# Chapter 1
# Introduction

## 1-1. Purpose

This manual provides guidance for the development, improvement, and maintenance of navigation and flood control projects at entrances to tidal inlets. Factors are presented that should be considered in providing safe and efficient navigation facilities with the least construction and maintenance costs. The design engineer is expected to adapt general guidance presented in this manual to site-specific projects; deviations from this guidance are acceptable if adequately substantiated. As the state of the art advances, this manual will undergo periodic revision.

## 1-2. Applicability

This manual applies to all HQUSACE elements, major subordinate commands, districts, laboratories, and field operating activities having civil works responsibilities.

## 1-3. References

The references listed below are required to carry out the design effort described in this manual.

*a. U.S. Army Corps of Engineers Publications.*[1]

(1) ER 1110-2-1404, Deep-Draft Navigation Project Design.

(2) ER 1110-2-1458, Shallow-Draft Navigation Project Design.

(3) EM 1110-2-1202, Environmental Engineering for Deep-Draft Navigation.

(4) EM 1110-2-1412, Storm Surge Analysis.

(5) EM 1110-2-1414, Water Levels and Wave Heights for Coastal Engineering Design.

(6) EM 1110-2-1502, Coastal Littoral Transport.

(7) EM 1110-2-1607, Tidal Hydraulics.

(8) EM 1110-2-1613, Hydraulic Design of Deep-Draft Navigation Projects.

(9) EM 1110-2-1614, Design of Coastal Revetments, Seawalls, and Bulkheads.

(10) EM 1110-2-1615, Hydraulic Design of Small Boat Harbors.

(11) EM 1110-2-1616, Sand Bypass System Design.

(12) EM 1110-2-2904, Design of Breakwaters and Jetties.

(13) EM 1110-2-5025, Dredging and Dredged Material Disposal.

*b. U.S. Government Publications.*

*Shore Protection Manual* (SPM), 4th ed., Vols I and II, U.S. Army Engineer Waterways Experiment Station (WES), Coastal Engineering Research Center. Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

## 1-4. Bibliography

Bibliographic information throughout this manual is denoted by author and date corresponding to the listing in Appendix A. These documents are available for loan upon request to the WES Technical Information Library, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

## 1-5. Background and Scope

Providing systematic design guidance for tidal inlets is a most difficult task. This is principally due to the inherent complexities in the morphology, migration patterns, and hydrodynamics of tidal inlets. A thorough understanding of the processes which control the inlet/back-bay system, however, will help assure that the design of engineering structures, or the modification of inlet hydraulics, will result in the most efficient project design. Optimally, such designs will have minimal impact on the tidal inlet system.

## 1-6. Overview of Manual

*a.* Coastal engineering projects at tidal inlets often require estimation of sediment transport, channel stability, structure stability, and a critical assessment of project requirements. The design engineer can gain insight about a tidal inlet project by dividing the system into

[1] U.S. Army Corps of Engineers publications available from: USACE Publications Depot, 2803 52nd Avenue, Hyattsville, MD 20781.

components and accurately assessing or classifying each component. A thorough understanding of the complex tidal inlet system is essential for proper planning and design of coastal structures at tidal inlets. Basic principles for making these decisions are presented in this manual.

*b.* This manual is general in nature and therefore requires that engineering judgment be exercised when applying methods and procedures presented herein to actual tidal inlets. Although a thorough understanding of the underlying concepts is not essential in performing tidal inlet design analysis, a basic understanding of the hydrodynamic processes and their interaction with the structural and geomorphic features present in the inlet system are required to ensure proper application.

*c.* This manual contains eight chapters. Chapter 1 provides an introduction and overview of the remaining chapters. Chapter 2 describes the geomorphology and morphodynamics of tidal inlets. Because inlets interrupt the continuity of coastal processes, they exert a dramatic influence on shoreline erosional and depositional trends, sediment transport patterns, and sediment budgets. Successful design and implementation of an inlet project require an ability to predict the morphologic behavior of an inlet; this chapter provides the necessary background information for making such predictive determinations. Various inlet classification schemes are presented and examples of types of information that can be gained through geomorphic and geologic analysis are demonstrated.

*d.* Hydrodynamic aspects of tidal inlets are described in Chapter 3. In addition to a presentation of the governing equations and general hydrodynamic parameters, techniques for evaluating inlet stability are discussed. Classic work by O'Brien, Bruun, Bruun and Gerritsen, Keulegan, and Jarrett regarding relationships between inlet cross-sectional area, tidal prism, maximum throat velocity, and littoral transport rate are reviewed.

*e.* Chapter 4 focuses on sediment budget analyses of tidal inlets. Included are discussions of factors to be considered in an inlet sediment budget analysis and a detailed summary of a sediment budget study performed for Beaufort Inlet, North Carolina by the Wilmington District. The sediment budget analysis was used to help evaluate shoaling patterns in the inlet area, bypassing mechanisms, effects of earlier dredging on the adjacent barriers, and future impacts of proposed channel deepening on the entire inlet system.

*f.* Engineering design of tidal inlets involves either improvements to an existing inlet or development of a new inlet. Structural improvements at inlets may include construction or rehabilitation of jetties, breakwaters, or sand bypassing plants. The ability to anticipate project impacts and implement appropriate measures to alleviate adverse effects are the keys to successful design practice. It is also important that the designed features perform their intended functions with minimum maintenance requirements. Chapter 5 discusses design aspects of inlet projects, including navigation channel design, jetty design theory and principles, types of construction material, stability considerations, and studies of estimated costs and benefits.

*g.* Chapter 6 describes the physical modeling of tidal inlets. Physical model studies of inlets are typically designed to investigate various methods of maintaining an effective navigation channel through an inlet. Additional inlet-related problems that can be addressed by physical models include optimizing structure dimensions and locations, shoaling and scouring trends, tidal prism changes, and salinity effects. Model theory, including assumptions and limitations, is discussed. Fixed-bed and movable-bed models are described and examples of each are provided. Considerations of scale, distortion, historical applications, utility of physical models, and combined numerical and physical models are discussed.

*h.* Numerical models and their application to tidal inlet analysis are discussed in Chapter 7. Various types of numerical models and modeling systems that have been applied in Corps inlet studies are presented. A brief description of each model is given, followed by model input and output requirements, example model applications, and additional references.

*i.* Chapter 8 presents guidance related to monitoring existing inlet projects. Criteria needed to evaluate structure performance, recommended equipment, instrumentation, and surveying techniques are outlined.

*j.* Appendices A and B respectively provide lists of references and notation appearing in the text. Appendix C presents an annotated bibliography of publications from the General Investigations of Tidal Inlets (GITI) program.