	2	16.4	56° 42' 3"	135° 14' 49"				Slope	Y	Y	Remove		
232	AU270	1				20.42	56° 41' 59.3333"	135° 14' 45.6655"	Rk	N	N	JV		
233	AU271	1				11.66	56° 41' 53.4257"	135° 14' 51.8338"	Rk	N	N	JV		Refer to FEAU11. See Danger to Navigation Report. Item 37.
234	AU273	2	20.1	56° 41' 45"	135° 15' 12"	14.53	56° 41' 45.3638"	135° 15' 13.145"	Rk	N	Y	Replace		
235	AU274	1				14.25	56° 41' 45.3782"	135° 15' 16.8494"	Rk	N	Y	Insert		
236	AU275	1				7.63	56° 41' 43.3162"	135° 15' 19.1657"	Rk	N	Y	Insert	See Danger to Navigation Report. Item 38.	

Shoal Categories

1-New Shoal Found

2-Charted Shoal Disproved / Not Found

Sequence No	Shoal No	Category	CHARTED			SURVEYED			Type of Feature	Kelp Area	Least Depth Found	Charting Recommendation	Remarks
			Charted Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)	Surveyed Depth (meters)	NAD 83 Latitude N (DMS)	NAD 83 Longitude W (DMS)					
237	AU279	2	25.6	56° 41' 42"	135° 15' 54"	10.56	56° 41' 41.5453"	135° 15' 51.8245"	Rk	Y	N	JV	Refer to FEKAU5. Possible Rk in Kelp. See Danger to Navigation Report. Item 39.
238	AU280	1				16.15	56° 41' 44.2813"	135° 15' 48.6342"	Rk	N	Y	Insert	
239	AU282	1				10.31	56° 41' 48.619"	135° 15' 38.8908"	Rk	Y	N	JV	Possible Rk in Kelp.
240	AU283	1				6.64	56° 41' 53.0102"	135° 15' 30.4618"	Rk	Y	N	BV	Possible Rk in Kelp.
241	AU285	1				15.17	56° 39' 33.3893"	135° 11' 45.8711"	Rk	N	N	JV	Refer to FEAU2. See Danger to Navigation Report. Item 40.
242	AU286	1				9.64	56° 42' 26.8859"	135° 12' 41.5343"	Rk	Y	N	JV	Refer to FEAU25. Possible Rk in Kelp. See Danger to Navigation Report. Item 41.
243	AU287	1				10.33	56° 39' 43.7324"	135° 11' 46.0068"	Rk	Y	N	JV	Refer to FEAU4. Possible Rk in Kelp.
244	AU289	1				12.22	56° 38' 43.0037"	135° 10' 8.4252"	Rk	Y	N	BV	Refer to FEKAU12. Possible Rk in Kelp.

Table 4: Chart Comparison Spreadsheet

Shoal Categories
 1-New Shoal Found
 2-Charted Shoal Disproved / Not Found

D.2 RECOMMENDED ADDITIONAL BOATWORK

For the H11540 survey the recommended additional boatwork was determined by:

1. Defining the seaward limit of good lidar seabed coverage as a M_COVR, CATCOV=1 polygon.
2. Reviewing the features for investigation compiled during data processing and adding the uncertain soundings identified during the chart comparison to this examination list.
3. Prioritizing all features for investigation with respect to the M_COVR polygon and dangers to safe vessel-based examination.
4. Recommending the vessel-based method of disproving 'suspicious' lidar features or confirming 'real' lidar feature detections and determining least depth.

D.2.1 Seaward Limit of Lidar Coverage

The survey area H11540 consists of a large number of islands, islets and many kelp covered submerged rocks close to the coast. Heavy kelp is present throughout the survey area, especially around the sheltered islands and islets. There were also many expansive areas of white water around exposed off-lying rocks. Due to the very poor water clarity experienced during lidar data acquisition, the presence of heavy kelp and expansive white water, many areas across the sheet have poor seabed coverage. This is reflected by gaps in the BASE surface rendered as part of the survey deliverables.

In particular, the areas of poor lidar seabed coverage include:

- South Beauchamp Island at position 56° 41' 55" N, 135° 14' 14" W
- South Beauchamp Island at position 56° 42' 15" N, 135° 13' 24" W
- Jamboree Bay
- Eastern shoreline of entrance to Necker Bay at position 56° 40' 20" N, 135° 08' 25" W and 56° 38' 50" N, 135° 09' 11" W
- Guibert Islets
- SE corner of sheet limits at position 56° 38' 25" N, 135° 08' 10" W

Traditionally, the suggested lidar-ship junctioning polyline was drawn too far seaward, across areas of sparse, 'noisy' lidar coverage. For this survey the polyline submitted as an S-57 M_COVR CATCOV=1 polygon is the seaward extent of good lidar coverage. When there is poor lidar coverage due to turbid water, the presence of kelp, or expansive white water, the polyline has been drawn just seaward of the MLLW line. It should be noted that TLI is not providing a recommended junctioning line. The determination of where multibeam survey lines need to be conducted is at the discretion of the Pacific Hydrographic Branch and the ships conducting the work.

When planning multibeam junctioning with lidar seabed coverage, the NALL and the following must be taken into consideration:

- Lidar / orthophoto derived MHW line, MLLW line
- Drying, awash and shallow features detected by lidar
- Features for examination
- ‘Unsurveyed’ polygons due to kelp, white water, turbidity and glassy seas

These are all provided in the S-57 feature file (US511540.000) or the Investigations.hob file for H11540.

The areas of good lidar seabed coverage include:

- Small bay on South coast of Beauchamp Island at position 56° 42’ 23” N, 135° 14’ 25” W
- Small bays on East coast of Walker Channel, South of Jamboree Bay.
- Inside passage of Slate Islets, around Aspid Cape.
- Yamani Cove

The seaward limit of good lidar data coverage has been described by the S-57 feature object M_COVR in the S-57 feature file (US511540.000).

D.2.2 Lidar Features Requiring Further Investigation

A significant list of uncertain lidar soundings was collated during data processing and is presented in an S-57 feature file. For example, some detections on isolated rocks in thick kelp beds were difficult to correctly classify as either rock or kelp. Sparse lidar coverage over rocks in areas that were permanently covered with white water were also identified. There were also instances of very suspicious shoal soundings occurring well offshore, which had no supporting data from overlapping lines, suggesting they were detections of floating kelp or possibly whales, being flagged during data processing. Often these shoal offshore soundings have been removed from the final data due to the lack of correlating soundings from different days of data acquisition, but they are provided as features to be examined prior to ship junctioning.

Tagging in the GS was used to flag features for which the least depth has not been found. Typically this meant that there were less than 4 supporting soundings within 0.5 – 1.0m of the depth on the primary and overlapping lines. These tags were then exported from the GS and compiled in CARIS BASE Editor. Features for examination have been captured within the Investigations.hob as M_NPUB feature objects. Where these features correlate with an item listed in the chart comparison spreadsheet, a reference has been made in the Investigations.hob file. The S-57 attribution methodology for lidar features requiring further investigation is presented in the table below:

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Attribute 1	Attribute 2	Attribute 3	Attribute 4
Nautical publication information	M_NPUB P		Used to relate additional nautical information or publications to the data.	INFORM (used for storing a unique Feature for Investigation ID)	NINFOM (used for storing the recommended examination method)	PUBREF (used for storing a reference to a Chart Comparison)	PICREP (used for storing a link to waveform screenshots)

Table 4: S-57 attribution for the CARIS Investigations.hob file

Refer to Section B.2.7 Gap and Feature Tagging for the descriptions of the GS tagging philosophy used for all lidar seabed coverage gaps and recommended features for investigation. During the review of the orthophoto mosaic in CARIS BASE Editor, additional drying, awash and shallow features were identified, which require further investigation. These were assigned an 'OPRA' (orthophoto rock awash) tag and were investigated within the GS to determine their investigation priority and recommended examination method.

In circumstances where least depth has not been found over a significant feature, a recommendation for investigation by boat for 167 uncertain soundings has been made in the CARIS Investigations.hob file. All features in the chart comparison that have not had least depth adequately surveyed also appear in this file.

D.2.3 Prioritization of Features Requiring Further Investigation

All features for investigation have been assigned a priority, based on location with respect to the lidar coverage polyline, the lidar 'unsurveyed' foul areas, and the NALL. In addition, they have been attributed with a recommended examination method, as specified in the following section. The priorities are assigned using the following table:

Priority	Location w.r.t. Polyline	Unsurveyed Foul Area / NALL	Examination Method	Remarks
1 Seaward	Seaward	No	Typically BV VV / BV for shallow features	MUST be examined prior to multibeam junctioning
2 Inshore	Inshore	No NALL Maybe within Foul	Typically BV VV / BV for shallow features	Investigation at ships discretion. Typically for uncertain shallow features.
3 Inshore / Seaward	Inshore / Seaward	NALL Coastal kelp	VV/BV	Investigation at ships discretion. Typically for drying rocks or rocks awash
4 Seaward	Seaward	No	JV	Can be safely navigated over during multibeam. Post acquisition comparison required.

Note: All features recommended for investigation are reported as possible hazards when conducting survey work by boat.

Table 5: Prioritization Hierarchy for Features Requiring Further Investigation

D.2.4 Recommended Examination Method of Features Requiring Further Investigation

Each feature for investigation has been attributed with a recommended examination method, based on the general depth around the feature, the least depth as detected by lidar and the nature of the feature (kelp, white water etc.) The examination methods are categorized as follows:

VV	Visual Verification - may be hazardous to approach even with shallow draft vessel running single beam.
VV / BV	Visual Verification required prior to Bathymetric Verification - potentially shoaler than 3m depth.
BV	Bathymetric Verification, generally greater than 3m depth.
JV Junctioning	Verification, generally greater than 6m depth.

D.2.5 Recommended Junctioning With Unsurveyed Lidar Areas

The ‘unsurveyed’ gaps in lidar seabed coverage are defined as polygons in the S-57 feature file. They were constructed utilizing the export of the operator assigned gap tags covered in Section B.2.7 Gap and Feature Tagging. In the case of ‘unsurveyed’ areas for kelp, white water and secondary exclusion zone, junctioning is not recommended for the obvious risks to surface vessels. The turbidity gaps defined by the unsurveyed polygons in the S-57 file may be junctioned with and filled by multibeam coverage. However, vessels should conduct this data acquisition at their discretion. Shoal features, which were not detected by lidar due to the extremely poor water clarity, may exist within these gaps.

D.3 SUMMARY OF CHARTING ACTIONS AND INVESTIGATIONS – H11540

D.3.1 Summary of Charting Actions – H11540

Total number of new significant islets recommended for insertion on chart: 34
 Total number of new significant drying rocks recommended for insertion on chart: 35
 Total number of new significant rocks awash recommended for insertion on chart: 19
 Total number of new significant rocks recommended for insertion on chart: 127
 Total number of charted features disproved by lidar: 29
 Total number of charted features recommended for amendment by lidar: 29

Total number of DtoNs submitted to PHB for H11540: 41

D.3.2 Summary of Lidar Features Requiring Further Investigation – H11540

Total number of Priority 1 investigations identified: 47
 Total number of Priority 2 investigations identified: 17
 Total number of Priority 3 investigations identified: 46
 Total number of Priority 4 investigations identified: 54

Total number of investigations recommended during data processing: 86
 Total number of investigations recommended from orthophoto mosaic review: 25
 Total number of investigations recommended from chart comparison compilation: 53

Total number of recommended feature investigations: 164

E. APPROVAL SHEET**LETTER OF APPROVAL – OPR-O112-KRL-06**

This report and the accompanying LADS survey deliverables are respectfully submitted.

Field operations contributing to the accomplishment of this survey were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and the accompanying LADS survey deliverables have been closely reviewed and are considered complete and adequate as per the Statement of Work.

Report _____	<u>Submission Date</u>
Descriptive Report – H11540	March 27, 2007

Listed below are supplemental reports submitted separately that contain relevant information to this survey.

Report _____	<u>Submission Date</u>
Data Acquisition and Processing Report OPR-O112-KRL-06 March	27, 2007
Horizontal and Vertical Control Report OPR-O112-KRL-06 March	27, 2007



Mark Sinclair
Hydrographer
Tenix LADS Incorporated

Date March 27, 2007

Revisions and Corrections During Office Processing and Certification

¹ The LIDAR survey referenced in this Descriptive Report has been applied to the multibeam surveys at junctions with. No stand-alone LIDAR information was compiled HCells. For information concerning the compilation of LIDAR features and soundings see the Descriptive Reports for multibeam surveys H11845 and H11846. LIDAR does not meet IHO object detection requirements. LIDAR was not used to supersede shoaler charted soundings or to disprove charted features.

The Data Acquisition and Processing Report and Horizontal and Vertical Control Report have been filed with the project records.

APPENDIX I – DANGERS TO NAVIGATION

DTONS Submitted to PHB

I.1.1. Danger to Navigation Report

Hydrographic Survey Registry Number: H11540

State: Alaska

Locality: Approaches to Sitka Sound

Sub-locality: Walker Channel to Necker Bay

Project Number: OPR-0112-KRL-06

Survey Dates: June – September 2006

Depths are in meters and reduced to Mean Lower Low Water using final verified tides. Drying heights are in meters relative to MLLW. Positions are based on the NAD83 horizontal datum. All times and dates are relative to UTC.

Charts Affected

Number	Version	Date	Scale
17328	7th Ed	May 1, 2006	1:40,000

The following items were found during hydrographic survey operations:

No.	Feature	Depth	Latitude (N)	Longitude (W)	Time and Date	Investigate
1	Shoal	13.6	56° 38' 36.26"	135° 08' 09.27"	03:09, Jul 6	Yes
2	Shoal	16.4	56° 39' 37.01"	135° 09' 00.17"	16:47, Jul 6	Yes
3	Shoal	12.1	56° 38' 17.83"	135° 09' 28.91"	20:25, Jul 6	Yes
4	Rk in kelp	3.0	56° 38' 32.96"	135° 09' 58.27"	17:10, Sep 8	Yes
5	Shoal	12.8	56° 38' 34.21"	135° 10' 07.90"	14:50, Jul 8	Yes
6	Shoal	11.9	56° 38' 38.68"	135° 10' 00.20"	16:37, Aug 22	Yes

No.	Feature	Depth	Latitude (N)	Longitude (W)	Time and Date	Investigate
7	Shoal	15.9	56° 38' 56.42"	135° 10' 17.51"	18:48, Jul 6	Yes
8	Shoal	14.0	56° 39' 04.29"	135° 10' 07.62"	04:52, Jul 6	Yes
9	Shoal	15.1	56° 39' 13.86"	135° 10' 12.01"	04:35, Jul 6	Yes
10	Shoal	13.4	56° 39' 25.81"	135° 09' 56.80"	03:52, Jul 6	No
11	Shoal	9.7	56° 39' 31.44"	135° 09' 58.29"	16:31, Aug 22	No
12	Shoal	6.8	56° 39' 40.95"	135° 09' 54.34"	20:07, Sep 8	Yes
13	Shoal	7.6	56° 40' 25.64"	135° 10' 27.49"	16:47, Jul 6	Yes
14	Rk	6.7	56° 40' 31.84"	135° 11' 33.61"	19:50, Sep 8	No
15	Shoal	9.8	56° 39' 37.18"	135° 11' 17.30"	04:52, Jul 6	Yes
16	Shoal	6.3	56° 39' 47.03"	135° 11' 48.24"	16:55, Aug 22	Yes
17	Rk	0.1	56° 39' 49.04"	135° 11' 40.91"	18:34, Jul 6	Yes
18	Rk	11.5	56° 39' 46.64"	135° 12' 48.09"	16:17, Jul 6	No
19	Rk in kelp	12.6	56° 40' 02.38"	135° 13' 12.61"	16:17, Jul 6	Yes
20	Rk in kelp	10.3	56° 40' 12.67"	135° 13' 24.66"	14:51, Jul 8	Yes
21	Rk in kelp	9.2	56° 40' 25.61"	135° 13' 06.11"	18:47, Jul 6	Yes
22	Rk in kelp	12.3	56° 40' 26.39"	135° 13' 42.30"	14:51, Jul 8	Yes
23	Rk	15.4	56° 40' 43.54"	135° 14' 10.38"	14:51, Jul 8	No
24	Rk in kelp	7.7	56° 40' 47.15"	135° 13' 43.25"	18:33, Jul 6	Yes
25	Shoal	15.2	56° 40' 59.94"	135° 14' 24.94"	20:24, Jul 6	Yes
26	Rk in kelp	4.9	56° 41' 03.16"	135° 14' 00.86"	18:33, Jul 6	Yes
27	Shoal	16.1	56° 41' 26.84"	135° 13' 58.31"	17:17, Sep 8	Yes

No.	Feature	Depth	Latitude (N)	Longitude (W)	Time and Date	Investigate
28	Shoal	10.6	56° 41' 54.52"	135° 10' 18.79"	20:10, Jul 6	Yes
29	Rk in kelp	10.8	56° 42' 43.44"	135° 11' 35.82"	01:33, Sep 6	Yes
30	Rk in kelp	10.7	56° 43' 10.10"	135° 12' 28.77"	01:32, Sep 6	Yes
31	Rk	10.0	56° 43' 14.40"	135° 12' 31.21"	17:36, Sep 8	No
32	Shoal	15.2	56° 43' 18.71"	135° 12' 26.41"	17:36, Sep 8	Yes
33	Rk in kelp	6.1	56° 42' 09.20"	135° 13' 44.57"	16:46, Jul 6	Yes
34	Rk	12.8	56° 41' 57.83"	135° 14' 26.48"	03:07, Jul 6	No
35	Rk in kelp	6.8	56° 42' 02.00"	135° 14' 28.51"	03:17, Aug 10	Yes
36	Rk awash in kelp	0.3	56° 42' 24.10"	135° 14' 26.12"	16:45, Jul 6	Yes
37	Shoal	11.7	56° 41' 53.42"	135° 14' 51.85"	20:56, Jul 6	Yes
38	Shoal	7.6	56° 41' 43.30"	135° 15' 59.17"	18:33, Jul 6	No
39	Shoal	10.6	56° 41' 41.55"	135° 15' 51.84"	20:23, Jul 6	Yes
40	Shoal	15.2	56° 39' 33.38"	135° 11' 45.88"	15:08, Jul 8	Yes
41	Shoal	9.6	56° 42' 26.87"	135° 12' 41.53"	19:02, Jul 6	Yes

COMMENTS: Final verified tides have been applied from the Sitka tide gauge (9451600). The shoals were found using LIDAR.

Questions concerning this report should be directed to the Survey Manager Mr. Darren Stephenson in the Tenix LADS Inc. office in Biloxi MS at (228) 594-6800.

DTONS Submitted to MCD**I.1.2. Danger to Navigation Report****Hydrographic Survey Registry Number: H11540**

Survey Title: **State:** **Alaska**
Locality: **Approaches to Sitka Sound**
Sub-locality: **Walker Channel to Necker Bay**

Project Number: OPR-O112-KRL-06**Survey Dates: June – September 2006**

Depths are in fathoms and feet, reduced to Mean Lower Low Water using final verified tides. Drying heights are in meters relative to MLLW. Positions are based on the NAD83 horizontal datum. All times and dates are relative to UTC.

CHARTS AFFECTED:

CHART	SCALE	EDITION	DATE
17326 1	:40,000 1	5th	Ju n. / 06
17328 1:	40,000 7t	h	05/ 01/06

DANGERS TO NAVIGATION:

<u>Feature</u>	<u>Depth</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Time, Date and Year</u>
Sounding	7 fms 4 ft	56° 38' 36.2"	135° 08' 09.3"	03:09, Jul 6, 2006
Sounding	8 fms 5 ft	56° 39' 37.0"	135° 09' 00.2"	16:47, Jul 6, 2006
Sounding	6 fms 3 ft	56° 38' 17.8"	135° 09' 28.9"	20:25, Jul 6, 2006
Rk	1 fm 3 ft	56° 38' 33.0"	135° 09' 58.3"	17:10, Sep 8, 2006
Sounding	7 fms	56° 38' 34.2"	135° 10' 07.9"	14:50, Jul 8, 2006
Sounding	6 fms 3 ft	56° 38' 38.7"	135° 10' 00.2"	16:37, Aug 22, 2006
Sounding	8 fms 4 ft	56° 38' 56.4"	135° 10' 17.5"	18:48, Jul 6, 2006
Sounding	7 fms 4 ft	56° 39' 04.3"	135° 10' 07.6"	04:52, Jul 6, 2006
Sounding	8 fms 2 ft	56° 39' 13.9"	135° 10' 12.0"	04:35, Jul 6, 2006

Sounding	7 fms 2 ft	56° 39' 25.8"	135° 09' 56.8"	03:52, Jul 6, 2006
Sounding	5 fms 2 ft	56° 39' 31.4"	135° 09' 58.3"	16:31, Aug 22, 2006
Sounding	3 fms 4 ft	56° 39' 41.0"	135° 09' 54.3"	20:07, Sep 8, 2006
Sounding	4 fms 1 ft	56° 40' 25.6"	135° 10' 27.5"	16:47, Jul 6, 2006
Rk	3 fms 4 ft	56° 40' 31.8"	135° 11' 33.6"	19:50, Sep 8, 2006
Sounding	5 fms 2 ft	56° 39' 37.2"	135° 11' 17.3"	04:52, Jul 6, 2006
Sounding	3 fms 2 ft	56° 39' 47.0"	135° 11' 48.2"	16:55, Aug 22, 2006
Rk	Awash	56° 39' 49.0"	135° 11' 40.9"	18:34, Jul 6, 2006
Rk	6 fms 2 ft	56° 39' 46.6"	135° 12' 48.1"	16:17, Jul 6, 2006
Rk	6 fms 5 ft	56° 40' 02.4"	135° 13' 12.6"	16:17, Jul 6, 2006
Rk	5 fms 3 ft	56° 40' 12.7"	135° 13' 24.7"	14:51, Jul 8, 2006
Rk	5 fms	56° 40' 25.6"	135° 13' 06.1"	18:47, Jul 6, 2006
Rk	6 fms 4 ft	56° 40' 26.4"	135° 13' 42.3"	14:51, Jul 8, 2006
Rk	8 fms 2 ft	56° 40' 43.5"	135° 14' 10.4"	14:51, Jul 8, 2006
Rk	4 fms 1 ft	56° 40' 47.2"	135° 13' 43.3"	18:33, Jul 6, 2006
Sounding	8 fms 2 ft	56° 40' 59.9"	135° 14' 24.9"	20:24, Jul 6, 2006
Rk	2 fms 4 ft	56° 41' 03.2"	135° 14' 00.9"	18:33, Jul 6, 2006
Sounding	8 fms 5 ft	56° 41' 26.8"	135° 13' 58.3"	17:17, Sep 8, 2006
Sounding	5 fms 5 ft	56° 41' 54.5"	135° 10' 18.8"	20:10, Jul 6, 2006
Rk	5 fms 5 ft	56° 42' 43.4"	135° 11' 35.8"	01:33, Sep 6, 2006
Rk	5 fms 3 ft	56° 43' 14.4"	135° 12' 31.2"	17:36, Sep 8, 2006
Sounding	8 fms 2 ft	56° 43' 18.7"	135° 12' 26.4"	17:36, Sep 8, 2006
Rk	3 fms 2 ft	56° 42' 09.2"	135° 13' 44.6"	16:46, Jul 6, 2006
Rk	7 fms	56° 41' 57.8"	135° 14' 26.5"	03:07, Jul 6, 2006
Rk	3 fms 4 ft	56° 42' 02.0"	135° 14' 28.5"	03:17, Aug 10, 2006
Rk	Awash	56° 42' 24.1"	135° 14' 26.1"	16:45, Jul 6, 2006

Sounding	6 fms 2 ft	56° 41' 53.4"	135° 14' 51.9"	20:56, Jul 6, 2006
Sounding	4 fms 1 ft	56° 41' 43.3"	135° 15' 59.2"	18:33, Jul 6, 2006
Sounding	5 fms 5 ft	56° 41' 41.6"	135° 15' 51.8"	20:23, Jul 6, 2006
Sounding	8 fms 2 ft	56° 39' 33.4"	135° 11' 45.9"	15:08, Jul 8, 2006
Sounding	5 fms 2 ft	56° 42' 26.9"	135° 12' 41.5"	19:02, Jul 6, 2006

COMMENTS: Final verified tides have been applied from the Sitka tide gauge (9451600). The sounding and rocks were found using LIDAR. This report was compiled by Tenix LADS Inc. and reviewed by PHB.

Questions concerning this report should be directed to the Chief, Pacific Hydrographic Branch at (206) 526 6835

APPENDIX VI – AWOIS

No AWOIS were assigned to this task order.

APPENDIX IV – TIDES AND WATER LEVELS

Abstract of Times of Hydrography

Start and End times refer to tidal applications requirement.

Time on Task indicates actual time of task in the survey area. All times and dates are in UTC.

06_5Rakof

Date Flown	JD	Sortie No	Start Time	End Time	Tide Duration	Time on Task
June-26-06	177	2	19:00	1:00	6:00	3:34
July-5-06	186	3	00:30	6:00	5:30	2:01
July-6-06	187	4	15:00	22:30	7:30	5:00
July-8-06	189	5	13:00	17:30	4:30	2:15
July-9-06	190	6	13:00	18:00	5:00	2:53
July-10-06	191	9	13:30	17:00	3:30	0:56
Aug-9-06	221	29	01:00	06:30	5:30	3:23
Aug-20-06	232	30	19:30	01:30	6:00	2:10
Aug-22-06	234	31	15:00	20:30	5:30	3:19
Aug-26-06	238	32	16:30	19:30	3:00	1:01
Sep-2-06	245	33	23:00	04:30	5:30	3:26
Sep-5-06	248	34	21:00	02:30	5:30	3:11
Sep-6-06	249	35	15:30	18:30	3:00	0:50
Sep-8-06	251	36	16:00	22:30	6:30	4:09
Sep-9-06	252	37	15:00	20:30	5:30	3:20

T I D A L D A T U M S

Tidal datums at SITKA, BARONOF ISLAND, SITKA SOUND based on:

LENGTH OF SERIES: 19 Years
TIME PERIOD: January 1983 - December 2001
TIDAL EPOCH: 1983-2001
CONTROL TIDE STATION:

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

HIGHEST OBSERVED WATER LEVEL (11/02/1948)	= 4.534
MEAN HIGHER HIGH WATER (MHHW)	= 3.029
MEAN HIGH WATER (MHW)	= 2.791
MEAN TIDE LEVEL (MTL)	= 1.618
MEAN SEA LEVEL (MSL)	= 1.610
MEAN LOW WATER (MLW)	= 0.445
MEAN LOWER LOW WATER (MLLW)	= 0.000
LOWEST OBSERVED WATER LEVEL (01/01/1991)	= -1.224

APPENDIX V – SUPPLEMENTAL SURVEY RECORDS AND CORRESPONDENCE

-----Original Message-----

From: RAMSAY Scott

Sent: Tuesday, December 05, 2006 2:48 PM

To: STEPHENSON Darren; GUILFORD James; CHAMBERLAIN Luke; SINCLAIR Mark - Internet

Subject: FW: H-Cell & S-57 guidelines

-----Original Message-----

From: mark.t.lathrop [mailto:Mark.T.Lathrop@noaa.gov]

Sent: Wednesday, 6 December 2006 7:10 AM

To: Thomas Newman; Jon Dasler; Rod Evans; RAMSAY Scott; Joseph Burke

Cc: gene_parker; Crescent Moegling; David Scharff

Subject: H-Cell & S-57 guidelines

Everyone,

Attached are draft H-Cell and S-57 guidelines drawn up at the Pacific Hydrographic Branch. These were requested by Fugro and will be shared to all of NOAA's hydrographic contractors. Many of these pertain to shoreline so may not be relevant to your work, but in the interest of fairness, you are receiving anyway. Please direct any questions to your branch COTR and cc Crescent, Dave, and/or myself. Of course, this can be discussed in greater detail at the Field Procedures Workshop.

Mark

S-57 Encoding Guidelines for Rocks and Islets

CJ Barry, PHB, Updated 6/14/2006

Preliminary, Pending Approval

MCD (Marine Chart Division) requires that rock attribution be in accordance with the Nautical Chart Manual Section 4.9. This required that S-57 rock attributes for VALSOU and WATLEV be defined in NOAA terms. A table devised for this purpose has been altered for the use of field units to assist in attributing features, such as rocks and wrecks, that use S-57 attributes VALSOU and WATLEV. The table for Pacific Coast is shown below:

Pacific Coast

VALSOU (in meters)	WATLEV
> 0.6 meters below MLLW	3: Always Underwater/Submerged
< 0.6 meters above MLLW to 0.6 meters below MLLW	5: Awash
0.6 m above MLLW to 0.6 m above MHW	4: Covers and Uncovers
> 0.6 meters above MHW	* Islet; No WATLEV; Use LNDARE & LNDELV objects, with ELEVAT attribute for LNDELV

* LNDARE objects are used to characterize islets. LNDARE objects may be points, lines or areas.

VALSOU encodes the value of the measurement of a sounding relative to the chart datum. **WATLEV** is the effect of the surrounding water on a feature or object, such as Submerged, Awash, Covers and Uncovers, Always Dry. Following are some of the S-57 Feature Objects that use WATLEV:

- MARCUL (Marine farm/culture) (Use WATLEV if under water), MORFAC (Mooring/warping facility), OBSTRN (Obstruction), SBDARE (Seabed area), SLCONS (Shoreline Construction), UWTRC (Underwater/awash rock), WRECKS (Wrecks)

Use the table, *S-57 Attribution of Rocks & Islets for Field Units*, following page, for attributing rocks, islets and other features with VALSOU and WATLEV. Start by locating the depth or elevation of the feature in the left column under “Meters Referenced to MHW and MLLW”. Instructions for determining if a feature is a rock or islet are included to satisfy your curiosity. (No, an islet is not determined by the presence of vegetation on it!) It is not necessary to make the rock/islet determination in the field. *Please reference all new features to the MLLW datum.*

S-57 Attribution of Rocks & Islets for Field Units

METERS REFERENCED TO MHW or MLLW	S-57 ENC ATTRIBUTE	
	WATLEV	VALSOU or ELEVAT
0.9	Islets: LNDARE & LNDELV Objects	Islets: ELEVAT= > 0.6 m above MHW
0.8		
0.7		
0.61 **		
-5.6 (0.6m above MHW) ***		
-5.5 (0.5m above MHW)		
-5.4 (0.4m above MHW)		
-5.3 (0.3m above MHW)		
-5.2 (0.2m above MHW)	WATLEV = 4	VALSOU =
-5.1 (0.1m above MHW)	0.6 m above MHW	
-5.0	Example MHW Plane of Refer.	to
-4.9	0.6 m above MLLW	
~~~~~	Covers & Uncovers	
-1.3		
-1.2		
-1.1		
-1.0		
-0.9		
-0.8		
-0.7		
-0.6		
-0.59		
-0.5		
-0.4		
-0.3	WATLEV = 5	VALSOU =

-0.2	Awash	
-0.1	0.6 m above MLLW	
0.0	MLLW Datum	to
0.1	0.6 m below MLLW	
0.2		
0.3		
0.4		
0.5		
0.6		
0.61		
0.7		
0.8	WATLEV = 3	VALSOU =
0.9		
1.0		
1.1	ALWAYS U/W	> 0.6 m below
1.2	SUBMERGED	MLLW
1.6		

For features  $\geq 0.6$  meters above the MHW Plane of Reference (shown in blue on the table) elevations are referenced to MHW instead of MLLW. Highlighted values will change according to the MHW value.

** In this example, with a MHW datum equal to 5.0 meters (meaning that the MHW datum is 5.0 meters above MLLW), a rock becomes an islet at 5.61 meters above MLLW. Islets are characterized by two S-57 feature objects: LNDARE and LNDELV. The ELEVAT (elevation) for the islet should be 0.61 meters.

*** In this example, VALSOU = -5.6 meters

APPROVAL SHEET  
H11540

Initial Approvals:

The survey evaluation and verification has been conducted according to branch processing procedures and the HCell compiled per the latest OCS HCell Specifications.

The survey and associated records have been inspected with regard to survey coverage, delineation of the depth curves, development of critical depths, S-57 classification and attribution of soundings and features, cartographic characterization, and verification or disproof of charted data within the survey limits. The survey records and digital data comply with OCS requirements except where noted in the Descriptive Report and are adequate to supersede prior surveys and nautical charts in the common area.

I have reviewed the HCell, accompanying data, and reports. This survey and accompanying digital data meet or exceed OCS requirements and standards for products in support of nautical charting except where noted in the Descriptive Report.