APPLICATION OF COASTAL ENGINEERING PRINCIPLES IN RESPONSE TO THE DEEPWATER HORIZON DISASTER: LESSONS LEARNED IN COASTAL ALABAMA

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Introduction

The explosion of the Deepwater Horizon drilling rig on April 20, 2010, and the subsequent events leading to the nation’s largest oil spill in recorded history, illuminated a threat not typically included in any practitioner’s list of coastal hazards: oil fouling thousands of miles of gulf coastline. Much uncertainty paralyzed early efforts to contain the spill at the source, and it soon became evident that containment strategies would be focused on preventing surface oil from fouling marshes, wetlands, beaches, bays, bayous, and estuaries. A number of containment strategies and efforts were employed to protect Alabama’s 1000 km of tidally influenced shoreline. Some strategies actively contained surface oils (e.g. booms, skimming), others were more passive (e.g. beach cleaning), and still others modified the properties of the oil to enhance degradation (e.g. dispersant). A considerable amount of time, effort, and money was spent on containment efforts and coastal defenses in Alabama during the nearly three-month period following the initial explosion and leak of the Macondo well. Some of these approaches were novel, some were rather crude, some worked, and some were costly. In the end, a qualitative review of these efforts suggests that applying fundamental coastal engineering principles could have yielded more effective coastal defenses, while potentially saving millions of dollars in the process. A synopsis of a few specific strategies will be provided in the proceedings paper including: the filling of a 2.5 km barrier island breach; the filling of the nation’s second smallest tidal inlet at Little Lagoon; a novel containment boom deployed at Perdido Pass; and a standard containment boom deployed across Main Pass, the main connection between Mobile Bay and the Gulf of Mexico. More attention will be given to a comparison of defense strategies employed to protect Alabama’s 100 km of beaches, with active defenses constructed on Dauphin Island, and more passive approaches taken (e.g. beach cleaning) along the beaches of Gulf Shores and Orange Beach. A brief synopsis of containment measures employed on Dauphin Island is provided for the purposes of evaluating the suitability of the proposed submission.

Containment Measures on Dauphin Island

On May 2, 2010, the combination of a spring tide and strong southeasterly winds produced a mild overwashing event on the west end of Dauphin Island. A typical elevation on this part of the island is roughly +1.5 m NAVD, although the crest of the beach berm can be slightly higher. This portion of the island is so susceptible to overtopping—usually through a combination of astronomical tides, wave setup, and wave runup—that the west end has been overwashed at least six times in the twelve-month period preceding the oil spill; and it has been overwashed during most tropical storm events that have impacted the island during the past 15 seasons.

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A decision was made by the elected officials of Dauphin Island to construct two protective sand barriers on the island as a primary strategy for protection and oil containment: the first to prevent complete overtopping during a weak tropical storm, and the second for containment under synoptic conditions. At the time, a means of stemming the leak was unavailable, a growing slick of surface oil had begun its translation toward the north-central gulf coast, and the forecast of an active hurricane season, suggested that the island’s west end could potentially be covered in oil during the next overwash event.

The first protective sand barrier was constructed just south of Bienville Boulevard extending from St. Stephens Street to the public park on the west end, a distance of approximately 4 km. It was completed in several days as a stopgap measure to prevent a complete overtopping event. Construction of a second protective sand barrier commenced shortly thereafter, and was placed at or near the highest elevation of the subaerial beach on the west end of the island with the goal of containing the oil spill on the beach face. Guidance provided in Hallermeier and Rhodes (1988) was used to estimate the level of protection offered by the sand barriers. The initial volume density of each barrier afforded protection against a storm having a recurrence interval of slightly more then one year. The first sand barrier was subsequently expanded to increase the level of protection to a 33-year storm event. Photographs of the protective sand barriers are shown in Figures 1 and 2.

Although the sand barriers were never fully tested by anything stronger than a distant tropical storm, oil was contained successfully on the beach face where regular beach patrols quickly removed tarballs and emulsifications. The volume density of the seaward containment barrier has subsequently been reduced, but the larger barrier remains. Vegetation is thriving on the large barrier (see Figure 1b), and six months of weathering has resulted in a much more natural looking feature. Neighboring beach communities that opted to forego containment near the shoreline continue to clean their beaches four months after the well was sealed. In some cases, drastic measures have been taken, including excavation and mechanical sieving of the top 1 m of beach material.

A number of obstacles were encountered in what one co-author politely entitled, “Incremental Field Engineering.” Siting issues, homeowner concerns, overhead utilities, water and sewer infrastructure, fire hydrants, and the availability of suitable fill material all dictated an immediate design modification at one time or another. Regular communication and coordination with the US Fish and Wildlife Service was a necessity, particularly in light of premature turtle activity in the area.
Figure 1. Photographs of the first protective sand barrier on the west end of Dauphin Island taken on (a) May 21, 2010 and (b) September 28, 2010. Note the location of the reference arrow in each photograph, and the flourishing panic grass. These photographs were taken during the subsequent increase in volume density.

Figure 2. Photographs of the second protective sand barrier on the west end of Dauphin Island taken on (a) May 14, 2010 and (b) September 28, 2010. Note the location of the reference arrow in each photograph.

References