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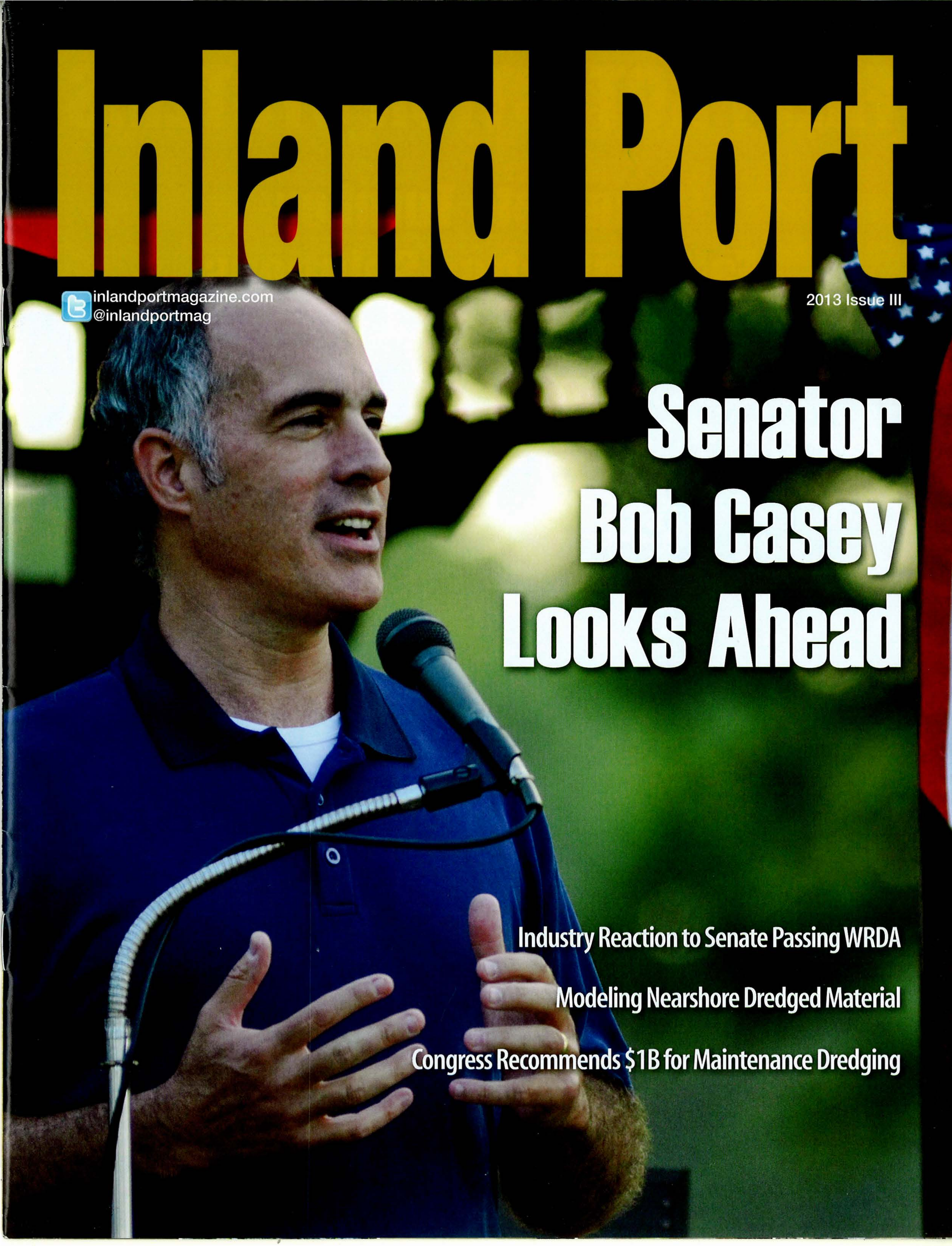

Senator Bob Casey Looks Ahead

Industry Reaction to Senate Passing WRDA

Modeling Nearshore Dredged Material

Congress Recommends $1B for Maintenance Dredging

Physical Modeling of Nearshore-Placed Dredged Material

Improved dredging is crucial for the future of inland waterways and ports. A USACE study has found that dredged material placed within the surf zone can be effective in reducing shoreline erosion in the vicinity of the placement site.

The US Army Corps of Engineers (USACE) continues to seek opportunities for the beneficial use of dredged material. Frequently, USACE dredged material management plans include offshore placement of dredged material from channel entrances and ebb shoals. This often removes material with a high sand percent from the littoral or regional system.

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Maintenance dredged material from these areas is generally not considered beach quality (>88 percent sand), but often includes approximately 60-80 percent sand.

Placement of dredged material in the nearshore permits natural winnowing/separation of the fine and sand particles. Nearshore mound locations, material, and configurations must be chosen judiciously to assure that the mound does not negatively impact the surrounding environment and that material remains in the littoral system and nourishes the beach.

Placement of material in shallower water is more costly than placement further offshore. However, benefits of additional sand placed in shallower water may be more cost-effective than offshore placement.

The USACE District, Buffalo (LRB), and the Engineer and Research Development Center's (ERDC) Coastal and Hydraulics Laboratory (CHL) performed movable-bed physical model experiments to assist in evaluating the fate and to help quantify the benefits of nearshore sand placement.

Three nearshore mound locations were subjected to waves in a three-dimensional basin, and the resulting bathymetry was measured with detailed surveys. The experiments demonstrated the benefits of nearshore placed sand to the shoreline and beach.

DESCRIPTION OF THE LSTF

Experiments were performed in the Large-scale Sediment Transport Facility (LSTF), a mobile-bed model intended to reproduce surf zone processes on natural beaches. The LSTF consists of a 30m-wide, 50m-long, 1.4m-deep basin, which includes a 27m (alongshore) by 18m (cross shore) sand beach. The beach is composed of fine quartz sand; having a median grain diameter, d_{50}, of 0.15mm. Waves are produced by four synchronized wave generators oriented at a 10-degree angle to the shoreline.

To minimize adverse laboratory effects created by the boundaries of the finite-length beach, wave-driven currents are supplemented by an external recirculation system. In the absence of an external recirculation system, the wave driven currents would develop a gyre within the facility, which would distort any test results.

The generated currents matched the mean longshore current at 20 cross-shore locations and had a peak current of 0.12 m/s onshore and tapered to 0 m/s offshore outside the surf zone.

Longshore sediment transport and its cross-shore distribution are measured with traps installed at the downdrift boundary.

Each trap was equipped with three load cells to weigh trapped sand, which was used to compute total longshore transport rates and the cross-shore distribution of longshore sediment transport.

MOUND EXPERIMENTS

Three experiments were performed with mounds in the LSTF at a 1:20 prototype to model scale to observe transport of nearshore placed sand at different depths. To minimize any effect of natural beach profile evolution, a base condition test also was performed to observe bathymetry change without a mound. These changes were removed when comparing beach change differences with mounds to help determine the influence of each mound.

Incident wave conditions at the 1:20 scale simulated a scaled offshore incident wave height (H_{mo}) of 10.8 feet, with a peak period of 6.7 seconds and a breaking wave angle of ~6.5 degrees from shore normal. The LSTF sand represented a prototype grain size of 0.54mm.

Mounds were located at approximate prototype depths of 11 and 4 feet relative to the still water level, and placement onshore. The two offshore mounds were, in prototype dimensions, approximately 5 feet high and 30 feet wide. The onshore mound was placed 10 feet high, prototype, at the shoreline and extended horizontally into the foreshore slope.

Mounds were placed at the same alongshore location in the LSTF for each experiment

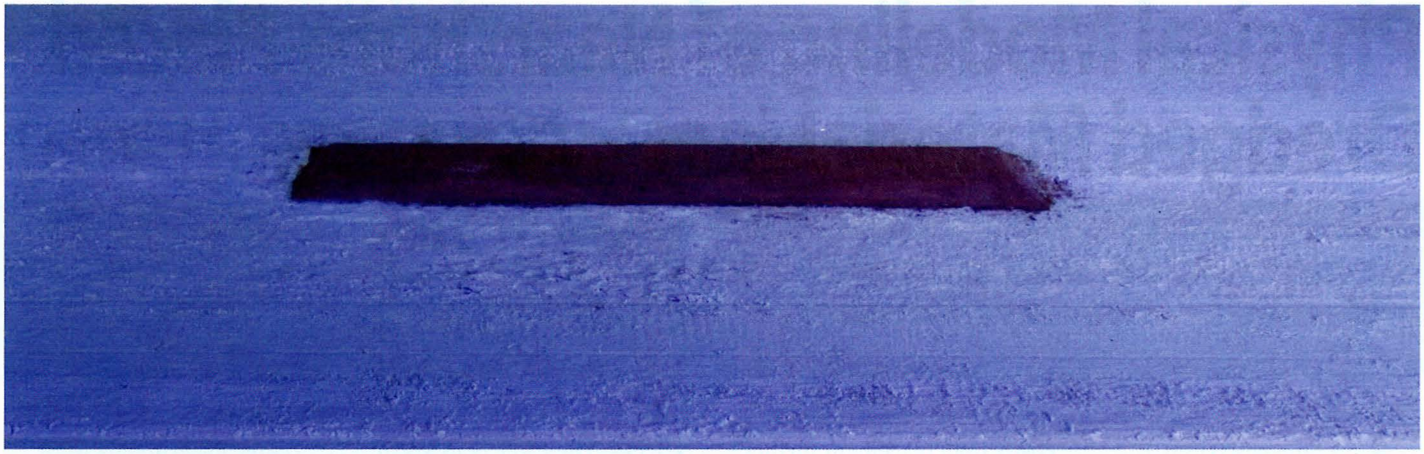
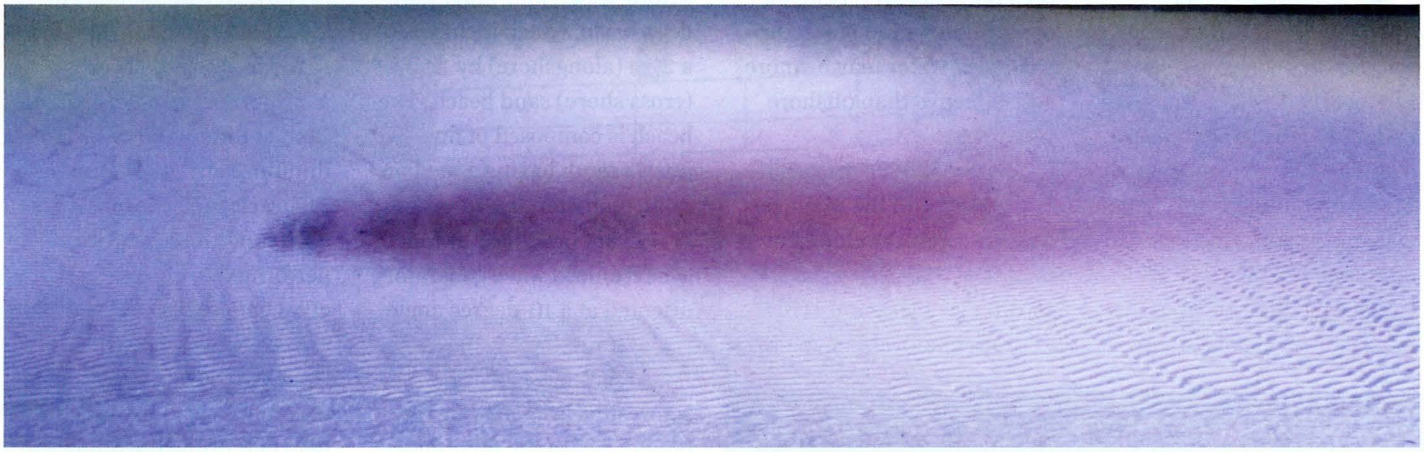


Figure 1: View of mound placed at 11 feet before waves (above) and mound after 60 minutes of waves (below).



and were constructed to a 200-foot prototype length, representing approximately 30,000-cubic-feet of placed sand.

Each mound was dyed with a different color to increase the contrast between the placed material and the beach. Concrete dye proved to be an effective dye for the sand. The process entailed mixing the dye with sand in a concrete mixer and baking it for no less than 24 hours at 180 degrees Fahrenheit. Subsequent analysis showed no difference in physical properties between the dyed and natural sand.

The beach was surveyed with a 3D laser scanner before and after completion of each mound placement experiment and at intermittent intervals during the experiment.

From the surveys, cross-shore and long-shore transport of the placed sand were calculated from comparisons between initial, intermittent and final surveys of each mound placement location.

Additionally, longshore transport rates were calculated from the volume of sand collected in the downstream traps of the facility for each test, and currents and wave heights were measured at 10 cross-shore locations at several longshore transects.

STUDY RESULTS

For each mound, placed sand dispersed quickly when subjected to wave action, and the mounds had diminished after 30 minutes of model waves. Figure 1 shows the 11-foot depth placed mound looking offshore. The top pane shows the mound before the test, and the bottom shows the mound after 60 minutes of waves. The dyed mound sand was transported downdrift and spread slightly onshore and offshore.

Figure 2 shows a bathymetry change plot of the mound in which waves approach from the right and updrift is at the top of the plot. Although mound sand was observed to be transported downdrift of the initial mound location, it is not apparent in Figure 2. Accretion is observed in Figure 2 directly onshore and onshore and updrift of the initial mound location. Erosion occurred onshore and downdrift of the mound.

The figures indicate that the mound impeded longshore sand transport, trapping sand onshore and updrift of the mound with erosion occurring downdrift where the sand supply was reduced. Similar results were observed with the mound placed at 4 foot prototype, with mound sand transported downdrift but accretion observed onshore of the mound. Sand from the onshore placed mound was transported and accreted directly downdrift. However, accretion also was observed updrift of the mound.

CONCLUSIONS

Physical model experiments of dredged mound placement within the surf zone demonstrated the added benefits of placed sediment in the nearshore. The dyed mound sand served as an additional indicator of the direction and dispersion of the sand movement.

Placed mounds within the surf zone dispersed rapidly downdrift and remained entrained in the nearshore. Although the mound sand was transported predominately downdrift, sand accretion was observed onshore of the initial mound locations for the offshore placed mounds. The onshore accumulation is believed to be a result of sheltering of the initial mound.

The study indicated that dredged material placed within the surf zone can be effective in reducing shoreline erosion in the vicinity of the placement site. *IP*

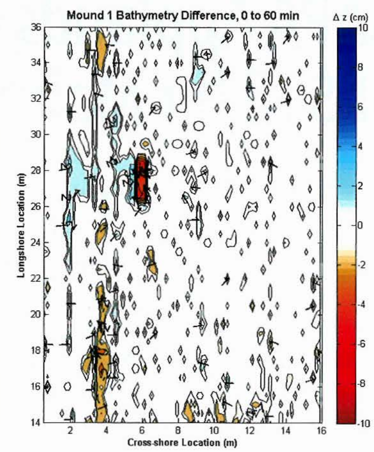


Figure 2: Bathymetry difference after 60 minutes of waves of mound placed at 11-foot depth.

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