

NOVEMBER 2008

POB

POINT OF BEGINNING

Imaging Coastal Areas

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Within hours after Hurricane Ike slammed into southeastern Texas in September, the U.S. Army Corps of Engineers (USACE) Galveston District, working in partnership with the U.S. Coast Guard, NOAA and the Gulf Intracoastal Canal Association, had assembled dozens of surveyors in the Houston/Galveston Bay complex (including the Port of Houston, Port of Galveston, Port of Texas City, Green's Bayou, Bayport and Barbers Terminals), the Sabine Neches Waterway, and other major ports to conduct hydrographic and sidescan sonar surveys and assess

the damage. Quickly reopening the waterways was crucial to the local and national economy, and the response was unprecedented. Among the organizations enlisted in the effort was TerraSond Ltd., a Palmer, Alaska-based surveying and mapping firm with offices in Seattle, Wash., and Houston and Corpus Christi, Texas.

Originally formed as Terra Surveys LLC in Alaska in 1994, TerraSond specializes in providing land and hydrographic surveys as well as marine geophysics. The firm began working with the Galveston District of the USACE in 2004 processing the USACE's in-house hydrographic



AFTER THE STORM

BY CHRISTINE L. GRAHL

Staying nimble and technologically advanced allows a surveying and mapping firm to play an important role in hurricane-recovery efforts.

survey data, and it continued to expand its scope to include single-beam, multibeam and sidescan sonar surveys in support of dredging, maintenance, design and emergency response. The firm has also monitored the position of contract dredges and USACE survey vessels using GPS and satellite communications. Following Hurricane Rita in 2005, TerraSond was able to put together a small flotilla of survey vessels to map the damage along the Texas coast. This



experience launched another new capability for the firm: hurricane response.

Over the next three years, the company's fleet in Alaska, Texas and Washington grew to include 10 survey vessels and a staff of 75, including ACSM-certified hydrographic surveyors, registered professional land surveyors and a supporting group of hydrographers, land surveyors, marine geophysicists, geologists, oceanographers, GIS and CAD specialists, IT professionals, and professional mariners. TerraSond's ability to provide quality work and a fast response enabled it to secure its second indefinite delivery/indefinite quantity (IDIQ) term contract with the Galveston USACE in July 2008. When Hurricanes Edouard and Gustav roared through the Texas/Louisiana region this summer, the firm responded with two vessels, including a smaller boat and a larger "offshore" vessel, and it sent out three survey boats after Hurricane Dolly. But Hurricane Ike was different. The devastation caused by the Category 2 hurricane in a number of major shipping ports required a rapid response on a much larger scale. Fortunately, TerraSond was up for the challenge.

A Plan of Action

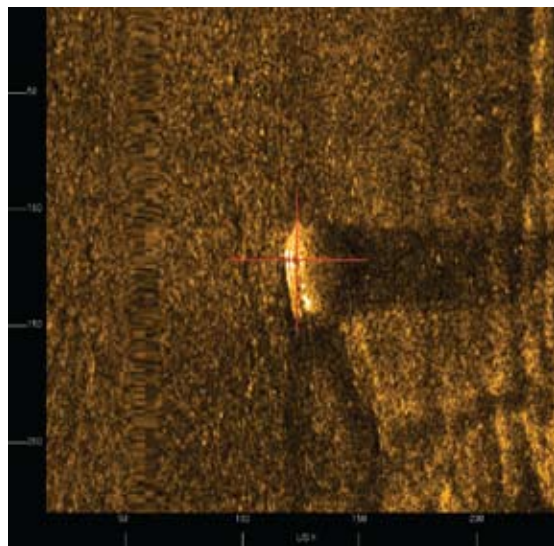
Working closely with Tim Updike, hydrographic survey coordinator for the Galveston District of the USACE, along with NOAA's National Weather Service and other agencies, TerraSond developed a plan of action before the storm hit the Texas coastline.

The firm organized a response team composed of its entire office and field staff in Texas as well as human resources and physical assets diverted from other projects in Alaska, Washington and Louisiana, including an ongoing project mapping debris from Hurricane Katrina for NOAA. TerraSond also subcontracted five other Texas survey firms for the project, including SURVCON Inc., Chris Ransome & Associates (CRA) Inc., PBS&J, Frontier Surveying Co. and Naismith Marine Services. The initial response would require a total of 17 survey vessels, nine of which would be provided by TerraSond and its subcontractors, including two large offshore vessels TerraSond chartered for

the effort. (See the sidebar, "Hurricane Ike Response Vessels and Equipment.")

"It was a massive undertaking in a very short period of time," says Brian Busey, an ACSM-certified hydrographer and general manager of TerraSond's Alaska office. "But all of the firms we contacted realized how serious the situation was, and everyone was willing to help."

The preplanning efforts paid off. As soon as Hurricane Ike struck Galveston, the USACE mobilized survey areas to determine where boats were needed and what the priorities were for each boat. The day after the storm, all of the survey crews were in the water at their assigned stations with equipment from TerraSond, its subcontractors and even some rented equipment. Using single-beam echosounders from Odom Hydrographic and Innerspace Technologies and sidescan sonar systems from Edgetech and Imagenex, the crews conducted clearance surveys in which they measured the depth of the water in the USACE-maintained navigation channels and located any obstacles to traffic. The single-beam echosounders determined the depth directly below the survey vessels, while the



Left: An overturned boat and debris.
Above right: Survey lines of the Port of Houston are superimposed on satellite imagery. The text indicates depth in feet.
Below right: This sidescan image of an upside-down hull was generated in SonarWiz.MAP.



Above: TerraSond survey vessel Royal Fish was one of the boats used in the emergency response. Left: A Texas marina following Hurricane Ike. Below: Downed power lines in Texas following the hurricane.

sidescan devices were towed behind the vessels and scanned the water to the left and right of each boat. The survey vessels ran three lines down each channel and a suitable pattern in turning basins and anchorages to perform the clearance work.

With access to only seven sidescan sonar devices, the team led by TerraSond had to improvise on the other two vessels. A Reson Seabat 8101 multibeam sonar from TerraSond's Houston office was used on one of the charter vessels to take soundings below and on both sides of the vessel in a pattern that allowed for complete coverage of the channels. The other charter vessel used a single-beam sonar and was only used to check for shoaling in an outer channel. The survey crews also used DGPS receivers, and the large charter vessels were equipped with heave sensors to compensate for heave and attitude, including heading, pitch and roll.

However, even with all of the advanced equipment, surveyors faced a significant challenge in determining the water levels. "The primary goal was to see if there was debris or anything that might damage a ship coming into the harbor, but the water levels

Hurricane Ike Response Vessels and Equipment Managed by TerraSond

Vessel:	Royal Fish
Echosounder:	Odom Mk-II
Sidescan:	EdgeTech 4200FS
GPS:	Trimble DSM-212
Software:	HYPACK and Onsite
Vessel:	Skully
Echosounder:	Odom Hydrotrak
Sidescan:	EdgeTech 4200FS
GPS:	Trimble DSM-212
Software:	HYPACK and Onsite
Vessel:	Gladys D (80')
Echosounder:	Odom CVM
Sidescan:	EdgeTech DF1000
Motion Compensation:	Applanix POS/MV
GPS:	CSI MBX-4 USCG DGPS into POS/MV
Software:	HYPACK
Vessel:	Spree (100')
Multibeam:	Reson Seabat 8101
Motion Compensation:	Coda Octopus F185
GPS:	CSI MBX-4 USCG DGPS into POS/MV
Software:	HYPACK
Vessel:	Howard Post
Echosounder:	Odom CVM
Sidescan:	EdgeTech DF1000
Motion Compensation:	Coda Octopus F185
GPS:	Trimble DSM-232
Software:	Trimble HydroPro
Vessel:	Seahawk
Echosounder:	Odom Hydrotrak
Sidescan:	EdgeTech DF1000
GPS:	Hemisphere L100
Software:	HYPACK
Vessel:	CRA 2
Echosounder:	Odom Hydrotrak
Sidescan:	EdgeTech T60/272
GPS:	Trimble DSM-232
Software:	HYPACK
Vessel:	Captain TD (85')
Echosounder:	Odom CVM
GPS:	Trimble R8
Software:	HYPACK
Vessel:	Sea Ox
Echosounder:	Innerspace 456
Sidescan:	Imagenex 872 YellowFin
GPS:	Trimble R8
Software:	HYPACK

in the harbors were quite a bit higher than they normally would be, and the tide gauges were all out,” Busey says. “Normally, we’d get that information digitally off the Internet after a storm, but that wasn’t an option in this case. We had to go by our best estimates or the best the Army Corps could get us.”

Sounding data collected during the day in HYPACK software was quickly processed by the field crews using the same software and transferred electronically to TerraSond’s Alaskan processing staff. The Alaska staff corrected the soundings using water-level data provided by USACE’s Updike. The Alaskan staff then created and managed the bathymetric surfaces generated from the soundings. “We gener-

ated .xyz files that were georeferenced to the soundings in the channels using the spacing specified by the Army Corps of Engineers for clearance,” Busey explains. “These data were overlaid on the existing nautical charts and .dxf files that the Army Corps of Engineers uses for survey-channel planning.”

Sidescan sonar data was monitored in real time on the vessels and then transferred to TerraSond’s Alaskan office where significant bottom features, such as sunken vessels, and obstructions to marine navigation were identified using Chesapeake Technology Inc.’s SonarWiz. MAP software. The team transferred these data to GIS maps, which were printed in a PDF format and uploaded to an FTP site. All of this work was completed overnight so that Army Corps personnel could access the files the next morning and use the information to develop a strategy for that day’s work. “There was no downtime,” Busey says. “The entire team was working around the clock.”

Indeed, some of the surveyors in the Houston/Galveston waterways worked 20 hours or more nonstop in the initial days after the storm. Surveying conditions were also less than optimum. “All of our Houston employees lost power, most had damage to their homes and two lost their homes,” says Thomas Newman, president of TerraSond. “All the problems that Texas was having with the availability of fuel and food, electricity, communications, and even places to sleep affected the survey crews. Several times, crews dispatched to work in an area spent the night sleeping in their trucks before starting work the next day because all remaining accommodations were taken.” Surveyors had to navigate around drowned farm animals, various household objects and all types of debris, some of which damaged the survey equipment and vessels. Despite the difficult working conditions, the ports had to be opened as quickly as possible.

“We were told that the gulf and coastal waterway does an estimated \$50 million worth of business every day,” Busey says. “We had to go in and survey before the salvage barges could get in and clear out the debris. Everyone realized how important these ports were to the economy.”

A Successful Strategy

Communication was key throughout the project. Twice-daily teleconferences managed by the USACE ensured that all of the response teams from the various agencies and private-sector firms were able to work efficiently. Cell phones, BlackBerry devices, satellite phones and wireless air cards were all used to keep voice communications, text messages and e-mail flowing. TerraSond’s Corpus Christi office, which had maintained power and communication capabilities after Ike, became the company’s command center for the response.

Within three days, crews had assessed the majority of the waterways, and TerraSond’s efforts were scaled back to two vessels that were primarily focused on performing more detailed condition surveys.

By Sept. 15, just two days after Hurricane Ike made landfall at Galveston, the U.S. Coast Guard Captain of the Port (COTP) had reopened the Houston Ship Channel and Sabine-Neches Waterway to shallow-draft vessels 16 feet or less. By Sept. 17, many of the other channels had been opened to both shallow- and deep-draft vessels during daylight hours, and by Sept. 23, the COTP had opened the Houston Ship Channel from the Sea Buoy to the Turning Basin for all transits up to the normal vessel drafts for both night and day passage and had also eased restrictions at the Port of Freeport. At press time, efforts to reset navigational markers continued, but most merchant ships were able to pass through the Gulf Coast channels and ports.



A sunken boat in a Houston shipping channel.

For Jim Nash, vice president of TerraSond in Houston, Hurricane Ike provided an opportunity to put his team's skills into action. "Prior to Ike's landfall, I enjoyed the challenge of arranging and planning the survey teams and subcontractors and all the specifics required for emergency work," Nash says. "This included arranging special entry permits for survey crews on roads under police control, finding alternative communication methods such as satphones, and organizing teams for emer-

gency conditions, including my own safety and hurricane survival planning. Once Hurricane Ike hit Houston, everything was in place to survey. When I found out that the agencies in charge were being asked daily by both Congress and the president when the ports would be operational, I realized how important our effort was to the U.S. economy. It is a rare opportunity to be in a position to help like that."

The project was the largest rapid emergency response TerraSond had ever han-

dled. But for a firm that strives to be both technologically advanced and nimble, it was all in a day's work. "As an employee-owned firm, TerraSond empowers all of its employees to seek out new technologies and methods that will improve our service and response time," Busey says. "We have the capability to assemble, integrate and install systems on vessels; make them work; and then take the acquired data and turn it into a product the client wants in a very short period of time. We constantly strive to know what technologies are out there and understand how to use them to their best advantage."

The firm also dedicates a substantial amount of resources to education and training to ensure that its employees remain on the cutting edge. All of these efforts help ensure that when the next storm hits, TerraSond will be ready. ☺

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