6 March 2009

MEMORANDUM

To: CAPT Steven Barnum, NOAA, Director, Office of Coast Survey
Hugo Gorziglia, Director, International Hydrographic Bureau
Dr. Edas Muñoz, Director, Gulf of Honduras Project

From: LCDR Chris van Westendorp, NOAA
Staff, Atlantic Hydrographic Branch

Cc: Kathryn Ries, Deputy Director, Office of Coast Survey
Eric Villalobos, USSOUTHCOM Naval Oceanography Program Regional Coordinator
Elliot Arroyo-Suarez, NAVOCEANO Navigation Products Division Technical Lead
Chris Smith, United Kingdom Hydrographic Office
Major Lloyd Jones, Belize Ports Commissioner
Michael Jenkins, Hydrographer, Belize Port Authority
Sue Kuester, Political/Economic Officer, U.S. Embassy (Belmopan, Belize)
Jeffrey Ferguson, Chief, Hydrographic Surveys Division
CDR Shep Smith, NOAA, Chief, Atlantic Hydrographic Branch

Subj: Trip Report for Gulf of Honduras Project Hydrographic Training Mission to Belize

Background:

1. The Gulf of Honduras (GoH) project is a tri-national, internationally funded initiative of the Governments of Belize, Honduras and Guatemala to protect the Gulf of Honduras from ship and land-based sources of pollution. Sponsored in part by the International Hydrographic Organization's (IHO) MesoAmerican-Caribbean Sea Hydrographic Commission (MACHC), this training mission falls under Component 3 of the GoH project (Enhancing navigational safety in shipping lanes).
2. Belize's participation in the project is unique when compared with Guatemala and Honduras in that it had no official hydrographic organization up until this year. Under Component 3 of the GoH project, the GoH countries are the recipients of hydrographic survey capacity building measures, including:
    a. Hydrographic survey equipment
        - Procured through the GoH Project Coordinating Unit, located in Puerto Cortes, Honduras
        - Vendor training was provided to familiarize Belize Port Authority (BPA) personnel with the equipment
    b. Basic training in hydrography and nautical charting
    c. Development of interregional (GoH) and international hydrographic partnerships

Trip Objectives:

1. Establish international partnership with BPA in support of newly formed hydrographic survey program
2. Assist BPA personnel in evaluation and setup of hydrographic survey equipment purchased through the GoH project

3. Provide basic hydrographic survey training with the outcomes that BPA personnel are able to understand and/or conduct:
    a. Configuration and installation of hydrographic equipment
    b. Survey planning
    c. Acquisition of hydrographic survey data to IHO standards
    d. Processing of hydrographic survey data to IHO standards
    e. Transmission of data to the UK Hydrographic Office for nautical chart updates

Training Timeline:

Prior to the in-country training detailed in the table below, a representative trainee from each of the three GoH countries attended the first two weeks of NOAA's annual Hydrotraining (2-13 February 2009) in Norfolk, Virginia. During this period, the trainees received intensive training in basic hydrographic survey principles, including (but not limited to):

- Geodesy
- Positioning & horizontal control
- Survey planning & data pipeline
- Survey system preparation & calibration
- Acoustics & sonars
- Single beam, multibeam, and side scan sonar principles
- Sound velocity
- Error budget & modeling
- Systems Integration
- Navigation & Orientation
- Navigational products
- Vertical control and tidal datums
- Benchmark and tide station installation

Date	On-the-Water (OTW)?	In-Country Training Accomplished with BPA Personnel
2/18	No	Introduction to course & NOAA GoH classroom training
2/19	No	NOAA GoH classroom training
2/20	No	NOAA GoH classroom training
2/21	Yes – pierside	Equipment installation & mount construction; 30 minutes of system demonstration
2/22	Sunday – No training	
2/23	No	Hypack & software classroom training; benchmark recovery & tide gage planning @ Port of Belize
2/24	No	Hypack classroom training; tide gage installation and GPS positioning verification @ Port of Belize
2/25	No	Tide gage leveling @ Port of Belize
2/26	No	Leveling analysis and releveling of one section @ Port of Belize; visited and conducted vessel planning @ SEA KING
2/27	Yes – 4 hours	Full system integration / mounting (minus MRU) with offset measurement; first OTW data collected; SSS interpretation
2/28	Yes – 6 hours	More OTW data collection and training; downloaded first set of tide station water level data
3/1	Sunday – No training	
3/2	No	Survey planning & Hypack classroom training
3/3	Yes – 7 hours	Full day of OTW data collection; line plan execution and modification; system monitoring/integration; coxswain training
3/4	No	Single beam and side scan processing; line planning; SVP cast acquisition and processing
3/5	Yes – 3 hours	System setup and line plan execution/modification; survey acquisition and monitoring; SVP, single beam, & tide processing; Line planning
3/6	No	Single beam and side scan processing; target development planning

Narrative / Observations:

1. **Dates and Location of Training** – In-country training was conducted with BPA personnel from 18 February 2009 through 6 March 2009, lasting 2 days longer than originally planned and yielding 15 total training days. The training took place in Belize City at the BPA headquarters office, the Belize National Coast Guard (BNCG), and the areas in and around the Port of Belize pier. As mentioned previously, preliminary hydrographic survey training was provided for one BPA member (Darrel Ramclam) in Norfolk, Virginia from 2-13 February 2009.

2. **Economic Climate** – Maritime commerce provides a critical artery for Belize's economy. Belize's ports provide the vast majority of its import and export trade (of which the United States is the primary commercial origin and destination, respectively). Tourism, another key link in the country's economy, is strongly supported by the cruise ship industry, which brings thousands of visitors to Belize City every week. Major exports of Belize include lumber, sugar, seafood, and citrus products. Major imports include food, consumer goods, machinery, mineral fuels and lubricants. The country's heavy reliance on maritime commerce further underlines the importance of building hydrographic capacity through this project.

3. **Belize Port Authority and Scope of Responsibility** – The BPA employs approximately 36 personnel and holds responsibility for the safety, inspection, and licensing of marine vessels and vessel operators in all Belizean ports. BPA headquarters is located in Belize City, the country's largest port and most populous city (approximately 100,000 people). The coastline of Belize spans approximately 200 miles and is largely protected by the MesoAmerican Barrier Reef System, the largest barrier reef system in the Western Hemisphere (second largest worldwide to Australia's Great Barrier Reef), which is frequently subject to negative shipping impacts..

4. **Survey Equipment** – Upon arrival in Belize, there was much work to be done regarding manufacturing / procuring proper cable terminations and power supplies prior to integrating the systems for hydrographic survey operation. Specifically, the Navisound 210 topside data connection, Navisound 210 DC power supply, VS-100 DC power supply, and Kongsberg MRU Z DC power supply all had bare wire connections. Of these, only the MRU Z was not addressed, as the manufacturer's manual requires a junction box (not supplied in the original equipment package) for power and data input/output interfacing. The following details the equipment received by the BPA from the GoH project:
    a. **Kongsberg MRU Z**: MRU Z sensor, shipping case, test cable (DB9 RS232 cable with bare DC power wires)
        i. The operating manual shows a junction box as part of the standard installation – no junction box was received in the shipment
        ii. The MRU was evidently tested during the contractor visit by connecting it to a 12V battery and reading MRU output via direct serial connection to the laptop.

iii. The MRU may be used without the manufacturer-recommended junction box, but a proper power termination and supply is required for continuous marine use and survey operation. After consulting with NAVO personnel and the Kongsberg MRU Z operating manual, I recommend against using the MRU without the junction box, as it provides critical heading/speed input to the MRU for compensation of induced heave accelerations.
iv. The MRU was therefore not used during the training period.
v. I strongly recommend the GoH Project provide the junction box to the BPA along with whatever peripheral equipment is needed for a proper installation (e.g. MRU mount).

b. **Hemisphere GPS Crescent VS-100**: VS-100 Receiver unit, Two (2) A10 GPS antennas, Two (2) antenna magnetic mounts, Two (2) 3-m antenna cables (TNC-TNC), Bare DC power cable, Two (2) DB9 RS232 serial cables
   i. The GPS was evidently tested during the contractor visit by connecting it to a 12V battery and reading the GPS output via serial connection with Hemisphere GPS software
   ii. For purposes of the training period, the VS-100 was powered using a spare 12VDC power supply from the BPA radio inventory
   iii. A more reliable and marine-grade power supply will be required for continuous marine use and survey operation. The BPA has made arrangements for purchase of such equipment.

c. **Reson Navisound 210**: Navisound 210 paper recorder/interface unit, single beam transducer-cable assembly w/ no connection or termination (bare cable), DC power cable with no termination (bare cable), DB9 RS232 serial interface cable, spare paper rolls (2), thermal head cleaning kit, connectors and fuses (separate)
   i. It is unknown as to whether or not this system was tested during the contractor visit, particularly since the data cable topside unit connection was not properly terminated.
   ii. For purposes of the training period, the Navisound 210 echosounder was powered using a spare 18VDC power supply from the BPA radio inventory
   iii. A more reliable and marine-grade power supply will be required for continuous marine use and survey operation. The BPA has made arrangements for purchase of such equipment.

d. **Imagenex Yellowfin Side Scan Sonar**: Yellowfin topside processing unit (TPU), towfish assembly, nosecone, aluminum ballast tube w/ ballast plate, tailfin/hydrophone assembly, kevlar reinforced tow cable w/ wet and dry end connectors, shackle, GPS antenna, AC power cord, DB9 RS232 serial interface cable, ethernet (Cat 5) cable, plastic retaining rods & cable ties
   i. Of all equipment received, the Yellowfin is the most complete and user installation friendly hydrographic survey system. No user termination or power supply work was required and the system was easily assembled and made to acquire survey-grade side scan sonar imagery within a few minutes.
   ii. No testing was accomplished on this system during the contractor visit, as it had not been delivered / released from Belizean customs until Day 3 of this training period (20 Feb).

e. **Panasonic Toughbook Laptop computer**: includes AC-DC converter/charger, PCMCIA card with 4-port DB9 serial adapter, and the following software installations: Tide Log (Valeport), SVP Control (Reson), Navisound 210 Control (Reson), Hypack Max 2008, MRU Z monitor (Kongsberg), VS-100 monitor (Hemisphere GPS)
f. **Reson SVP-15**: Sound velocimeter, hard carrying / shipping case, sound velocity probe display computer (SVPD 10), AC charging cable, DB9 serial interface cable, proprietary velocimeter-display computer interface cable and plug
g. **Valeport 740**: Tide gage assembly (logging unit, pressure sensor, and data cable), DB9 RS232 serial interface cable, carrying case

5. **Survey Vessel Availability** – Prior to my arrival, there were concerns over the lack of a suitable vessel for OTW training. The BPA's planned survey vessel (M/V SEA KING) had been in a state of overhaul and renovation since Fall of 2008. SEA KING was still not ready for water testing or survey in time for the in-country training session (incomplete cabin construction, electrical wiring, engine installation, etc). In order to avoid further delay of the in-country training, the BPA Hydrographer (Michael Jenkins) was able to make arrangements with the Belize National Coast Guard (BNCG) to use one of their closed-cabin vessels for the training period. While it would have been better to conduct the training on the BPA's actual survey vessel, the BNCG vessel made it possible to meet the trip objectives.

6. **Loss of Planned Boat Time** – Although the availability of the BNCG vessel made OTW training possible, many originally planned boat days were lost since both BNCG and BPA personnel had to attend to their normal duties during the training period. Boat time was lost primarily due to deployment of the BNCG vessel for detainment duties of the merchant vessel CARIBE MARINER (arrested for grounding and causing damage to the barrier reef approximately 3 months earlier). Availability of transportation to and from the headquarters office and the Port of Belize also caused some loss of boat time. Loss of boat time forced the extension of training for two additional days.

7. **Classroom Training** – Classroom training followed the outline:

a. Introduction to Hydrography
b. Office of Coast Survey International Activities
c. Acoustics
d. Geodesy
e. Tidal Datum Overview
f. Basic Tidal Theory (abbreviated)
g. Benchmark Overview
h. Geodetic Leveling
i. Introduction to Sonars
j. Introduction to Side Scan Sonar
k. Sound Velocity
l. Error Budget and Modeling
m. Systems Integration
n. Various Hypack-specific training modules

While classroom training was originally planned to cover just 2 days of the MACHC-approved 14 day period, it was used in lieu of boat time during the times mentioned in (6) to maximize time-training value. The NOAA GoH training presentations offered a good

baseline of information for the trainees, but the Hypack training modules provided the best task-oriented training experience. The Hypack modules took the trainees through each specific process used in the planning-acquisition-processing data pipeline. Also, while most of the BPA personnel had basic Microsoft Windows skills, many required additional training on the use of the laptop's touchpad interface and basic windows/explore management methods. Windows training occurred both in the classroom and OTW.

8. **Primary On-the-water Lessons Learned** – Due to the limited amount of OTW training time, BPA personnel faced a steep learning curve with respect to hydrographic survey acquisition operations. However, trainees gleaned numerous big-picture lessons from the boat training that occurred. Note that the following provides only a small subset of all OTW training and lessons learned during the training period:
    a. Prior to conducting hydrographic survey operations, ensure sufficient preparations are in place for an entire day to minimize lost production time (fuel, food, water, equipment, line plans, transportation to/from vessel launch site, etc).
    b. Whenever a piece of hydrographic survey equipment is in the water, that equipment should hold the primary focus of the hydrographer. This includes the side scan sonar towfish, pole-mounted single beam echosounder, and sound velocimeter.
    c. The primary focus of the vessel coxswain should be on vessel and personnel safety; the secondary coxswain focus is on hydrographic survey operations. Additionally, the coxswain should be fully aware of over-the-side hydrographic equipment with respect to vessel movements.
    d. When deploying the side scan sonar towfish, ensure the vessel is making forward way through the water and maintain positive control of the towfish and cable at all times. This particular lesson emerged on the first day of underway survey training. After being deployed directly off the stern of the BNCG vessel while it was dead in the water (DIW), the towfish was almost immediately sucked up into the propeller of the starboard outboard engine. Damage to the towfish included scraping and scarring of the aluminum ballast tube and a gouge to a corner of the port side scan transducer. Fortunately, troubleshooting and consultation with Imagenex Technical Support showed no critical damage to the transducer elements, and the transducer gouge was sealed/repaired using epoxy to prevent future deterioration or damage.
    e. Before commencing hydrographic survey operations, make sure there is a plan for emergencies (i.e. man overboard, snagged towfish, emergent shoaling, etc) that is understood by all members of the survey party.
    f. If the survey plan does not meet the coverage requirements of the survey or maximize survey efficiency, do not be afraid to change the plan after consulting with the Chief Hydrographer.
    g. When troubleshooting, follow the NOAA Hydrotraining methodology:
        i. Check power
        ii. Check physical connections
        iii. Check power
        iv. Check equipment status lights/indicators
        v. Check power
        vi. Check software settings
        vii. Check power

9. **Assessment of BPA Post-Training Capability** – Using training objectives established in the training outline, BPA personnel have received instruction and basic experience in the following:
    a. Configuration and installation of hydrographic equipment
        i. The theory behind and purpose of each piece of survey equipment
        ii. Installation of GPS, single beam echosounder, side scan sonar, and MRU, including proper power sourcing and backup
        iii. Measurement and Hypack entry of offsets from either a vessel reference point or the MRU
        iv. Measurement and Hypack entry of uncertainty values
        v. Establishment of proper Hypack devices for system integration
    b. Survey planning
        i. Identification and establishment of survey areas
        ii. Correlating equipment capabilities with survey environment
        iii. Design and plot of mainscheme single beam echosounder and side scan sonar line plans
        iv. Design and plot of development line plans
        v. Modification of existing line plans with respect to real-time survey results
    c. Acquisition of hydrographic survey data to IHO standards
        i. Integration and communication of hydrographic survey equipment
        ii. GPS/MRU positioning and attitude acquisition
        iii. Single beam echosounder operation and calibration
        iv. Side scan sonar operation and calibration
        v. Hypack survey navigation, acquisition, and data display
        vi. Tide water level acquisition
        vii. Sound velocity profile acquisition
    d. Processing of hydrographic survey data to IHO standards
        i. Application of offset, uncertainty, tide, and sound velocity correctors to raw single beam bathymetric soundings
        ii. Viewing and editing of bathymetric data
        iii. Exporting processed bathymetry into XYZ selected sounding set
        iv. Viewing and editing side scan sonar imagery
        v. Identification and tagging of side scan sonar contacts for development and reporting
        vi. Production of side scan mosaics to prove survey coverage
        vii. Backup of raw and processed survey data
    e. Transmission of data to the UK Hydrographic Office for nautical chart updates
        i. Review of previous Report of Survey from U.S. Naval Oceanographic Office.

10. **Future Work** – BPA has received enough training to competently plan for hydrographic surveys, acquire hydrographic survey data, and process that data for further work and/or submission to the U.K. Hydrographic Office for the nautical chart updates. It should be noted however that data acquired during the training period will most likely not be adequate for transmittal to the UKHO due to lack of attitude correction (heave, pitch, roll).

Specific items that will be addressed through continued communication with BPA personnel include:

a. Proper equipment installation and power sourcing
b. Proper measurement and application of offsets and uncertainty values
c. Proper calibration of navigation timing latency, single beam echosounder positioning, and side scan sonar positioning
d. Verification of UTC/ZDA timing synchronization within Hypack
e. Proper acquisition and processing of hydrographic survey data to IHO Order 1 specifications
f. Production of a complete UKHO deliverable package, including XYZ bathymetric sounding files, feature files, reports of survey, and Danger and/or Aid to Navigation reports

11. **Current BPA Goals** – As stated through numerous conversations with BPA personnel, including the Chief Hydrographer (Michael Jenkins) and Port Commissioner (Major Lloyd Jones), BPA's current goals for its hydrographic survey program include:
    a. Complete work and equipment installation on SEA KING to have an official fully operational hydrographic survey vessel
    b. Maintain the hydrographic survey program at BPA with at least 4 personnel and be able to produce nautical charting products for UKHO
    c. Send another BPA employee to the upcoming Category B hydrography course in Japan (Mr. Jenkins has already attended)
    d. Survey critical areas of the country's main channels and anchorages, to be followed by environmental mapping
    e. Following channel/anchorage/environmental mapping surveys, survey around uncharted and/or unsurveyed charted areas around cayes and lagoons

<u>Closing Thoughts</u>:

1. **Accomplishment of Objectives** – Although numerous roadblocks emerged throughout the visit, the BPA trainees and I accomplished the vast majority of training objectives. I would have preferred more survey acquisition and processing time, but I am comfortable with the group's overall level of knowledge with respect to hydrographic survey operations.

2. **Pre-visit State of Equipment** – Training time was not fully maximized due to the impact of the following issues that ideally should have been addressed prior to my arrival: (1) identification, procurement and/or recommendation of proper power supplies; (2) manufacturing proper data and power cable terminations for all equipment; and (3) delivery of a trip report from the equipment vendor detailing what was and/or still needed to be accomplished. Numerous hours of training time were lost in order to resolve these issues.

3. **Support of Hydrographic Survey Program** – While existing bureaucratic processes sometimes made procurement of materials and transportation to/from the various training sites difficult, it is clear to me that the BPA management is fully behind developing the hydrographic survey program into a successful and sustainable one. In the brief time I was able to speak with Major Lloyd Jones (Ports Commissioner), he showed steadfast

commitment to building BPA's hydrographic survey capacity and pledged that he would continue to pass the importance of such a program to his superiors. I expressed the necessity that he provide continuous communication of BPA's needs to the various players involved in this project (GoH Project Office, MACHC, etc.), as that would increase the opportunity for long term project success as well as accomplish short term goals (i.e. follow-up training visits, procurement of improved/advanced technologies, etc.).

4. **Hydrographic Survey Program and Local Politics** – There is a common misconception in the political ranks of the Belizean government that once an area is surveyed, it does not require further work. This lack of general knowledge in physical ocean processes should be corrected with continued progress of the BPA hydrographic survey program. In the mean time, Major Jones is "selling" the need for the program by arguing that it is required to (1) conduct emergent surveys of the channels in the event of a vessel grounding and/or storm, and (2) find exact locations of reef and marine habitat for environmental conservation and enforcement activities.

5. **Follow-up Work & Visits** – I stressed to all BPA trainees that the only way they will be able to master the "art" of hydrographic survey is to continue reviewing training presentations, conduct hands-on work with the survey suite, and learn from their discoveries and mistakes. Of all of the objectives addressed, the fifth objective (deliverables to UKHO) was covered the least, partially due to time and partially due to lack of submission-quality data. This particular objective can be somewhat addressed via e-mail and telephone communications following further data acquisition and processing by BPA personnel, but a follow-up visit in-country will ensure that all data to be submitted will meet IHO and UKHO standards. Additionally, a follow-up visit will enable BPA personnel to gather more experience with and provide more specific questions about their individual hydrographic survey operations. The best time for a follow-up visit would probably be approximately 6-8 months from now. I recommend that the MACHC and GoH Project strongly consider identifying the resources to reinforce and continue this nascent and promising effort.

Gulf of Honduras Training Group (Belize Port Authority). From left to right: Zachary Young, Darrel Ramclam, Mark Sabal, Chris van Westendorp (NOAA), Michael Jenkins, Michael Usher

Survey acquisition training onboard Belize National Coast Guard vessel.