Contents

List of Figures

List of Tables

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic yards	0.7645549	cubic meters
degrees (angle)	0.01745329	radians
feet	0.3048	meters
gallons (U.S. liquid)	0.003785412	cubic meters
inches	25.4	millimeters
miles (U.S. statute)	1.609347	kilometers
square feet	0.09290304	square meters
pounds (mass) per cubic foot	16.01846	kilograms per cubic meter
pounds (mass) per square foot	4.882428	kilograms per square meter

Preface

This study was conducted by the U.S. Army Engineer Research and Development Center (ERDC) (formerly U.S. Army Engineer Waterways Experiment Station (WES)), Coastal and Hydraulics Laboratory (CHL), Coastal Evaluation and Design Branch (CE&DB). The study was authorized and funded by the Dredging Operations and Environmental Research (DOER) Program. The technical manager was Dr. Robert Engler (ERDC). Mr. James Clausner (ERDC) was technical area leader. Dr. Jack Davis (ERDC) was the Principal Investigator.

Work was performed under the general supervision of Ms. Joan Pope, former Chief, Coastal Evaluation and Design Branch and Dr. Yen-Hsi Chu, Chief, CE&DB; Mr Bruce Ebersole, Chief, Coastal Processes Branch; Dr. Zeki Demirbilek, Acting Chief, Coastal Hydraulics Branch; Mr. Rob McAdory, Chief, Tidal and Hydraulics Branch; Mr. Thomas Pokrefke, Acting Deputy Director, CHL; and Mr. Thomas W. Richardson, Acting Director, CHL. This report was prepared by Drs. Donald K. Stauble, Jack E. Davis, Joseph Z. Gailani, Lihwa Lin, Edward F. Thompson, and Messers. Howard Benson, and Thad C. Pratt of CHL, and Dr. Marian Rollins, formerly of Geotechnical and Structures Laboratory (GSL) and now of Cold Regions Research and Engineering Laboratory (CRREL).

The authors would like to thank Ms. Linda Lillycrop, U.S. Army Engineer District, Mobile, for coordination, providing data, base maps, dredging information and discussion on the project. Field data collection was assisted by Messers. Sam Varnell, Terry Waller, Chris Callahan (CHL), on board the *SV Mr. Dave* and Messers. Ellis Mnott, Tommy Hughes, Matt Tate, and Nathan Lovelace (U.S. Army District, Mobile), aboard the *SV Gatlin*. Additional District personnel assisted with logistics and data collection efforts.

At the time of publication of this report, Dr. James R. Houston was Director of ERDC, and COL John W. Morris III, EN, was Commander and Executive Director.

1 Introduction

As part of the U.S. Army Corps of Engineers' Dredging Operations and Environmental Research (DOER) Program, the U.S. Army Engineer Research and Development Center's (ERDC) Coastal and Hydraulics Laboratory (CHL) and U.S. Army Engineer District, Mobile, constructed a mixed sediment dredged material mound offshore of Mobile Bay, AL. Monitoring the long-term fate of the mixed sediment mound was initiated immediately following construction. The purpose of the field investigation was to provide data to advance our understanding of the geotechnical properties of dredged material before, during, and after dredging, and for verification of Corps numerical models, which predict the fate of dredged sediments during the many phases of dredging. Of greatest interest is the long-term fate of mixed sediments (i.e., dredged material with a fraction of fines equal to or greater than about 50 percent) placed at a nearshore location. The expectation is that over time the sand fraction will become part of the nearshore littoral sediment transport system, potentially providing sand to nourish beaches, while the fine fraction will disperse to deeper, quieter water where other fine material exists without adverse consequences. Acceptance of placing mixed sediments in the nearshore zone will provide for beneficial uses of material, reduce haul distance, and reduce shoreline erosion (McNair 1998). This report describes the construction, monitoring efforts, and initial study results.

Background

The Corps annually dredges approximately 268 million cu m (350 million cu yd) of material to improve and maintain Federal harbors and channels. The Corps has estimated that somewhere between 20 to 30 percent of the dredged material is used beneficially. A large volume of the dredged sediment is composed of silts and clays, but can contain a significant fraction of sand. In coastal settings, the most common placement of dredged material is in open-water sites some distance from the coast where it is not confined by structures and is removed from the littoral system. In nearshore and beach environments, the only dredged material placement usually allowed is sand, due to concerns that fine materials (silts and clays) will disperse and smother benthic organisms as well as cause excessive nearshore turbidity. The turbidity may affect the use of the area by marine life for feeding or spawning, and may directly impair the growth of some organisms like sea grasses or corals. Another concern is that some of the fine materials might be transported onto the beach, which might lessen the beach's public appeal. The actual turbidity or magnitude of suspended sediments that might be generated from a given nearshore mixed-sediment mound is unknown, as well as the magnitude of any adverse environmental effects. So, until more is known about the erosion and transport processes of mixed sediments, dredged material containing significant fractions of fine-grain sizes may not be allowed in the nearshore.

The ability to numerically simulate and predict mixed-sediment erosion and transport would be helpful in that a variety of climatic scenarios could be explored and the environmental risks of nearshore placements investigated. A good description of the processes of erosion and transport of such sediments is necessary to develop a model for simulations. Jepsen, McNeil, and Lick (2000); Roberts et al. (1998); and Jepsen, Roberts, and Lick (1997) have shown that sediment mixtures of sand, silt, and clay have significantly more complex erosion characteristics than pure sand or predominately sandy sediments. These mixed sediments are often referred to as cohesive because of the tendency of the particles to adhere to each other. The erosion characteristics of these sediments cannot be described using the well-established methods for sandy sediments, where erosion is a function of grain-size distribution. Mixed sediment erosion rates will be affected, by not only grain size, but also bulk density, mineralogy, pore water chemistry, organic content, and the presence of gas bubbles. It is qualitatively understood that, depending on the conditions, one or more of these bulk properties may have an order of magnitude or more effect on erosion rates. However, insufficient data are available to quantify the effects of these parameters.

To begin the process of adding to our understanding of mixed-sediment transport processes, ERDC-CHL, and the Mobile District, are conducting research into the long-term fate of a mixed-sediment mound, placed on the western edge of the Mobile Bay entrance ebb shoal (Figure 1). Field data will be used to advance our understanding of the geotechnical properties of dredged material before, during, and after dredging, as well as provide quality data for verification of numerical models being developed by the Corps. Specifically, the Long Term Fate (LTFATE) (Scheffner et al. 1995) and Multiple Dump Fate (MDFATE) (Moritz 1994) models for dredged material placement can be verified with this data set for the fate of mixed sediments. These models are used to predict the fate of dredged material (i.e., where the material moves) during placement and over a given period (up to years) after placement. While data exists for sandy dredged-material mounds and for which the models have been well verified, little information is available regarding mixed sediments. Therefore, the data set collected through this study will provide a unique opportunity to advance our understanding of and ability to predict the fate of mixed-sediment dredged material. The ultimate goal is to have accurate numerical models that may be used to simulate the fate of nearshore mixed sediments to optimize placement such that the sandy portion of the material can replenish the littoral system without detrimental environmental effects from the silts and clays.

Project Description

Beginning in late October 1998, about 268,000 cu m (350,000 cu yd) of dredged material were placed in a designated study site outside the entrance to

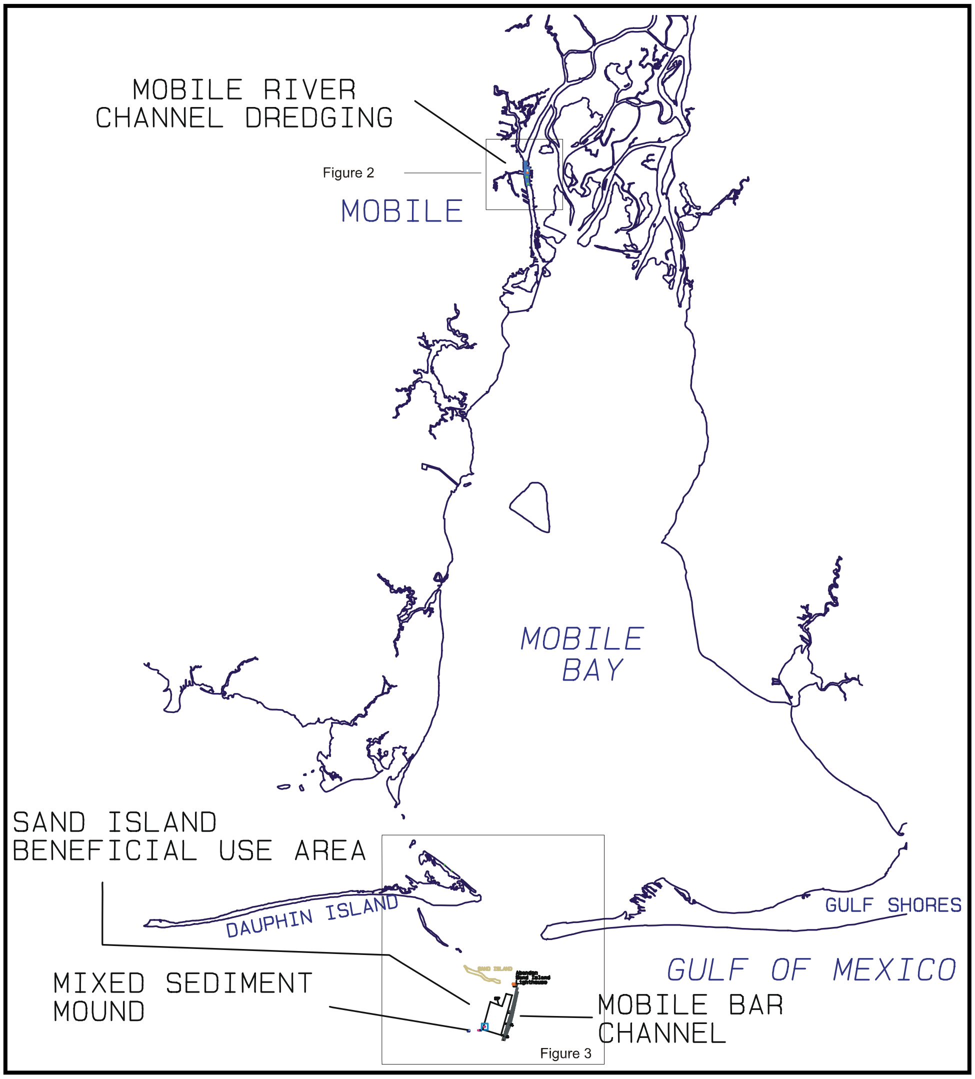

Figure 1. Location map

Mobile Bay. The material was dredged from the Mobile River in the upper reaches of Mobile Bay near St. Louis Point (Figure 2). The material was removed with a bucket dredge and transported to the placement site using one 5,046-cu m (6,600-cu yd) and two 3,058-cu m (4,000-cu yd) split-hull barge scows. The placement area was roughly 93 m (1,000 ft) square and located on the south-western edge of the entrance ebb shoal (Figure 3). All of the dredging and placement was accomplished over a 1-month period. Prior to dredging, the channel material was sampled to estimate the fraction of sands, silts, and clays. Tests indicated that the material was close to 50 percent sand, which was considered ideal for the study. Subsequent sampling of the placed dredged material indicated that it was only 20 percent sand, which was still satisfactory for the study. The material was cohesive and could be described as a black, fine-grained, cohesive sediment. The characteristics of the material are described in more detail in a later section.

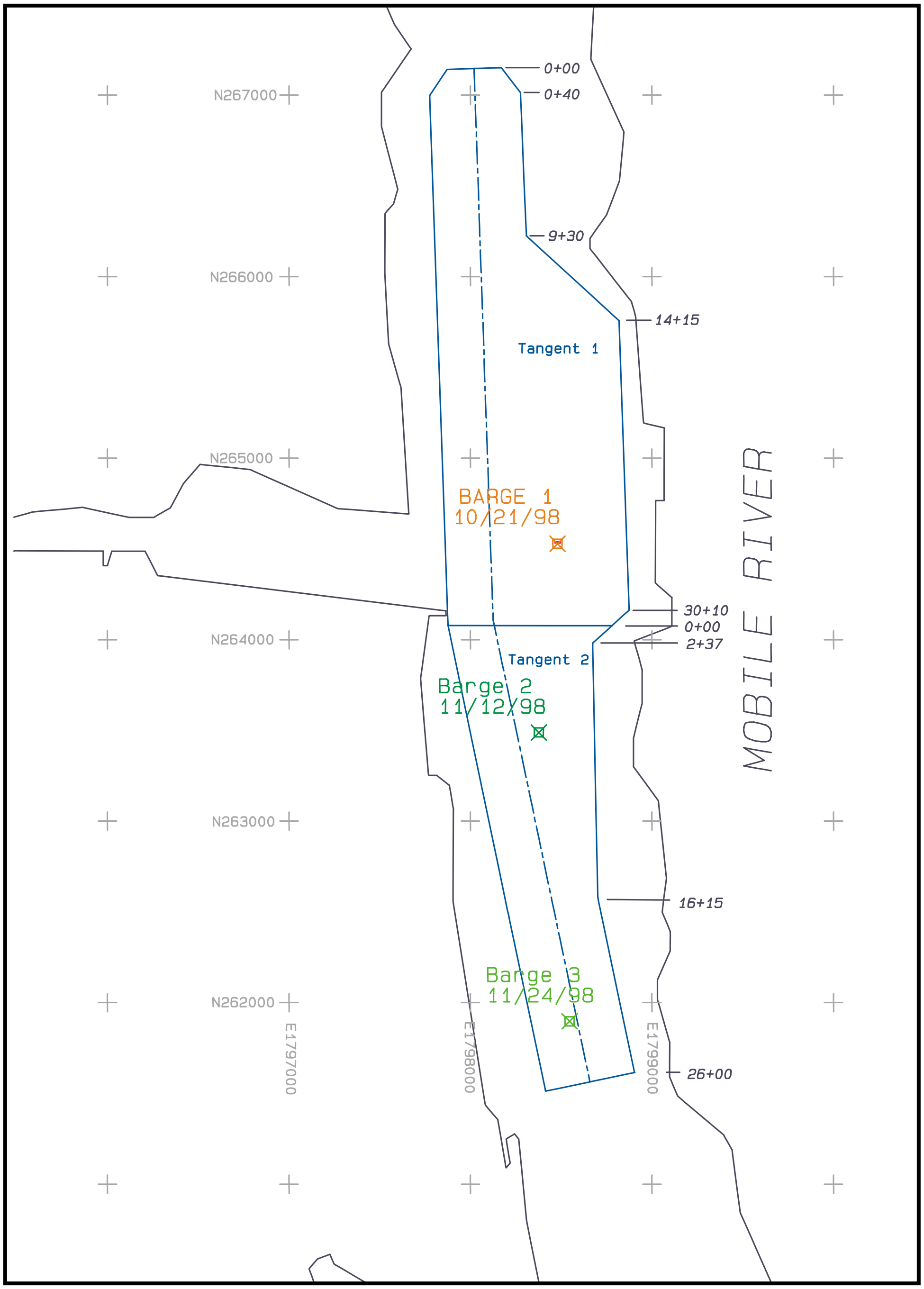

Figure 2. Dredge area in Mobile River

Data were collected prior to, during, and periodically following the dredging and placement operations. Data collection and analyses included sediment characteristics of the material while it was in the barge and after placement in the mound, sediment characteristics of the surrounding seabed before and after placement, laboratory-measured dredged-material settling rates, periodic bathymetry of the study area, waves (measured and hindcast) and currents (Table 1).

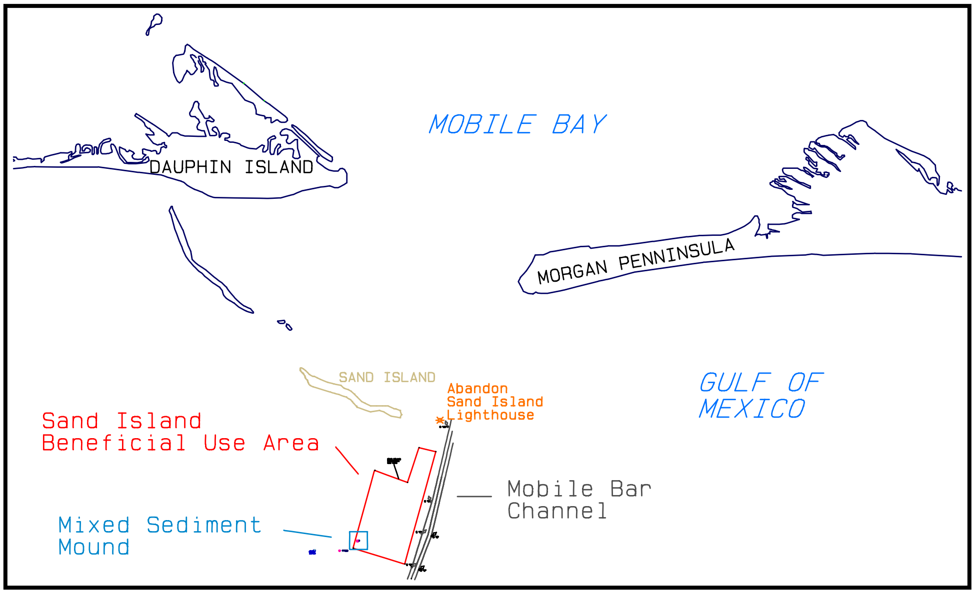

Figure 3. Location of mixed-sediment mound on southwest edge of Mobile Bay entrance ebb shoal

Postplacement monitoring at the mound was continued for 1 year to assess the changing characteristics of the mound.

Table 1
Project Time Line

Date	Comments	Bathymetric Survey	Sediment Samples	ADP	Wave Gage	ADCP	Wave Modeling
1998							
Apr		Fathometer presurvey 4/21, 23					
May							
Jun							
Jul							
Aug							
Sep	Hurricane Georges 09/28						
Oct	Mound Construction 10/27-11/25	Multibeam presurvey 10/4-28	Presamples 10/20, 26	Deployed	Deployed		Start
Nov			Barge samples 10/21, 11/12, 11/24				STWAVE 10/98 – 12/98
Dec		Multibeam postsurvey 12/2	Postsamples 12/2				
1999							
Jan							
Feb							WISWAVE 10/98 – 12/99
Mar		Multibeam postsurvey 3/16-19					
Apr							
May		Multibeam postsurvey 5/19-23, 5/25-26, 6/1-2	Postsamples 5/26-27				
Jun							
Jul				Removed	Removed		
Aug							
Sep							
Oct		Multibeam postsurvey 10/4-28	Postsamples 10/26-27			Boat lines 10/28	
Nov							
Dec							End