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Tidal Flows in Rivers and Harbors



June 1987

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> Committee on Tidal Hydraulics CORPS OF ENGINEERS, US ARMY

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PREFACE

Report No. 2, "Bibliography on Tidal Hydraulics," and Supplements 1-9 thereto were published by the Committee on Tidal Hydraulics in 1954, 1955, 1957, 1959, 1965, 1968, 1971, 1975, 1980, and 1985, respectively, in connection with certain of its objectives. This supplement consists of 497 references on the subject and includes both current and older references which have been accumulated. References not indicated by a dagger (†) are available for loan within the continental United States from the Library Branch, US Army Engineer Waterways Experiment Station (WES).

This supplement follows the same form as the original bibliography and consists of eight sections, each preceded by a brief statement of its scope. As a further convenience to the user, the references are arranged alphabetically under each subject matter heading (section), and all have been annotated. Although the majority of the references appear in more than one section, the complete entry appears only once--under the most applicable subject heading--with other listings giving only author, title, and key for its location.

Copies of this and other reports of the Committee may be obtained from the Committee on Tidal Hydraulics, care of US Army Engineer Waterways Experiment Station, ATTN: WESIM-TS, PO Box 631, Vicksburg, Mississippi 39180-0631.

This supplement was compiled by Katherine M. Kennedy, Special Projects Branch (SPB), Technical Information Division, Information Technology Laboratory (ITL), WES, under the general supervision of Mr. F. A. Herrmann, Jr., Chief, Hydraulics Laboratory, and Chairman, Committee on Tidal Hydraulics. Recognition is made of the following persons who provided assistance on this supplement: Marsha C. Gay, editor, Information Products Division, ITL, and Paul A. Taccarino, SPB, and F. E. Crevitt, Jr., Hydraulics Laboratory, who provided research services.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

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SECTION I. THEORETICAL CONSIDERATIONS

Basic principles of tidal hydraulics, including the mechanics and types of tides, height and time of tide, tide-producing forces, tidal currents, theories, cubature techniques, predictions, computations, estuarine circulation, and meteorological effects.

Abraham, G. 1980. "On Internally Generated Estuarine Turbulence," <u>Proceedings, Second</u> <u>International Symposium on Stratified</u> <u>Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:344-353.

The processes producing turbulence and mixing must be examined carefully when dealing with stably stratified fluids. According to Turner (1973), a distinction must be made between "external" turbulence generated directly at a solid boundary, and "internal" turbulence arising in the interior. This observation is also applicable to estuarine mixing. At the one extreme, in a well-mixed estuary the turbulence is primarily boundary generated. At the other extreme, in a highly stratified estuary with an arrested salt wedge, the turbulence is primarily generated at the interface, i.e., in the interior of the stratified fluid. Nevertheless, the distinction between external and internal turbulence has not been made in the literature on estuarine mixing as yet (Fischer, 1976). The significance of this distinction is the subject of the present paper. The first part of the paper gives a theoretical criterion to determine under which circumstances the effect of internal turbulence on the production of turbulent energy exceeds the effect of external turbulence. The criterion is based on an approximate solution of the equation of motion in the longitudinal direction. The second part of the paper is an analysis of salinity intrusion field data collected in the Rotterdam Waterway and in the Chao Phya Estuary. This analysis confirms that above a certain level of stratification, internal effects are to be taken into account. The third part of the paper elaborates upon the implications of the aforementioned findings for the numerical two-dimensional simulation (with longitudinal and vertical space dimensions) of salinity intrusion in partly mixed estuaries. References (15 items).

- Ali, A. "A Comparison Between Vertically Integrated and Multilevel Models of Tidal Dynamics in Channels." (See complete entry in Section VI.)
- Amin, A., and Graff, J. "Some Notes on Simplifying the HSWC Method of Tidal Analysis." (See complete entry in Section VIII.)
- Anwar, H. O. "Measurements on Entrainment Through a Front." (See complete entry in Section III.)
- Anwar, H. O. 1983. "Turbulence Measurements in Stratified and Well-Mixed Estuarine Flows," <u>Estuarine, Coastal and</u> <u>Shelf Science</u>, 17(3):243-260.

From mean velocities measured in estuarine flows it has been found that the velocity distributions are log-linear in stratified flows and logarithmic in well-mixed flows. The results of salinity measurements reveal that the mean salinity profiles are geometrically similar and expressible as a power law. The buoyancy parameters, such as the Monin-Obukhov length scale and the gradient and the flux Richardson numbers, are independent of the flow state. The gradient and the flux Richardson numbers are almost equal, indicating the existence of a local equilibrium layer. The nondimensional parameter describing dissipation rates of turbulent kinetic energy is a constant of 0.2 and 0.3 for stratified and well-mixed flows, respectively. In wellmixed flow, the drag coefficient varies with time approaching a constant of about 3.2×10^{-3} when the flow is stratified. The shape of the turbulent energy spectra is generally flatter and broader in stratified as compared with those of well-mixed flows. References (30 items).

Awaji, T. 1982. "Water Mixing in a Tidal Current and the Effect of Turbulence on Tidal Exchange through a Strait," <u>Journal</u> <u>of Physical Oceanography</u>, 12(6):501-514.

By means of numerical calculations of the Lagrangian movement of water particles released in a turbulent tidal current during three cycles of the M_2 tide, the mechanism of tidal mixing of the inner and outer waters divided initially by a strait and the effect of turbulence on tidal exchange through the strait are studied. In the vicinity of the strait, combined with the large Stokes drift due to the spatially rapid changes of the amplitude and the phase lag of the tidal current, turbulence strongly affects the Lagrangian movement of particles. Some of initially adjacent particles moving in a turbulent tidal current have much larger drifts than the Stokes drifts (nonturbulent), and the others much smaller drifts than those. As a result, the adjacent particles released in a turbulent tidal current are widely scattered, and they are well mixed with water particles initially far apart from them, i.e., local mixing of water amplified to a great extent occurs compared with that due only to turbulence. By the interaction of a large degree of local mixing induced by the Stokes drift and turbulence in the vicinity of the strait and the dynamic process of tidal exchange through the strait, the inner and outer waters are also well mixed with each other over an extensive area around the strait. With regard to the effect of turbulence on tidal exchange between two basins connected by the strait, turbulence has a minor influence on water volume exchanged through the strait, but it has a major influence on the enlargement of sea areas

affected by tidal exchange. It is also shown that the dispersion coefficient evaluated from the variance of particle spread reaches 8×10^6 cm² s⁻¹ in the vicinity of the strait. References (15 items).

- Bartholdy, J. "Transport of Suspended Matter in a Bar-Built Danish Estuary." (See complete entry in Section VI.)
- Basu, A. N. "Composite Mathematical Model of Saptamukhi River System Including Outfall Channels for Studying the Effect of Closure." (See complete entry in Section VI.)
- Battisti, D. S., and Clarke, A. J. 1982. "A Simple Method for Estimating Barotropic Tidal Currents on Continental Margins with Specific Application to the M₂ Tide off the Atlantic and Pacific Coasts of the United States," <u>Journal of Physical</u> <u>Oceanography</u>, 12(1):8-16.

Theory is developed to describe barotropic tidal currents on "smooth" continental shelves, that is, continental shelves with longshore scales much greater than the shelf width. Two models are considered, one in which sea level does not vary significantly across the shelf and the other in which it does. Both models include longshore gradients and friction (parameterized linearly in velocity). The models were tested by calculating the M, tidal currents off the Atlantic and Pacific coasts of the United States and then comparing the calculated currents to those measured. Results show that theory and observation are in very good agreement as far offshore as 300 km. Along the Atlantic coast, on account of the wide continental shelf, current velocities are typically $O(0.10-0.15 \text{ m s}^{-1})$ north of Cape Hatteras and $O(0.15-0.28 \text{ m s}^{-1})$ off Savannah, Georgia. Currents rotate anticyclonically and are highly elliptical (ellipticity E = -0.4), with the semimajor axis oriented normal to the coast. Friction is significant in the South Atlantic Bight and acts to rotate the zerofriction current ellipses in a clockwise direction. Off the Pacific coast, where the continental shelf is narrow, M_2 tidal currents are relatively weak (0.02- 0.08 m s^{-1}) and strongly oriented in the longshore direction (E = 0.1). The currents rotate counterclockwise with negligible friction influence. The good agreement between calculated barotropic M, currents and the observed currents off the southwest Pacific coast and all along the Atlantic coast of the United States suggests that the semidiurnal tides along these coasts are largely barotropic. References (9 items).

Battisti, D. S., and Clarke, A. J. 1982. "Estimation of Nearshore Tidal Currents on Nonsmooth Continental Shelves," <u>Journal of</u> <u>Geophysical Research</u>, 87(C10):7873-7878.

The theory of Battisti and Clarke to calculate analytically barotropic tidal currents across "smooth" continental margin topography is shown to be valid nearshore on "nonsmooth" continental shelves. The theory includes longshore gradients and friction and produces formulae easily evaluated with coastal sea level data. The tidal currents across three such shelves (West Florida, south of Long Island, and Vancouver Island) are calculated and compared with those observed. References (6 items).

Benqué, J. P., et al. 1982. "New Method for Tidal Current Computation," <u>Journal</u>, <u>Waterway, Port, Coastal and Ocean Divi-</u> <u>sion</u>, ASCE, 108(WW3):396-417.

The computation of two-dimensional tidal currents using the Alternating Direction Implicit Method (ADI) can be subject to numerical attenuation, parasitic oscillations, and poor reproduction of wave propagation when large time-steps are used. The new method described in the paper is designed to overcome these difficulties. It is based on a fractional step method in which momentum advection is calculated using the method of characteristics, horizontal momentum diffusion is calculated using an implicit finite difference scheme, and wave propagation is calculated using an iterative alternating direction implicit algorithm. The resulting method has been incorporated in the CYTHERE-ES1 modeling system, in which tidal flat flooding and drying as well as wind effects and Coriolis acceleration are taken into account. The basic principles of the method, as well as its application to four schematic test cases and two engineering studies, are described. References (14 items).

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- Berndt, D., et al. "Artificial Roughness in Physical Models of Estuaries for Storm Surge Investigations." (See complete entry in Section VI.)
- Bottin, R. R., Jr., and Earickson, J. A. "Buhne Point, Humboldt Bay, California, Design for the Prevention of Shoreline Erosion; Hydraulic and Numerical Model Investigations." (See complete entry in Section VI.)
- Bowman, M. J., et al. "Shelf Fronts and Tidal Stirring in Greater Cook Strait, New Zealand." (See complete entry in Section VI.)

- Brazier, A., and Strachan, W. V. "Swansea Channel--A Study of Waterways Management." (See complete entry in Section V.)
- Brocard, D. N., and Hsu, S.-K. "Combined Near- and Far-Field Water Quality Predictions in an Estuary." (See complete entry in Section VI.)
- Brown, W. S. 1984. "A Comparison of Georges Bank, Gulf of Maine and New England Shelf Tidal Dynamics," <u>Journal of</u> <u>Physical Oceanography</u>, 14(1):145-167.

The semidiurnal tidal currents associated with the near-resonant response of the Gulf of Maine-Bay of Fundy system are amplified over the relatively shallow depths of Georges Bank, thus leading to enhanced energy dissipation, vertical mixing, and secondary flows on the Bank. Within the western Gulf of Maine, the tidal sea level amplitudes are larger but currents are less energetic than those observed on Georges Bank, while on the New England shelf the tidal response is the least energetic of the three regions. In this paper we explore some of the details of the tidal dynamics in these three very different tidal regimes by estimating terms in the volume-integrated momentum equations using observations of current and bottom pressure. The computations are performed for the M₂ semidiurnal tidal constituent, which is the dominant tide in all of the regions, and are presented in terms of an instantaneous "stress" balance. Results show that in the acrossisobath direction on Georges Bank the M2 inertial term is balanced principally by the sum of the Coriolis and pressure gradient terms plus a small residual term, while in the along-isobath direction the principal balance is between the inertial and Coriolis terms. Even in this region of relatively high currents the nonlinear terms are found to be small in both directions, thus justifying the use of monochromatic input data. The instantaneous dynamic balances and the clockwise rotary elliptical currents are quantitatively consistent with the signature of an across-isobath propagating, forced gravitational-gyroscopic progressive wave which is strongly influenced by bottom slope. In the western Gulf of Maine a sum of the inertial and Coriolis terms in both the along- and across-isobath directions is balanced by the relatively large pressure gradient terms--dynamic balances that are consistent with those of a rotary standing wave. The distribution of counterclockwise rotary elliptical currents suggests the presence of a reflected Kelvin wave in the western Gulf. On the less energetic New England shelf the across-isobath inertial term is balanced by a sum of the Coriolis and pressure gradient terms as found on Georges Bank. However, in the

along-isobath direction, unlike Georges Bank, the same dynamical balance is found because of the importance of coastline irregularities in producing significant along-isobath tidal pressure gradients. The tidal response of the New England shelf combines the dynamical characteristics of those on Georges Bank and on the New Jersey shelf to the southwest and is less easily described in terms of the simple forced-wave models that are reasonably successful in the adjacent regions. The Georges Bank and Gulf of Maine observed tides are compared with the Greenberg fine-grid numerical results with generally good overall result. Some small systematic differences, which are found, may be due to the way friction is specified in the numerical model. Other results concerning the vertical structure and frictional character of Georges Bank tidal flow, which are presented here, suggest that the continued study of the way tidal energy dissipation is computed is warranted. References (27 items).

- Buchak, E. M., and Edinger, J. E. "User Guide for CE-QUAL-ELV2: A Longitudinal-Vertical, Time-Varying Estuarine Water Quality Model." (See complete entry in Section VI.)
- Butler, H. L. "Coastal Flood Simulation in Stratched Coordinates." (See complete entry in Section VI.)
- Butman, B., et al. 1983. "An Upper Bound for the Tidally Rectified Current at One Location on the Southern Flank of Georges Bank," Journal of Physical Oceanography, 13(8):1452-1460.

Long-term current observations at 45 and 75 m at one location on the southern flank of Georges Bank in water 85 m deep were examined for evidence of tidal rectification. Loder has shown analytically that rectification of the strong semidiurnal tidal current can cause a mean along-bank flow, and thus may partially drive the observed clockwise circulation around Georges Bank. The amp_itude of the tidally rectified along-bank flow is proportional to the squared amplitude of the cross-bank tidal current. A simple extension of Loder's model to include the weaker N₂ and S₂ tidal components suggests that fortnightly (354 h) and monthly (661 h) variations of the square of the cross-bank tidal current should cause a modulation of the subtidal along-bank flow. The predicted ratio (R) of the fortnightly and monthly modulation of the along-bank flow to the mean along-bank flow on the southern flank was a function of position and ranged from ~0.1-0.5. The amplitude of modulation of the along-bank flow at 360 and 648 h. estimated from the (weak) coherence between the observed

along-bank flow and the subtidal_envelope of a simulated surface tide, was less than ~ 1.1 and 0.9 cm s⁻¹, respectively, at 45 m. The amplitude of the modulation which can be attributed to tidal rectification may be in error by the astronomically forced Mm and MSf tidal currents, which are undescribed in this region. However, the magnitude of the mean alongbank tidally rectified current determined from the observed modulation and R predicted by the analytical model was -2.0 cm s⁻¹ at 45 m (36 percent of the observed mean current in winter) and less than 1.6 cm s⁻¹ at 75 m (43 percent of the observed mean current). Although R may change in a more realistic model, this analysis suggests that only part of the seasonal-mean along-bank flow on the southern flank of Georges Bank may be caused by tidal rectification. References (10 items).

Byrne, R. J., Gammisch, R. A., and Thomas, G. R. 1980. "Tidal Prism-Inlet Area Relations for Small Tidal Inlets," <u>Pro-</u> <u>ceedings, Seventeenth Coastal Engineering</u> <u>Conference, March 23-28, 1980, Sydney,</u> <u>Australia</u>, ASCE, III:2517-2533.

Fourteen tidal inlets within the lower Chesapeake Bay were studied to examine whether significant differences existed in their hydraulic behavior relative to the larger oceanic inlets hitherto studied. Measurements included simultaneous external and internal tides, gaging of discharge through a tidal cycle, measurements of inlet geometry, and basin area. The results indicate that (a) smaller inlets (A < 100 m²) depart from the relationship between inlet throat area and tidal prism developed for oceanic inlets; (b) examination of inlet width versus depth indicates the departure from ocean inlet geometry occurs at $\rm A_{\rm C}$ values between 100 and 500 m²; (c) the maximum velocity in smaller inlets is significantly less than oceanic inlets (~0.35 versus 1.0 m/s); (d) tidal phase lags and tidal range ratio were generally equal. However, for conditions of significant tide range reduction, the low-water phase lags more closely approximated the tide range ratio. References (20 items).

Carr, G. R. 1978. "Thames Flood Barrier," <u>Papers, 7th International Harbour Con-</u> <u>gress</u>, K.V.I.V. (Royal Society of Flemish Engineers), Antwerp, Belgium, 22-26 May 1978, I:3.10/1~3.10/16.

The Thames Flood Barrier under construction at Woolwich forms part of a comprehensive improvement of the River Thames flood defenses to protect London and the estuarial borders of Kent and Essex from meteorologically induced tidal surges. Due to sinking land levels and increasing mean sea level and tidal range, extreme high-water levels in London have increased at a rate of about 0.8 m per century. Environmental and economic reasons dictated the choice of a barrier rather than continuing to raise the river walls in London. The barrier will have ten hydraulically operated steel gates supported on concrete piers. Four 61-m-wide and two 31.5-m-wide openings will give unobstructed passage to shipping except when the gates are closed to hold back a tidal surge. The gates in these openings are of a new type known as the rising sector gate, the remaining four gates being of the falling radial type. All barrier design aspects have been aimed at achieving utmost reliability. The cost of the barrier alone, estimated at March 1977, is £207 million. Completion is expected in 1982. References (7 items).

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Carton, J. A. 1983. "The Variation with Frequency of the Long-Period Tides," <u>Jour-</u> <u>nal of Geophysical Research</u>, 88(C12):7563-7571.

The oceanic response to long-period tidal forcing in closed basins approaches equilibrium for periods much longer than a month for moderate values of dissipation. At a given frequency the response is closest to equilibrium near the eastern wall of the basin. Global calculations of the Mf and Mm tides, made using a $2^{\circ} \times 2^{\circ}$ grid, are presented. Changes in the length of day have also been computed for these tides. References (19 items).

Chiang, W.-L., and Lee, J.-J. 1981. "Tide-Induced Currents in Harbors of Arbitrary Report No. USCSG-TR-01-81, Institute for Marine and Coastal Studies, University of Southern California, Los Angeles, California.

The water quality in a harbor depends strongly on its circulation patterns. As a result, it is a primary importance to find an efficient method to study and predict the harbor circulation. The goal of the present study is to find an efficient way of predicting tide-induced currents in harbors of arbitrary shape and apply this general technique to various configurations (present and future) of Los Angeles-Long Beach Harbor. In order to achieve this goal, a numerical model for the harbor circulation problem is proposed. The numerical method developed in this study is capable of reproducing the gyre structure in the harbor. References (118 items).

Christiansen, H., and Siefert, W. "Storm Surge Prediction by Combined Wind and Tide Data." (See complete entry in Section VIII.)

- Chu, W.-S., and Willis, R. "Mathematical Modeling of Humboldt Bay." (See complete entry in Section VI.)
- Chu, W.-S., Yeh, W. W.-G., and Kristof, R. C. "Mathematical Modeling and Parameter Identification in a Two-Dimensional Estuary: Case Study of the Hydraulic Model of the San Francisco Bay and Delta." (See complete entry in Section VI.)
- <u>Coastal Sediments '77, Fifth Symposium of</u> <u>the Waterway, Port, Coastal and Ocean Di-</u> <u>vision of ASCE</u>. (See complete entry in <u>Section II.)</u>
- Colman, R. S. "The Modification of a Natural Drainage System and the Subsequent Effects on a Small Estuary and its Surrounding Beaches." (See complete entry in Section V.)
- Committee on Tidal Hydraulics, Corps of Engineers, US Army. "Evaluation of Numerical Storm Surge Models." (See complete entry in Section VI.)
- Cooper, C. K., and Pearce, B. R. "Development of a Simple Numerical Model to Calculate the 3-D Structure of Currents in Coastal Areas Using a Depth Varying Eddy Viscosity." (See complete entry in Section VI.)
- Crout, R. L., and Murray, S. P. "Shelf and Coastal Boundary Layer Currents, Miskito Bank of Nicaragua." (See complete entry in Section VIII.)
- Czerniak, M. T. "Engineering Concepts and Environmental Assessment for the Stabilization and Sand Bypassing of Moriches Inlet, New York." (See complete entry in Section II.)
- Daifuku, P. R., and Beardsley, R. C. "The K_1 Tide on the Continental Shelf from Nova Scotia to Cape Hatteras." (See complete entry in Section VIII.)
- Dandy, G. C., Mills, D. A., and Hinwood, J. B. 1980. "Water Movement Studies Required for Port Planning," <u>Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:3010-3026.</u>

Some of the factors involved in the design of a program of measurement and analysis of current, temperature, and salinity data required for the environmental assessment of an estuarine port are considered in the context of a study carried out in the Port of Melbourne, Australia. The study was undertaken as part of the Port of Melbourne Environmental Study, 6 Webb Dock Marine Study, which was aimed at assessing the present regime and the effects on the marine and coastal environments resulting

from the construction of Berth 6, Webb Dock in Hobsons Bay. To this end, integrated investigations of water movement, water quality, coastal processes, and marine ecology were conducted. Although the results presented in this paper are specific to Hobsons Bay, the approach taken is of general applicability to the environmental assessment of proposed physical changes in complex estuaries and embayments. In such cases, the prediction of changed patterns of currents and density structure is a key element in assessing likely changes in other environmental factors such as water quality and the biota. In general, an environmental study of water movement in an estuary will involve some measurements of the existing conditions of current, temperature, and salinity, followed by appropriate analyses of these data to enable the likely changes to be predicted. References (5 items).

- Davesne, M., and Graff, M. "Mathematical and Physical Models for Navigation in Approach Channels and Harbour Entrances." (See complete entry in Section V.)
- Davies, A. M. "Role of 2D and 3D Models in JONSDAP '76." (See complete entry in Section VI.)
- Devine, M. "Some Features of the Dynamic Structure of a Deep Estuary." (See complete entry in Section VI.)
- Dronkers, J. 1978. "Longitudinal Dispersion in Shallow Well-Mixed Estuaries," <u>Proceedings, Sixteenth Coastal Engineering</u> <u>Conference, August 27-September 3, 1978,</u> <u>Hamburg, Germany</u>, ASCE, III:2761-2777.

In this paper theoretical expressions are obtained for dispersion processes of a particular type, which appear mainly as a consequence of the tidal motion and the geometry. The results may be applied to estuaries with strong tidal mixing (tidal prism of the same order of magnitude as the average volume of the estuary) and a small freshwater discharge. The cross sections in the estuary are divided in two parts: a deep part, representing the channel, in which the longitudinal motion takes place, and a shallow part without longitudinal motion, representing a tidal flat, which is filled and emptied by the tide. The interaction between these two parts generates longitudinal dispersion related with the following three phenomena: (a) mixing on the tidal flat caused by an irregular topography and by bottom friction, (b) exchange of water between the channel and the tidal flat caused by eddies or density currents, (c) the occurrence of a phase shift between the tidal elevation and the tidal velocity. An analytical expression for the contribution of these effects to the dispersion

coefficient is obtained by considering the resulting transport of constituent through a fixed plane. The application of the model to general geometries is discussed, providing an approximate expression for the dispersion coefficient in natural situations. This expression shows the explicit dependency of the dispersion coefficient on geometrical and tidal parameters. References (2 items).

- Durham, D. L. "Los Angeles Harbor and Long Beach Harbor: Analyses of Prototype Wave and Ship Motion Data." (See complete entry in Section VIII.)
- Duwe, K. C., and Hewer, R. C. "A Semiimplicit Tidal Model for Wadden Sea Areas (Ein semi-implizites Gezeitenmodell für Wattgebiete)." (See complete entry in Section VI.)
- Dyer, K. R. "Mixing Caused by Lateral Internal Seiching Within a Partially Mixed Estuary." (See complete entry in Section III.)
- Dyer, K. R. "The Mixing Processes in a Partially Mixed Estuary: Southampton Water." (See complete entry in Section VII.)
- Ebbesmeyer, C. C., and Barnes, C. A. "Control of a Fjord Basin's Dynamics by Tidal Mixing in Embracing Sill Zones." (See complete entry in Section VIII.)
- Edinger, J. E., and Buchak, E. M. "Estuarine Laterally Averaged Numerical Dynamics: The Development and Testing of Estuarine Boundary Conditions in the LARM Code." (See complete entry in Section VI.)
- Egan, J. T., and Jones, H. L. "Tidal Measurement, Analysis, and Prediction." (See complete entry in Section VII.)
- Elahi, K. Z., and Sundermann, J. 1978. "The Wind-Driven Circulation in the Northern Arabian Sea," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, III:2708-2714.

The circulation pattern in the northern Arabian Sea is presented for the welldefined wind fields, which are classified as the Southwest Monsoon and the Northeast Monsoon. To check the reproduction ability of the model, first tidal waves are computed. The results show a good agreement with the known values given in literature. References (4 items).

Elliott, A. J. 1978. "Observations of the Meteorologically Induced Circulation in the Potomac Estuary," <u>Estuarine and</u> <u>Coastal Marine Science</u>, 6(3):285-299.

For the 1-year period from July 1974

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through July 1975, current measurements were made at three depths in the Potomac estuary. The records were first filtered to remove the major tidal components and then averaged within 24-hour blocks to produce a sequence of estimates of the residual flows during each calendar day. The resulting low-pass currents revealed fluctuations which had periods of 2-5 days, or longer, and whose amplitudes were an order of magnitude larger than the long-term means. Meteorological data were also collected and it was found that the nontidal currents were responding to two distinct forcing mechanisms. One response was due to the local wind and could account for 55 percent of the total variance in the records; however there was a second response, of almost equal importance, which was caused by nonlocal effects propagating into the estuary from the Chesapeake Bay. The nonlocal effects would prevent the Potomac from being modeled as an isolated system, and suggest that the interaction with the Chesapeake Bay should be included in a model of the wind-driven response of the Potomac. The results from the current meters at the three depths were used to identify six distinct circulation patterns. The circulation usually associated with a partially mixed estuary (surface outflow, inflow at depth) was the most common, having a mean duration of 2.5 days and occurring for 43 percent of the total time. The reverse of this circulation (surface inflow, outflow at depth) and storage (landward flow at all depths) were the second most frequent patterns, each occupying about 20 percent of the total time. References (16 items).

Escoffier, F. F. 1977. "Hydraulics and Stability of Tidal Inlets," GITI Report 13, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents a summary of several of the important basic developments pertaining to analysis of the hydraulics and related stability of tidal inlets. The original inlet stability concept proposed by Escoffier is extended in light of recent work. The report also contains brief discussions on tidal inlet characteristics and functional design requirements as well as case studies of selected inlets on the United States coasts. References (44 items).

Essen, H.-H., Gurgel, K.-W., and Schirmer, F. 1983. "Tidal and Wind-Driven Parts of Surface Currents, as Measured by Radar," <u>Deutsche Hydrographische Zeitschrift,</u> <u>36(3):81-96.</u>

In December 1982, surface current measurements by means of an HF radar station were carried out from the Federal German island of Sylt in the North Sea. Two carrier frequencies Journ Mdr and 29.85 MHz; were tested with respect to their applicability. Hourly sampled 70-hours time series of (1-dimensional) radial currents at different distances and directions from the radar are analyzed with the objective of determining the tidal and wind-driven parts. Assuming a homogenous current field, semidiurnal tidal ellipses are synthesized and compared with currents, as documented in the "Atlas der Gezeitenströme in der Deutschen Bucht" (Deutsches Hydrographisches Institut [1983]). References (13 items)

Evans, J. J., and Pugh, D. T. 1982. "Analysing Clipped Sea-Level Records for Harmonic Tidal Constituents," <u>The Interna-</u> <u>tional Hydrographic Review</u>, 59(2):115-122.

Coastal sea-level measurements must sometimes be made at sites where the gage dries out at low levels. By progressively removing the lower part of a tidal record and analysing the remainder with the conventional least-squares criteria, stable values of the principal constants have been obtained until only half of the original range remained. This stability has implications for the definitions of tidal constants and of mean sea level in regions of very shallow water and drying banks. References (6 items).

- Everts, C. H. "A Method to Predict the Stable Geometry of a Channel Connecting an Enclosed Harbor and Navigable Waters." (See complete entry in Section II.)
- Falconer, R. A. "Mathematical Model Study of Mass Transport in Harbours." (See complete entry in Section VI.)
- Falconer, R. A. "Modelling of Planform Influence on Circulation in Harbours." (See complete entry in Section VI.)
- Fandry, C. B. "Development of a Numerical Model of Tidal and Wind-Driven Circulation in bass Strait." (See complete entry in Section VI.)
- Fandry, C. B. "Model for the Three-Dimensional Structure of Wind-Driven and Tidal Circulation in Bass Strait." (See complete entry in Section VI.)
- Ferentinos, G., and Collins, M. "Effects of Shoreline Irregularities on a Rectilinear Tidal Current and Their Significance in Sedimentation Processes." (See complete entry in Section II.)
- Fiadeiro, P. M. 1978. "Study of Water Quality in the Tagus Estuary" ("Etudes sur la Qualite de l'Eau dans l'Estuaire du Tage"), <u>La Houille Blanche</u>, 33(6):431-434 (In French).

The Tagus Estuary plays a particularly important part in the country's economy.

Attempts have been made to determine the flow characteristics in the estuary, analyse trends, establish correlations and determine dispersion coefficients. The tidal prism is of considerable magnitude $(7 \times 10^{\pm8} \text{ m}^{\pm3})$ and the flow is characterized essentially by two-layer flow, with both diffusive and advective processes assisting the salt flux upriver. References (10 items).

- Filloux, J. H., and Snyder, R. L. "A Study of Tides, Setup and Bottom Friction in a Shallow Semi-Enclosed Basin; Part I: Field Experiment and Harmonic Analysis." (See complete entry in Section VIII.)
- Fischer, H. B. 1977. "The Effect of Estuarine Circulation on Pollution Dispersal," <u>Estuarine Pollution Control and</u> <u>Assessment, Proceedings, Conference, Washington, D.C., Environmental Protection</u> Agency, March 1977, II:477-485.

This paper gives a brief review of different types of circulation in estuaries, how they act to disperse pollutants, and to what extent the dispersion process can be modeled by existing analytical, numerical, and hydraulic models. References (23 items).

Fischer, H. B., et al. 1979. <u>Mixing in</u> <u>Inland and Coastal Waters</u>, Academic Press, Inc., New York.

Chapter 1 discusses the relevance of this book to overall environmental management and explains certain basic concepts which apply throughout, such as dimensional reasoning. Chapter 2 presents the classical theory of diffusion in the context of molecular diffusion, primarily as an introduction to the equations and concepts used in later chapters. Chapter 3 introduces the necessary statistical concepts and concludes with a useful summary of the limitations of the Fickian equation in turbulent mixing. Chapter 4 describes shear flow dispersion -- that phenomenon that describes the stretching and mixing of pollutant clouds caused by the combined action of shear and lateral mixing--and completes the presentation of background material necessary to the study of mixing in the environment. Chapter 5 treats transverse mixing and longitudinal dispersion in rivers. Chapter $\overline{6}$ on mixing in reservoirs discusses density structure and its effect on internal motions and mixing processes. Estuarine mixing, discussed in Chapter 7, includes wind-driven circulation, tidal shear, residual circulation, dead zones and gravitational circulation due to salinity gradients. The section on one-dimensional analysis of pollutant dispersion is primarily concerned with models employing the concept of averaging over a tidal period. Chapter 8 contains a rather abbreviated description of numerical

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techniques and Eulerian and Lagrangian approaches. The San Francisco Bay model is used as a case study for discussion of the role of distorted physical models. Chapter 9 treats buoyant jets and plumes, strong man-induced flow patterns used to achieve rapid initial dilutions for water quality control. Chapter 10 gives a design-oriented discussion of outfall diffusers and includes sections on the internal hydraulics of outfalls and the techniques of hydraulic modeling of outfall flows with density differences. References (309 items).

- Fischer, K. "Numerical Tidal-Salinity Models of the Ems Estuary." (See complete entry in Section VI.)
- FitzGerald, D. M., Fico, C., and Hayes, M. O. "Effects of the Charleston Harbor, S.C., Jetty Construction on Local Accretion and Erosion." (See complete entry in Section II.)
- Fleming, J. H., McMillan, P. H., and Williams, B. P. "The River Hull Tidal Surge Barrier." (See complete entry in Section V.)
- Foster, D. N., McGrath, B. L., and Bremner, W. "Rosslyn Bay Breakwater, Queensland, Australia." (See complete entry in Section VI.)
- Franco, A. d. S. 1980. "On the Shallow-Water Harmonic Tidal Constituents," International Hydrographic Review, 57(2): 139-150.
 - This is an investigation of the physical law governing the interaction of the astronomical tidal constituents which generates the shallow-water tidal constituents, for the simple case of a narrow channel. The solution for both progressive and standing waves, up to the fifth order, is presented. The fluid is supposed nonviscous, and the flow frictionless. References (12 items).
- Freeland, H. J. 1979. "Tidal Analysis and the Energy Budget of a Deep Stratified Inlet," <u>Symposium on Long Waves in the</u> <u>Ocean</u>, June 6-8, 1978, Manuscript Report Series No. 53, Marine Sciences Directorate, Department of Fisheries and the Environment, Ottawa, Ontario, 49-51.

Knight Inlet is a fjord on the mainland of British Columbia, Canada. The tides in the inlet are mixed type, predominantly semidiurnal. The inlet is generally deep, but has a sill, 75 km from the head of the inlet, where depth drops to about 60 m. The sill is in the middle of a long straight section of the inlet, which is connected to the head by a sinuous stretch, about 50 km in length. References (2 items). Gardner, G. B., and Smith, J. D. 1980. "Observations of Time-Dependent, Stratified Shear Flow in a Small Salt-Wedge Estuary," <u>Proceedings, Second Inter-</u> <u>national Symposium on Stratified Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:944-951.

The Duwamish Waterway is a small, saltwedge type estuary in Seattle, Washington. In addition to the large stratification typical of salt-wedge estuaries, the Duwamish is influenced by a large tidal amplitude which results in a highly timedependent flow. Two types of internal hydraulic phenomena have been observed: an internal wave field which exists over an extended region, and a large-amplitude internal lee wave caused by flow between support structures for a bridge. Both grow to unstable amplitudes during the ebb, and contribute to vertical mixing. The model of Lee and Su (1977) is used to investigate the nature of these phenomena, and the results are compared with echosounder images of the pycnocline. References (4 items).

Garvine, R. W. "River Plumes and Estuary Fronts." (See complete entry in Section III.)

Gatto, L. W. 1978. "Estuarine Processes and Intertidal Habitats in Grays Harbor, Washington; A Demonstration of Remote Sensing Techniques," CRREL Report 78-18, US Army Cold Regions Research and Engineering Laboratory, Hanover, N. H.

The utility of remote sensing techniques as an operational tool in the acquisition of data required by the USACE in the Grays Harbor, Wash., project was demonstrated. Aerial imagery was used to map surface circulation and suspended sediment patterns near the hopper dredge pump site at the harbor entrance and near pulpmill outfalls in Aberdeen, Wash. Using primary aerial color infrared (CIR) photography and ground surveys, the areal distribution and extent of nine wetland vegetation types, dune vegetation, and three types of eelgrass were also mapped. Thermal imagery was more useful than CIR photographs for mapping circulation; CIR photographs were more useful than thermal imagery for mapping intertidal habitats. Current velocities estimated by remote sensing tennniques were comparable at some locations to current velocities measured by in situ current meters. References (49 items).

George, K. J. (982) "Application of the Species Concordance Method to the Tidal Currents in the Loire" ("Application in La Méthode les Concordances Par Espèce à La Marée Tans La Loire"), <u>Annales</u> Hydrographiques, 10(757):51-63 (In French).

The species concordance method, perfected by Simon for the Gironde, has been extended to the tide in the Loire estuary. It has been improved in a significant way by the introduction of a new formula. Moreover it lends itself to necessary modifications so as to take into account the river level variations which are important in the Loire. References (3 items).

George, K. J., and Simon, B. 1984. "The Species Concordance Method of Tide Prediction in Estuaries," <u>The International Hydrographic Review</u>, 61(1):121-146.

The harmonic method of tide prediction is developed to its fullest extent, so that it can deal with tide curves which are so distorted that they have gradient discontinuities. It is better, however, to use a new two-step method known as the method of species concordance. This method is applied to the Gironde, and then to the Loire, where the variation in freshwater level is important. References (6 items).

- Gerrard, R. T., Long, J. J., and Shah, H. R. "Barking Creek Tidal Barrier." (See complete entry in Section V.)
- Gibbs, R. J. 1982. "Currents on the Shelf of North-eastern South America," <u>Estu-</u> <u>arine, Coastal and Shelf Science</u>, 14(3): 283-299.

From the continental shelf region extending 400 km north of the mouth of the Amazon River, current-meter data and data on salinity, temperature, and suspended material were analyzed to study mean and tidal currents. Based on a grid-point system, the mean circulation patterns along the shelf are shown and the temporal variations in the tidal currents are depicted for the region at 2-hr intervals. Maximum and minimum current speeds were studied for information on the spatial structure of the flow and on the alongshelf and across-shelf components. References (14 items).

- Gibbs, R. J. "Suspended Sediment Transport and the Turbidity Maximum." (See complete entry in Section II.)
- Gibson, R. A., and Wilson, E. M. "Tidal Energy Integration Using Pumped Storage." (See complete entry in Section V.)
- Glen, N. C. "The Tidal Survey of the British Isles." (See complete entry in Section VII.)
- Godin, G. 1984. "The Tide in Rivers," <u>The</u> <u>International Hydrographic Review</u>, 61(2):159-170.

The tide in a river consists of waves

which propagate into it from the ocean and which are distorted by friction and by the discharge of fresh water. Observations show that, as it progresses upstream, the time interval between low water (LW) and high water (HW) shortens so that the duration of ebb increases steadily. In extreme cases the level rises abruptly in some portions of the river and a shock wave develops, the bore. The tide in a river has other characteristics which are not as well known: (a) The semidiurnal component of the tide progresses upstream more rapidly than the diurnal component and it is more affected by friction. (b) HW progresses more rapidly than LW. (c) LW progresses faster in the estuary, while it is slowed down in the upstream region, during neap tides. The reverse holds during spring tides. (d) An increased discharge of fresh water diminishes the range of the tide. It increases the velocity of LW in the upstream portion of the river while it may enhance the range in some parts of the estuary. (e) Slow semimonthly and monthly oscillations in the level are induced in the upstream region by the succession of neap and spring tides downstream. (f) The tide in the upstream region cannot be reproduced by a one-dimensional model. References (3 items).

Gopalakrishnan, T. C., and Machemehl, J. L. 1980. "Boundary Conditions for Analysis of Flow in Tidal Inlets," <u>Proceedings,</u> <u>Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2595-2606.</u>

One-dimensional gradually varied flow analysis of flood routing and inlet flows (Mahmood and Yevjevich, 1975; Amein, 1975; and Hinwood and Wallis, 1975) has been a subject of study in the last few decades; and many mathematical models have been developed based on those studies. A common feature in all these models is that the boundary conditions at the ends of the channel reaches are supplied from measured values of stage, discharge, or velocity. These boundary conditions form an integral part of the mathematical models. In the case of implicit schemes, without the supply of these boundary conditions there will be more unknowns than equations. Even though in the explicit schemes they are not required in order to supply sufficient equations, it is obvious that the flow will not be properly simulated without imposing proper end conditions of flow. Normally two end conditions will be required, the upstream and downstream conditions, even though in a network of channels there will be more than two end conditions. Of these two, the upstream condition is usually the forcing function and the downstream one is the result of the flow due to the forcing function. The

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downstream condition depends on what happens to the flow outside the system. In other words, it depends on the shallowwater wave reflections from the continuation of the channel beyond the downstream end of the system considered. These reflections are characterized by the expansion or contraction of the channel, the rate of change of the side slopes, and other channel characteristics. As mentioned earlier, the downstream end condition is supplied from measured values of flow parameters so that the channel features (outside the system) mentioned above are automatically simulated. However, if it is required to know the response for any given forcing function, the corresponding measured downstream values may not be available. This means that the downstream boundary condition cannot be imposed in the usual way. This paper describes a method by which the downstream boundary condition can be imposed in the absence of measured downstream response to a given forcing function. However, the method presupposes that measured values for at least one forcing function are known as part of the features of the channel or channel system. References (4 items).

- Gopalakrishnan, T. C., and Machemehl, J. L. "Verification of a Numerical Flow Model for Carolina Beach Inlet, North Carolina." (See complete entry in Section VI.)
- Gordon, D. C., and Longhurst, A. R. "The Environmental Aspects of a Tidal Power Project in the Upper Reaches of the Bay of Fundy." (See complete entry in Section V.)
- Gourlay, M. R., and Hacker, J. L. "The Interaction Between Fluvial and Tidal Processes in the Pioneer River Estuary." (See complete entry in Section II.)
- Graham, D. S., Hill, J. M., and Christensen, B. A. "Verification of Estuarine Model for Apalachicola Bay, Florida." (See complete entry in Section VI.)
- Greer, M. N., and Madsen, O. S. "Longshore Sediment Transport Data: A Review." (See complete entry in Section II.)
- Hale, J. "Emergency Erosion Protection and Contingency Planning for Los Angeles County." (See complete entry in Section II.)
- Hales, L. Z. "Erosion Control of Scour During Construction; Report 8, Summary Report." (See complete entry in Section V.)
- Hall, R. W., Jr. "Evaluation of Marsh" Estuarine Water Quality and Ecological Models: An Interim Guide." (See complete entry in Section VI.)

Hamilton, A. D. 1980. "Nontidal Circulation and Mixing Processes in the Lower Potomac Estuary," <u>Estuaries</u>, 3(1):11-19.

The vertical structure of nontidal longitudinal currents and salinity in a reach of the lower Potomac River estuary, Chesapeake Bay, was studied. Values for vertical eddy viscosity and eddy diffusivity scale with water depth H , tidal current amplitude U, and bulk Richardson number were determined by conventional empirical formulas. The constant which relates the vertical eddy coefficients under conditions of neutral stability to UH was an order of magnitude less than that expected for tidal conditions. The degree of enhancement of longitudinal dispersion by the shear effect associated with the nontidal currents is a strong function of bulk Richardson number. References (10 items).

- Hamrick, J. M. "Baroclinic Circulation and Dispersion in Estuaries." (See complete entry in Section III.)
- Harleman, D. R. F. "Diffusion and Dispersion Processes." (See complete entry in Section VI.)
- Harten, H. "Improvements on Tidal Estuaries and the Effects on Tidal Current." (See complete entry in Section V.)
- Hartnoll, R. G., and Hawkins, S. J. "The Emersion Curve in Semidiurnal Tidal Regimes." (See complete entry in Section VIII.)
- Haury, L. R., et al. "Tidally Generated High-Frequency Internal Wave Packets and their Effects on Plankton in Massachusetts Bay." (See complete entry in Section VIII.)
- Häuser, J., Eppel, D., and Tanzer, F. "Analysis of Thermal Impact in Tidal Rivers and Estuaries." (See complete entry in Section VI.)
- Hawley, N. 1982. "Intertidal Sedimentary Structures on Macrotidal Beaches," Journal of Sedimentology Petrology, 52(3):785-795.

A one-month survey of three macrotidal beaches located in south Wales has shown that the distribution of bed forms in the intertidal zone is controlled primarily by wave climate and tidal range. The areas near the high- and low-water marks reflect the predominance of swash-zone action, whereas the middle part of the beach is more likely to contain bed forms formed in either the breaking or shoaling wave zones. Since none of the structures were formed by current action, changes in tidal range affected only the width of the areas, not the type of bet forms protocol. with changes in wave height; on high waveenergy beaches, the model of Clifton et al. is valid, whereas on lower energy beaches it must be modified. The rapid response of the beaches to changes in wave climate makes it unlikely that bed forms will be preserved except possibly during extremely severe storms, when the lowermost part of the bed forms might be preserved as part of a vertical sequence produced by migrating facies. References (23 items).

- Hayes, M. O., Kana, T. W., and Barwis, J. H. "Soft Designs for Coastal Protection at Seabrook Island, S. C." (See complete entry in Section VIII.)
- Heath, R. A. "Generation of the M_u Tide in Cook Strait, New Zealand." (See complete entry in Section VI.)
- Heathershaw, A. D., Carr, A. P., and Blackley, M. W. L. "Swansea Bay (SKER) Project, Topic Report 8; Coastal Erosion and Nearshore Sedimentation Processes." (See complete entry in Section II.)
- Heathershaw, A. D., and Hammond, F. D. C. 1979. "Swansea Bay (SKER) Project, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations and Their Response to Meteorological Conditions," Report No. 92, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

This report describes the tidal and residual current circulation patterns in Swansea Bay, particularly how they effect sediment transport toward or away from the foreshore. Consideration is given to wind-driven currents, surge currents, and density currents. References (69 items).

- Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 6; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)
- Heathershaw, A. D., and Lees, B. J. 1980. "Sizewell-Dunwich Banks Field Study, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations," Report No. 104, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

Recording current meter data, tidal elevations, and meteorological data have been used to examine the tidal and residual circulations in the area and their response to meteorological forcing. Current meter data have confirmed that the tidal currents are essentially rectilinear with ellipticities of the order of 5 percent and less and with tidal stream maxima of the order of 100 cm s^{-1} . The residual flow pattern in the area is complex although there is evidence of an anticlockwise eddy in the mean circulation, which is situated over the Sizewell Bank and possibly extends to cover the Dunwich Bank. Current measurements from a longterm current meter mooring have confirmed that the residual circulation is likely to be influenced by meteorological forcing. In particular, the alongshore components of the residual flow and wind stress are well correlated during storm periods. Analysis of current meter and tidal elevation data has shown that the tides in this area may be considered as a mixture of standing wave and progressive wave oscillations, consistent with the proximity of the study area to an amphidrome. For both the ${\rm M}_2$ and ${\rm S}_2$ tides, the standing wave component is dominant. References (26 items).

- Hickel, W. "The Influence of Elbe River Water on the Wadden Sea of Sylt (German Bight, North Sea)." (See complete entry in Section III.)
- Higuchi, H., Yasuda, H., and Hayakawa, N. "Experimental Study on Scale Effect of Tidal Model." (See complete entry in Section VI.)
- Hinwood, J. B. 1978. "Large Scale Turbulence in Tidal Currents," <u>Proceedings,</u> <u>Sixteenth Coastal Engineering Conference,</u> <u>August 27-September 3, 1978, Hamburg,</u> <u>Germany</u>, ASCE, III:2598-2601.

Aerial photographs of tidal inlets sometimes show an orderly pattern of large eddies or cells aligned in long rows along the mean streamlines. A highly ordered "cellular" structure of turbulence has been observed in strong tidal currents. The cells have only been observed where the velocity is high and have not been observed during strong winds. The cell dimensions are in the order of the water depth and velocities about one-tenth those of the main current. The observation of cells is described, but their complete structure and origin are not yet known; however, it has been established that density variations are not a factor. References (3 items).

- Holloway, P. E. "Internal Tides on the Australian North-West Shelf: A Preliminary Investigation." (See complete entry in Section VIII.)
- Holloway, P. E. "Tides on the Australian North-west Shelf." (See complete entry in Section VIII.)
- Holz, K.-P., and Januszewski, U. "Automatic Calibration of Numerical Tidal Models." (See complete entry in Section VI.)

- Hopkins, T. S., Salusti, E., and Settimi, D. "Tidal Forcing of the Water Mass Interface in the Strait of Messina." (See complete entry in Section VIII.)
- Howarth, M. J. "Intercomparison of Current Meters in Fast Tidal Currents." (See complete entry in Section VII.)
- Howell, G. "Florida Coastal Data Network." (See complete entry in Section VII.)
- Hsueh, S. F., and Ahlert, R. C. "Mixing in Shallow Coastal Sea: Case Study." (See complete entry in Section VI.)
- Hubbard, D. K., Oertel, G., and Nummedal, D. 1979. "The Role of Waves and Tidal Currents in the Development of Tidal-Inlet Sedimentary Structures and Sand Body Geometry: Examples from North Carolina, South Carolina, and Georgia," <u>Journal of</u> <u>Sedimentary Petrology</u>, 49(4):1073-1092.

Morphologic variability in tidal inlets along the southeastern coast of the United States has been considered with respect to the distribution of large-scale sand bodies, intertidal and subtidal bed forms, and internal sedimentary structures. Data indicate that the morphologic variability in these inlets can be largely explained as a response to waves and tides. Other factors (tidal prism, inlet crosssectional area and shape, the nature of the back-barrier bay, the degree of flood or ebb dominance, freshwater input, relative changes in sea level and sediment supply) exhibit lesser controls and their effects are less easily quantified. Three types of inlets are identified: tidedominated, wave-dominated, and transitional. (a) Tide-dominated inlets are characterized by a deep, ebb-dominant main channel flanked by long, linear channelmargin bars. Flood-tidal deltas are poorly developed or nonexistent. Sand bodies landward of the inlet throat are confined to tidal point bars further landward in the marsh creek system. (b) Wavedominated inlets are characterized by large, lobate flood-tidal deltas building into wide, open lagoons. The ebb-tidal delta is small and extends only a short distance from the beach. Tidal channels are generally shallow (less than 6 m) and often bifurcate landward and seaward of the throat. (c) In transitional inlets, major sand bodies are typically concentrated in the inlet throat. These inlets vary widely in morphology and sand body geometry. Logically, this variability should be expressed in the rock record. In a vertical section through a tidedominated inlet channel, a coarse base, overlain by bidirectional trough cross stratification from the deep channel and ebb-oriented, planar and trough cross stratification from the shallower channel

should be expected. Swash-generated, horizontal plane laminations or slightly inclined accretion beds formed along the channel margins are less likely to be preserved. In contrast, a wave-dominated inlet sequence would contain primarily landward-oriented, planar and cross stratification from the shallower channel bottom, overlain by dominantly horizontal or slightly inclined plane laminations from the shallow channel sides. Transitional inlets would produce a variety of sequences, the exact nature of which would reflect the relative importance of waves and tides. References (57 items).

- Hunkins, K. "Salt Dispersion in the Hudson Estuary." (See complete entry in Section III.)
- Huntley, D. A., and Nummedal, D. "Velocity and Stress Measurements in a Tidal Inlet." (See complete entry in Section VII.)
- Huthnance, J. M. "On the Formation of Sand Banks of Finite Extent." (See complete entry in Section VI.)
- Huzzey, L. M. 1982. "The Dynamics of a Bathymetrically Arrested Estuarine Front," <u>Estuarine, Coastal and Shelf Science</u>, 15(5):537-552.

The mixing and circulation associated with a bathymetrically arrested estuarine front were studied using hydrographic and current data. A quasi-steady front, exhibiting strongly convergent surface flows, is formed along the steeply sloping inner margins of the flood tide delta during each semidiurnal tide cycle. This front separates the brackish ambient water within a deep estuarine basin from the incoming oceanic tidal water. The position of the front is dependent on the local water depth and the difference in density between the two water masses. Beneath the surface there is an inclined frontal interface where static stability is very low and vertical mixing intense. A vertically integrated horizontal momentum equation was derived for flow in the upper layer and an estimate made as to the value of the associated entrainment coefficient. References (24 items).

- Imasato, N. "What is Tide-Induced Residual Current?" (See complete entry in Section VI.)
- Indlekofer, H. "On Numerical Stability of One-Dimensional Seciment Transport Models for Unsteady and Tidal Flows." (See complete entry in Section VI.)
- Ingram, R. G. 1980. "Generation and Decay of an Estuarine Front," <u>Proceedings, Sec-</u> ond International Symposium on <u>Stratified</u>

<u>Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:548-550.

This is a brief article which describes the T-S and velocity characteristics of a convergent surface front along the northern boundary of Ile Rouge Bank in the St. Lawrence estuary. References (3 items).

- Jiang, J. X., and Falconer, R. A. "On the Tidal Exchange Characteristics of Model Rectangular Harbours." (See complete entry in Section VI.)
- Jones, I. S. F., and Padman, L. 1983. "Semidiurnal Internal Tides in Eastern Bass Strait," <u>Australian Journal of Marine</u> and Freshwater Research, 34(1):159-171.

Variations in the vertical thermal structure near the shelf break in eastern Bass Strait have been observed for a 1-year period during 1980-1981. For the periods when the water column was stratified, energetic oscillations of the thermocline were frequently observed, these being well correlated with the surface tide. A peak occurred at the semidiurnal frequency in approximately half of the spectra, each constructed from 4 days of thermistor records. The amplitude of this internal tide was up to 40 m from crest to trough in February 1981. The internal tide lagged the surface tide by 0-6 hr in the five records analyzed for phase. This, together with the consistency of phase in longer records, supports the proposal that these internal motions were due to forcing not far from the site of observation. It is suggested that topographic forcing can be scaled on the parameter $h^{-2} \partial h/\partial x$, where h is water depth and x is measured perpendicular to the isobaths, and a map of this parameter shows a line of strong generation near the 100-m isobath, about 10 km from the measurement site. References (16 items).

Joshi, P. B. 1982. "Hydromechanics of Tidal Jets," <u>Journal, Waterway, Port,</u> <u>Coastal and Ocean Division</u>, ASCE, 108(WW3):239-253.

A unified theoretical investigation of the fully developed region of a tidal jet is presented. The jet is treated as a vertically averaged flow and the effects of lateral mixing, bottom friction, and variable bathymetry are included. It is shown, without assuming any specific form of the similarity function, that the cross-stream length scale and the centerline velocity of the jet must satisfy certain differential equations in order for the jet to be self-similar. Solutions of these equations are obtained for some simple forms of bottom topography. For a flat, frictional bottom, the jet exhibits exponential growth and decay of the center-line velocity which is in agreement with earlier investigations. An exact analytical solution for the similarity function is obtained upon introduction of Prandtl's eddy viscosity hypothesis. The theory contains two free constants which must be determined in future experimental investigations. References (13 items).

- Joshi, P. B., and Taylor, R. B. "Circulation Induced by Tidal Jets." (See complete entry in Section VI.)
- †Kabbaj, A., and LeProvost, C. 1980. "Nonlinear Tidal Waves in Channels: A Perturbation Method Adapted to the Importance of Quadratic Bottom Friction," <u>Tellus</u>, 32(2):143-163.

Bottom friction plays an important role in the propagation and damping of long waves in shallow water. A perturbation method, well adapted to the importance of this bottom stress, is presented and applied for channels with constant mean depth and mean cross-section area. The main idea results from a development of quadratic bottom friction in a Fourier series up to the third order of approximation. A quasi-linearization of the damping effect of bottom stress is deduced from this expansion, which allows one to introduce the second-order damping effects of friction into the first-order system defining the fundamental component of the spectrum, and the main part of the third-order damping terms into the computation of the secondorder harmonic components. From this expansion, the generating role of the harmonic played by friction is also identified and taken into account in the secondorder approximation. Analytical and analyticonumerical solutions are presented and compared to numerical solutions of the full nonlinear equations obtained by the Lax-Wendroff $(L-\dot{W})$ finite difference integration technique. These comparisons show that the analytical solutions limited to the second-order approximation fit very well with the L-W solutions.

Karunartne, D. A. 1980. "An Improved Method for Smoothing and Interpolating Sea Level Data," <u>The International Hydro-</u> graphic Review, 57(1):135-148.

A method for smoothing and interpolating observed hourly digital tidal elevations is presented. The method which is based on fitting a small number of harmonic tidal components to the data series has proved to be superior to standard smoothing procedures and can be applied to data from different tidal regimes. The method is relatively simple, economical, and can be executed on standard digital computers with limited storage capacity. References (5 items). 5.2.5

Kashiwamura, M., and Yoshida, S. 1978. "Outflow Dynamics at a River Mouth," <u>Pro-</u> <u>ceedings, Sixteenth Coastal Engineering</u> <u>Conference, August 27-September 3, 1978,</u> <u>Hamburg, Germany</u>, ASCE, III:2925-2944.

This paper consists of two main parts, one of which is on the transient behavior of the fresh water, when it passes through a river mouth, and the other is on the mechanism of mixing of two layers inside and outside the river mouth. In the former, the freshwater flow is concluded to be dynamically identical with the transonic flow in aerodynamics. In the latter, three types of mixing are described. One is that of the Kelvin-Helmholtz instability, found outside the mouth. Another is a new type due to the interference of the interfacial waves and the roughness at the interface. This type is expected to occur inside the mouth. The last one is that induced by the tidal current. References (11 items).

Kato, M. 1979. "Observation of Crustal Movements by Newly-Designed Horizontal Pendulum and Water-Tube Tiltmeters with Electromagnetic Transducers (2)--Variations in the Amplitude and Phase of Tidal Tilts Observed with a Water-Tube Tiltmeter at Kamitakara," <u>Bulletin of the Disaster</u> <u>Prevention Research Institute</u>, Kyoto University, Kyoto, Japan, Part 2, 29(263): 83-87.

Using the data collected over nearly one year obtained with a water-tube tiltmeter installed at the Kamitakara Station $(36^{\circ}17' \text{ N}, 137^{\circ}20' \text{ E}, \text{ H} = 800 \text{ m})$ in the northwestern Chubu region, Japan, temporal variations in the amplitude and phase of the M_2 and O_1 constituents have been investigated by means of the least-squares method. The results show that variations in the amplitude and phase of tidal tilts observed in three of four directions are $\pm 2 \sim 4$ percent and $\pm 1 \sim 2^{\circ}$ for the M₂ constituent, and ±3~6 percent and ±3.5° for the \boldsymbol{O}_1 constituent, respectively, during the observation period. Considering the error limit in sensitivity measurements, it may be concluded that both the M, and O_1 tidal constants have not changed significantly during this period, suggesting no essential change of elastic properties in the shallow crust. This conclusion may be consistent with the fact that seismic activity around the region has not been so high. Successive analyses with 30-day data have also been performed by shifting the central epoch by a 2-day step, and it has become clear that there is a common periodic oscillation in the amplitudes and phases of both M. and O , but this can be easily removed by a moving-average method. It might be possible to find out more detailed variations in the tidal constants from the averaged results. References (12 items).

- Kawahara, M. 1981. "Periodic Finite Elements in Two-Layer Tidal Flow," <u>Interna-</u> tional Journal for Numerical Methods in Fluids, 1(1):45-61.
- The aim of this paper is to present the finite element method and its application to quasi-steady periodic two-layer tidal flow in estuaries and coastal seas. Formulating the weighted residual equations, using quadratic polynomials for velocity and linear polynomials for water elevation as interpolation functions and employing the periodic Galerkin method, the nonlinear simultaneous equations can be derived. The present method is used for the simulation analysis of the Niigata Port redevelopment planning. References (26 items).
- Kelley, J. T. "Composition and Origin of the Inorganic Fraction of Southern New Jersey Coastal Mud Deposits." (See complete entry in Section II.)
- Kieslich, J. M. "A Case History of Port Mansfield Channel, Texas." (See complete entry in Section II.)
- Kieslich, J. M. "Tidal Inlet Response to Jetty Construction." (See complete entry in Section V.)
- King, H. L., Scott, M. A., and Smith, T. J. "Some Femarks on the Analysis of Short Tidal Records." (See complete entry in Section VIII.)
- Kirby, R., and Parker, W. R. "A Suspended Sediment Front in the Severn Estuary." (See complete entry in Section II.)
- Kjerfve, B. "Calibration of Estuarine Current Crosses." (See complete entry in Section VII.)
- Kjerfve, B., ed. <u>Estuarine Transport Pro-</u> <u>cesses</u>. (See complete entry in Section <u>II.</u>)
- Knight, D. W. "Some Field Measurements Concerned with the Behaviour of Resistance Coefficients in a Tidal Channel." (See complete entry in Section VIII.)
- Knight, D. W., et al. "The Measurement of Vertical Turbulent Exchange in Tidal Flow." (See complete entry in Section VII.)
- Knowles, C. E. "Estimation of Surface Gravity Waves from Subsurface Pressure Records for Estuarine Basins." (See complete entry in Section VII.)
- Komar, F. L. 1976. <u>Beach Processer and Sedimentation</u>, Prontice-Hall, Inc., Englewood Cliffs, N. J.

The book has an introductory chapter that includes a description of the uses of

beaches, the various disciplines that study beaches, and pertinent literature sources. Chapter Two deals with coastal geomorphology and presents the general terminology that will be needed throughout the remainder of the book. Because there are other books already available on coastal geomorphology, the length of Chapter Two was kept short on purpose. The next few chapters deal with nearshore processes: water waves (their generation, travel, refraction, and breaking); tides and longer-term sea level changes; longshore current generation and prediction; and sand transport on beaches. The subsequent chapters deal with the response of the beach to these processes; shoreline configuration, including the variety of rhythmic shoreline forms; the beach profile; and the effects of constructing engineering structures in the nearshore and how this alters the equilibrium. The final chapter deals principally with the geological aspects of beach sedimentation, including what governs the composition of the beach, the roundness and shape of its grains, the many sedimentary structures found there, and the organisms found in the nearshore and how they affect the sedimentation. It ends with a summary discussion, including examples, of the identification of ancient beach deposits in the geologic rock record. References (215 items).

- Kraft, J. C., John, C. J., and Maurmeyer, E. M. "Morphology of Coastal Barriers, Delaware, U.S.A." (See complete entry in Section II.)
- Krause, G. "Separation of Climatic Fluctuations and Impacts of Engineering Activities in Estuaries." (See complete entry in Section III.)
- Kuo, C. Y., and Blair, C. H. "Comparison of Verified Physical and Mathematical Model." (See complete entry in Section VI.)
- Lai, C. "A Computer Simulation Study of Traveltimes of Injected Particles and Tide-Waves in Well-Mixed Estuaries." (See complete entry in Section VI.)
- Lai, C. "Computer Simulation of Two-Dimensional Unsteady Flows in Estuaries and Embayments by the Method of Characteristics: Basic Theory and the Formulation of the Numerical Method." (See complete entry in Section VI.)
- Lai, C. "The Boundary Conditions in the Implicit Solution of River Transients." (See complete entry in Section VI.)
- Lara-Lara, J. R., Alvarez-Borrego, S., and Small, L. F. 1980. "Variability and Tidal Exchange of Ecological Properties in

a Coastal Lagoon," <u>Estuarine and Coastal</u> <u>Marine Science</u>, 11(6):613-637.

Sea level, current velocity, temperature, salinity, oxygen, inorganic phosphate, chlorophyll a, seston and its organic and inorganic fractions, phytoplankton species abundance, particulate organic carbon and nitrogen, and primary productivity time series were generated for the mouth of San Quintin Bay, Baja California, Mexico, for 18 days during the summer of 1977. This was done to elucidate the main factors that cause variability of these ecological properties and to frame some generalizations about the offshore waters during the summer season. San Quintin Bay is of considerable interest because of its developing mariculture potential, and because it is representative of a type of coastal lagoon that is rapidly being altered by man's activities. Alternation of upwelling events was the main cause of variability for all properties except temperature. Semidiurnal tides were the main cause of variability for temperature. Conservative variables such as temperature and salinity had a semidiurnal component greater than the diurnal one. Most nonconservative variables (chlorophyll a and phosphate concentrations, for example) had equal diurnal and semidiurnal variability components, due to biological processes that strongly depend on the solar radiation cycles. The relationship between variability components for oxygen was intermediate to those relationships for the conservative and nonconservative variables. Seston variability was mainly due to turbulence induced by winds and tidal currents. Lack of correlation between particulate organic carbon and nitrogen, and the wide range of C:N ratios in particles, indicate that bay-derived seston of widely varying organic and inorganic content represents most of the suspended particulate matter. Mean transports of all properties measured at the bay mouth, over the complete sampling period and within each upwelling event, were positive, indicating net movement into the bay. During the second upwelling event (the last 7 days of the sampling period), mean fluctuation fluxes for temperature, oxygen, and chlorophyll a at the bay mouth were significantly negative, indicating exports of these properties from the bay. For all other variables, and during the first upwelling period and the upwelling relaxation period, there were no significant fluctuation fluxes at the bay mouth. Diatoms were always the most abundant phytoplankton group. Primary productivity was always greatest at the surface, with a mean value of 27 mg C m 3 h $^{-1}$ through the sampling period. Maximum surface productivity values were obtained for the upwelling relaxation period (up to 49 mg ("mothers"). A mean value of 122 mp

C m⁻² h⁻¹ was found for the entire water column during the 18-day period. These values are comparable to the productivity maxima of other upwelling areas. The mean surface assimilation ratio was 6.6 mg C (mg chl <u>a</u>)⁻¹ h⁻¹, which indicates nutrient-rich waters. References (45 items).

- Lees, B. J. "Observations of Tidal and Residual Currents in the Sizewell-Dunwich Area, East Anglia, U.K." (See complete entry in Section VIII.)
- Lees, B. J., and Heathershaw, A. D. "Sizewell-Dunwich Banks Field Study, Topic Report 5; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)
- Lepetit, J. P., and Davesne, M. "Dynamics of Silt in Estuary, Residual Current or Flocculation Which Prevails?" (See complete entry in Section II.)
- Lepetit, J. P., and Hauguel, A. "A Numerical Model for Sediment Transport." (See complete entry in Section II.)
- Le Provost, C. "A Model for Prediction of Tidal Elevations Over the English Channel." (See complete entry in Section VI.)
- Le Provost, C., and Poncet, A. 1978. "Finite Element Method for Spectral Modelling of Tides," <u>International Journal</u> for Numerical Methods in Engineering, 12(5):853-871.

A spectral method for modelling of tides is proposed and applied to the calculation of the M, component of the tide in the English Channel. The classical nonlinear hyperbolic problem of long wave propagation in shallow waters is transformed into a sequence of elliptic problems by looking at a multiperiodic solution the frequencies of which are previously known. The method is based upon a perturbation technique, but the principal difficulties arise from the nonanalytical form of the quadratic friction term: the main conclusions of the corresponding study only are given here because the purpose of this paper is to present a practical application of the method to the calculation of a tidal component by the finite element method. The variational formulation of the problem is presented and the finite element package used is described. Some results are given for the M_2 tide in the English Channel: cotidal maps and current fields. References (10 items).

Lewis, R. E., and Lewis, J. O. "The Principal Factors Contributing to the Flux of Salt in a Narrow, Partially Stratified Estuary." (See complete entry in Section III.)

Lie, H.-J., and El-Sabh, M. I. "Formation of Eddies and Transverse Currents in a Two-Layer Channel of Variable Bottom with Application to the Lower St. Lawrence Estuary." (See complete entry in Section VI.) · D.M.W. REPRESE Prese

Lin, P., Dai, Z., and Li, K. 1982. "Unsteady Flow Studies in China," Journal, <u>Waterway, Port, Coastal and Ocean</u> <u>Division, ASCE, 108(WW3):343-360.</u>

This article summarizes some results of research on unsteady flow problems encountered in China. These results are in general little known to the world outside of China. The report is not intended to be general, although it does touch on considerable variety of problems, such as one- and two-dimensional tidal flow in estuaries, dam-break waves, routing of suspended load, and prediction of salinity. References (21 items).

- Lin, P., and Shen, H. "Two-D Flow with Sediment by Characteristics Method." (See complete entry in Section II.)
- Lin, W.-M. 1978. "The Harmonic Analysis of 25 Hours Tidal Current Observation," <u>Proceedings, International Conference on</u> <u>Water Resources Engineering</u>, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:331-341.

The harmonic analysis of tidal current data of a short observational period is proposed. The presented method is based on the least-squares method, which has been conventionally used for the harmonic analysis of the tides, as well as on the equilibrium tide theory. By this method, the harmonic constants concerning tidal currents of ten constituents can be computed from 25-hour observations. The probable error is also discussed. References (9 items).

- Liou, Y.-C., and Herbich, J. B. "Velocity Distribution and Sediment Motion Induced by Ship's Propeller in Ship Channels." (See complete entry in Section II.)
- Liu, S. K., and Leendertse, J. J. "Three-Dimensional SGC Energy Model of Eastern Bering Sea." (See complete entry in Section VI.)
- Lundgren, H. 1978. "Struggle of Physics and Mathematics," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, 1:13-24.

This paper gives examples of the separate and combined efforts of physics and mathematics in coastal engineering with

particular reference to the possibilities in the future. It points to the fact that physical thinking is necessary as an inspiration to mathematical and numerical work. While there is relatively little duplication of work (among the various institutions) of a purely theoretical character, the same statement does not apply to numerical models. One may hope that the future will produce more coordination in this respect. There are two disciplines where the establishment of high-quality numerical models will require a particularly strong combination of basic research, numerical expertise, and fieldwork: three-dimensional mixing processes and sediment problems. It would seem that no single institution has available both the integrated expertise and the capital investment required. Hence, a close cooperation among several institutions is almost mandatory.

- McAnally, W. H., Jr., and Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: Physical and Numerical Tidal Models: A Comparison." (See complete entry in Section VI.)
- McAnally, k. H., Jr., et al. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth." (See complete entry in Section VI.)
- MacArthur, R. C. 1979. "Turbulent Mixing Processes in a Partially Mixed Estuary," Ph. D. Dissertation, University of California, Davis.

Analyses of observed half-hourly data collected from the Savannah River estuary have provided a better understanding of several of the complex mixing processes occurring in partially mixed estuaries. A method of estimating the nature and magnitude of the parameters which describe the flow, in the region near the bed, located below the maximum density gradient in partially mixed estuaries is developed and validated. Accurate determination of these parameters allows the calculation of the vertical profiles of velocity and an estimation of the vertical turbulent mixing coefficients within this region. Calculated values of the local bed shear stress obtained from numerically integrating a form of the two-dimensional momentum equation were found to be accurate when compared to the measured sediment bed shear strengths for various orders of aggregation throughout a mean tide. Orderly flows occur during specific periods of time during a tidal cycle and only within certain vertical regions of the flow within the Savannah estuary. Criteria are developed to be able to identify these periods of "fully developed" flow. Vertical distributions of velocity, shearing

stress, and turbulent exchange coefficients are derived from Prandtl and von Karman forms of the "mixing length theory." These relations are applied and validated with observed data from the Savannah estuary. Two distinct regions of flow separated by a central mixing zone are identified and analyzed for their individual hydrodynamic properties. Couette flow characteristics and those properties typically found in "drag-reducing" flows are identified and analyzed within the "near-bed" region. Values of von Karman's constant, k, are observed to be reduced by the presence of stable density gradients and high concentrations of suspended sediment. A variable form of von Karman's constant k/@ is developed for the nearbed region based upon a modified form of the Monin-Obukhov stability function $\Phi(\zeta)$. Calculated values of this effective von Karman's parameter k/& tended to an average value of 0.2. Observed vertical profiles of velocity and eddy viscosity are successfully reproduced using theoretical relationships which incorporate the newly defined effective von Karman's parameter k/Φ . A simple linear relationship is found to exist between the near-bed layer turbulent Schmidt number and Reynolds number. This relationship confirms results obtained from dimensional analyses and compares closely with previous results observed in laboratory flumes by Orlob. Observation of logarithmic velocity profiles, constant shearing stress distributions, and simple linear Schmidt to Reynolds number relationships within the near-bed region indicates that boundary-layer type flows exist during periods of fully developed flow in partially mixed estuaries. Results from the analyses reported herein indicate that the presence of stable density gradients and high concentrations of suspended sediment require the modification of fundamental turbulent flow relationships in order that observed local flow characteristics be accurately described. References (210 items).

- MacAyeal, D. R. "Numerical Simulations of the Ross Sea Tides." (See complete entry in Section VI.)
- McCann, S. B., Reinson, G. E., and Armon, J. W. 1977. "Tidal Inlets of the Southern Gulf of St. Lawrence, Canada," <u>Coastal</u> <u>Sediments '77, Fifth Symposium of the</u> <u>Waterway, Port, Coastal and Ocean Division</u> <u>of ASCE</u>, Charleston, South Carolina, November 2-4, 1977, ASCE, 504-519.

Barrier islands and sandspits, cut by numerous tidal inlets, are an important element of the coastline of the southern Gulf of St. Lawrence, which had been little studied prior to 1970. However, recent investigations by the authors and

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others have provided a basic understanding of the morphology and dynamics of the barrier systems and some of the principal inlets. Only one of the inlets, Portage Channel at the entrance to the Miramichi estuary, is utilized by oceangoing vessels, to reach the New Brunswich ports of Chatham and Newcastle, but there are numerous small craft harbors situated inside the barriers all around the southern Gulf. Thus, many of the inlets are heavily utilized by small fishing vessels, and periodic dredging of inlet and lagoon channels is necessary. The present paper examines shoreline and inlet conditions along the northeast coast of New Brunswick, in particular at the entrance to the Miramichi estuary, and along the Malpeque shore of Prince Edward Island. The two areas illustrate the range of conditions in terms of littoral drift rates, inlet size and stability, and associated sand bodies which are typical of the region. The Gulf of St. Lawrence is a "protected sea," microtidal coastal environment, in which normal shore processes are curtailed for more than 3 months each year due to the presence of pack and shorefast ice. Swell waves from the North Atlantic enter the southern Gulf for only 7 percent of the year; the wave climate is dominated by waves generated across the relatively short fetches of the Gulf itself. Wind fetches are generally less than 200 km, except for the narrow fetch "window" (500-700 km) to the northeast. The waves are generally steep with short wavelengths in relation to wave height. Wave periods over 9.5 sec and wave heights over 5 m are uncommon. The tides are mixed diurnal to semidiurnal in character, and the small tidal range restricts wave action vertically. Mean tidal range at Portage Island on the Miramichi barrier is 1.1 m, and at Malpeque is 1.2 m. References (16 items).

- McCave, I. N., and Geiser, A. C. "Megaripples, Ridges and Runnels on Intertidal Flats of the Wash, England." (See complete entry in Section VIII.)
- McClimans, T. A., and Gjerp, S. A. "Numerical Study of Eistortion in a Froude Model." (See complete entry in Section VI.)
- Macdonald, G. J., and Weisman, R. N. "Oxygen-Sag in a Tidal River." (See complete entry in Section IV.)
- Machemehl, J. L., and Gopalakrishnan, T. C. "Comparison of Numerical Simulation Flow Models for Coastal Inlets." (See complete entry in Section VI.)
- Magnell, B. A., et al. 1980. "The Relationship of Tidal and Low-Frequency Currents on the North Slope of Georges Bank,"

Journal of Physical Oceanography, 10(8):1200-1212.

Measured currents at the steeply sloping north edge of Georges Bank show an unusually strong correlation between tidal and lower frequency components. The dominant current constituents are the rotary semidiurnal tides (amplitude ~30 cm s^{-1} , ellipticity 0.6) and the mean isobath-parallel flow to the northeast (ranging from zero to 40 cm s⁻¹). At the middle water depth in the period range of 3-5 days, the along-isobath low-frequency current component is highly coherent $(\gamma^2 > 0.8)$ with the amplitude of the semidiurnal tidal current. The fact that variation of the tidal current amplitude occurs on time scales appropriate to winddriven events suggests that the tidal structure must be significantly baroclinic, and this is supported by hydrographic data. The evidence thus suggests a local nonlinear interaction between tidal and low-frequency currents, with both the steep bottom topography and the density structure being important factors. References (7 items).

- Maiar-Reimer, E. "Residual Circulation in the North Sea Due to the M_2 -Tide and Mean Annual Wind Stress." (See complete entry in Section VI.)
- Marche, C. "Stability Study of an Artificial Salt Intrusion in Estuaries." (See complete entry in Section III.)
- Matsunaga, K., et al. "Behavior of Organically-Bound Iron in Seawater of Escuaries." (See complete entry in Section III.)
- Maxworthy, T. "A Note on the Internal Solitary Waves Produced by Tidal Flow over a Three-Dimensional Ridge." (See complete entry in Section VI.)
- Milliman, J. D., et al. "Tidal Phase Control of Sediment Discharge from the Yangtze River." (See complete entry in Section II.)
- Mills, D. A., Colman, R. S., and Dandy, G. C. "Water Movement in a Complex Estuarine Embayment--A Methodology for Data Collection and Analysis." (See complete entry in Section VII.)
- Monahan, D. "Morphology and Sediments of Sand Waves in the St. Lawrence Estuary." (See complete entry in Section II.)
- Montgomery, J. R. "Predicting Level of Dissolved Reactive Phosphate in the Lafayette River, Virginia, from Information on Tide, Wind, Temperature, and Sewage Discharge." (See complete entry in Section IV.)

- Morris, F. W., IV, Walton, R., and Christensen, B. A. "Point and Nonpoint Pollutant Flushing in Tidal Canal Networks." (See complete entry in Section IV.)
- Muench, R. D., and Coachman, L. K. 1980. "Energy Balance in a Highly Stratified Embayment: Norton Sound, Alaska," <u>Proceedings, Second International Symposium on Stratified Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:515-526.

Norton Sound is a broad, shallow subarctic coastal embayment indenting the Alaskan coast in the northeastern Bering Sea. The eastern portion of the sound contains in summer a strongly two-layered hydrographic structure, with the interface between layers the focus of extreme vertical gradients in temperature, salinity, and density. The layering persists through the summer despite shallow depths (15-20 m) and vigorous tidal currents (~20 cm sec⁻¹). Presence of the layering reflects an unusual balance between buoyancy input and turbulent mixing. Buoyancy additions, primarily from local freshwater addition and solar insolation, are confined almost entirely to the upper layer, due to the marked suppression of vertical turbulence by the extreme pycnocline, abetted by the sluggish horizontal circulation of the upper layer and near-zero mean flow of the lower. Energy for turbulent mixing comes almost entirely from tidal dissipation and is largely confined to the lower layer. Rates of these energy additions are estimated for a summer period. In other coastal regions, 1-2 percent of the tidal dissipation has been found adequate to vertically mix the water columns; in Norton Sound buoyancy addition is ~5 percent of tidal dissipation, an unusually large value sufficient to form and maintain the observed two-layered structure in the presence of substantial tidal mixing energy. References (15 items).

Muir, L. R. 1980. "Internal Tides in a Partially-Mixed Estuary," <u>Proceedings,</u> <u>Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:538-547.</u>

In 1974, 1975, and 1977, measurements of temperature, salinity, and velocity were carried out on the Middle Estuary of the St. Lawrence River in order to provide information on the primary physical processes controlling the circulation of this partially-mixed estuary. An examination of the 44 current meter records showed that, in addition to the barotropic tidal currents, it would also be necessary to include baroclinic tidal currents in any explanation of the velocity structure. The 66 tidal profiling stations provided enough density information to show that the tidally averaged density structure in the estuary could be expressed in the form $\bar{\rho}(x,y,z) = a_1(x,y) \exp(a_2/z+a_3)$, where a, and a, are constants throughout the Middle Estuary. It was not possible to provide an analytical form for $a_1(x,y)$. but there was enough information to show that there are large horizontal density gradients present and that the effect of these tidally averaged horizontal density gradients on the observed instantaneous density structure must be accounted for. Using the baroclinic structure derived from the tidally averaged vertical density structure and the presence of horizontal density gradients which are advected back and forth in the estuary, a set of prediction equations is developed. These equations allow the prediction of the instantaneous densities and velocities that would be measured by an instrument fixed to the bottom of the estuary. The results of applying these equations to a hypothetical channel, somewhat like the St. Lawrence, result in instantaneous density and velocity profiles very like those observed. It is not possible to ignore either of these effects, and still get results that look like the observations. It is suggested that the concepts developed here have application in many partially-mixed estuaries besides the St. Lawrence. References (14 items).

- Muralikrishna, I. V., and Devanathan, R. "Circulation and Salinity Distribution in Coastal Inlets." (See complete entry in Section VI.)
- Murty, T. S., and Henry, R. F. "Tides in the Bay of Bengal." (See complete entry in Section VIII.)
- Najarian, T. O., Wang, D-P., and Huang, P-S. "Lagrangian Transport Model for Estuaries." (See complete entry in Section VI.)
- Nakagawa, T., and Hinwood, J. B. "A Proposed Model of Large Scale Cellular Motion in Strong Tidal Flows." (See complete entry in Section VI.)
- Nasner, H. "Time-Lag of Dunes for Unsteady Flow Conditions." (See complete entry in Section II.)
- Nece, R. E., and Forsyth, G. W. 1980. "Annotated Bibliography on Tidal Flushing and Circulation in Marinas," Technical Report No. 67, Charles W. Harris Hydraulic Laboratory, University of Washington, Seattle.

The bibliography presented in this report includes papers, reports, etc., under the following headings: Tidal Flushing and

Circulation, Physical Hydraulic Model Studies, Numerical Models, Sedimentation Problems, Water Quality (Field Investigations), Environmental Impact Statements, and Literature Review.

- Nece, R. E., and Scheffner, N. W. "Field Data Analysis for Chesapeake Bay Model Verification." (See complete entry in Section VIII.)
- Nece, R. E., and Smith, H. N. "Tidal Exchange in Proposed Sitka, Japonski Lagoon, Small Boat Harbor." (See complete entry in Section VI.)
- Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in Marinas." (See complete entry in Section VI.)
- Nelson, R. C., and Keats, A. J. 1980. "A Coastal Inlet with Fixed Bed and Mobile Sides," <u>Proceedings, Seventeenth Coastal</u> <u>Engineering Conference, March 23-28, 1980,</u> <u>Sydney, Australia</u>, ASCE, III:2534-2549.

The coastal inlet dealt with in this paper has a fixed bed of exposed rock and mobile side boundaries of sand that overlie the bedrock platform. The work was undertaken to investigate the response of the throat section to natural hydraulic and meteorological events and to observe the nature and rate of recovery of the inlet after the more extreme events. These events included sea and swell states, wind, freshwater flood flows, and short-term changes in mean sea level (storm surges or meteorological tides). The 3-year study involved the inlet at the mouth of the Barwon River, Victoria, Australia. The work forms part of a continuing study to assess the impact of engineering works on the stability of the estuary and inlet, and was required to assist in delineating the natural inlet variability from that due to engineering works. The study described here looked specifically at the inlet throat section which refers to the short narrow waterway connecting the estuary with the sea. The inlet throat section at Barwon Heads is well defined. The inlet itself is free of training walls and is normally flanked by sandy beaches. However, the depth of the inlet is limited by a bed of rock, there being, in effect, unlimited mobility on a side boundary only. The study therefore included an investigation to see if such an inlet conformed to equilibrium criteria developed from inlets with unrestricted bed mobility. Some results of previous investigations on the estuary and inlet were reported by Nelson (1977). References (5 items).

Nielsen, A. F., and Gordon, A. D. (980). "Tidal Inlet Behavioural Atalysis," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2461-2480.

For many years stability theories have been used both to design inlets and to appraise the performance of them. There are a variety of approaches to the formulation of stability criteria ranging from the purely empirical (Stevenson, 1884, cited by Bruun and Gerritsen, 1958; O'Brien, 1931; Bruun, 1977) to the generalized analytical (Escoffier, 1940; Bruun and Gerritsen, 1958; Keulegan, 1967; O'Brien and Dean, 1972). In 1966 a seemingly small perturbation made to the inlet of Wallis Lake resulted in significant changes to the estuary. The direct application of existing stability theories was of marginal value in explaining these changes and predicting the stable regime that the estuary may ultimately reach. This paper highlights some of the limitations of existing stability theories, presents a new method of dynamic behavioural analysis, outlines the case study of an estuary to which existing stability theories could not be effectively applied but to which the behavioural analysis produced interesting results, and recommends the direction in which further research could yield beneficial results. References (13 items).

Nihoul, J. C. J., ed. 1979. <u>Marine Forecasting; Predictability and Modelling in Ocean Hydrodynamics; Proceedings, 10th International Liège Colloquium on Ocean Hydrodynamics, Elsevier Oceanography Series 25, Elsevier, Amsterdam.</u>

The papers presented report fundamental and applied research and address such different fields as storm surges, mixing in the upper ocean layers, surface waves, cyclogenesis, and other air-sea or sea-air interactions. Most of the papers contain well-documented case studies or applications of mathematical models to the forecasting of marine hydrodynamics. Fartial content: "Non-Linear Three-Dimensional Modelling of Mesoscale Circulation in Seas and Lakes" by J. C. J. Nihoul, Y. Runfola, and B. Roisin, References (24 items); "Recent Storm Surges in the Irish Sea" by N. S. Heaps and J. E. Jones, References (8 items); "Extratropical Storm Surges in the Chesapeake Bay" by D.-P. Wang, References (6 items): "First Results of a Three-Dimensional Model on the Dynamics in the German Bight" by J. Backhaus, References (8 items); "Tidal and Residual Circulations in the English Channel" by F. C. Ronday, References (16 items); "Recent Results from a Storm Surge Prediction Scheme for the North Sea" by R. A. Flather, References (20 items); "Belgian Real-Time System for the Forecasting of Curnerts and Elecations in the North Sea" by S. Atam. Economics see items i "Vyclopereisis and

Forecast of Dramatic Water Elevations in Venice" by A. Tomasin and R. Frassetto, References (21 items); "The Response of the Coastal Waters of N. W. Italy" by A. J. Elliott, References (11 items); "A Numerical Model for Sediment Transport" by J. P. Lepetit and A. Hauguel, References (5 items); "Security of Coastal Nuclear Power Stations in Relation with the State of the Sea" by J. Bernier and J. Miquel, References (5 items).

- Nishimura, J. K., and Lau, L. S. "Structure for Automatic Opening of Closed Stream Mouths." (See complete entry in Section V.)
- Noble, M., Butman, B., and Williams, E. 1983. "On the Longshelf Structure and Dynamics of Subtidal Currents on the Eastern United States Continental Shelf," Journal of Physical Oceanography, 13(12):2125-2147.

Strong correlations were observed among subtidal longshelf currents from the Middle Atlantic Bight (MAB) to the Georges Bank region, a distance spanning 615 km. The longshelf current consisted predominantly of wind-forced motions and freely propagating events, which together accounted for 75-90 percent of the longshelf current energy. Much stronger longshelf currents were observed in the MAB than on Georges Bank. The MAB/Georges Bank energy ratio for wind-forced currents on the 60-m isobath was 20. The ratio for freely propagating events was 3. The magnitudes of many of the terms in the vertically integrated wind-driven momentum equations were estimated from observations of current pressure, and surface stress, and from calculations of bottom stress. The cross-shelf momentum balance was geostrophic. Surface and bottom stress, the longshelf pressure gradient, and the Coriolis force on the cross-shelf flow were important terms in the longshelf momentum balance. An analytic model of wind-forced current, which incorporates the significant force balances, accounted for the observed longshelf variation of the wind-forced currents. Average bottomdrag and bottom-resistance coefficients estimated from current and bottom-stress records range from 4-8 (\star 10⁻³) and 0.07-0.20 cm s⁻¹, respectively. References (26 items).

- Nof, D. "On Geostrophic Adjustment in Sea Straits and Wide Estuaries; Theory and Laboratory Experiments, Part I: One-Layer System." (See complete entry in Section VI.)
- Novak, P., and Cabelka, J. <u>Models in Hy-</u> draulic Engineering; Physical Principles and Design Applications. (See complete entry in Section VI.)

- Nummedal, D., and Fischer, I. A. "Process Response Models for Depositional Shorelines: The German and the Georgia Bights." (See complete entry in Section II.)
- O'Brien, M. P. 1980. "Comments on Tidal Entrances on Sandy Coasts," <u>Proceedings</u>, <u>Seventeenth Coastal Engineering Confer-</u> <u>ence, March 23-28, 1980, Sydney, Aus-</u> <u>tralia</u>, ASCE, III:2504-2516.

The areas discussed in these comments include flow area-tidal prism, hydraulic characteristics, stability of inlets, and inlet closure. References (24 items).

- O'Connor, D. J., and Lung, W. "Suspended Solids Analysis of Estuarine Systems." (See complete entry in Section VI.)
- Odd, N. V. M. 1979. "Significance of Long-Period Tidal Oscillations in Estuaries," HRS Notes, Hydraulics Research Station, Wallingford, Oxfordshire, England, 21:7.

A brief description is presented of the application of a mathematical model to $M_{\rm f}$ or MS_f tides (periods of 14-15 days) in the Gambia Estuary. References (2 items).

Odd, N. V. M. 1978. "Vertical Mixing in Stratified Tidal Flows," <u>Journal, Hydrau-</u> <u>lics Division</u>, ASCE, 104(HY3):337-352.

A set of mixing length functions based on an adaption of the theories of Prandtl, Rossby, Montgomery, and Ellison is presented as a means of calculating the internal shear stresses and vertical flux of solutes in gradually varying turbulent stratified tidal flows. Field observations, made in a straight canalized reach of an estuary, were used to determine the best-fit values of empirical coefficients in generalized relationships between the mixing lengths and gradient Richardson number. The main purpose of the research was to improve the representation of vertical exchange processes in mathematical models of estuaries. References (11 items).

- Officer, C. B. "Tidal Exchanges and Far Field Effects." (See complete entry in Section IV.)
- Officer, C. B., and Lynch, D. F. "Dynamics of Mixing in Estuaries." (See complete entry in Section III.)
- O'Kane, J. P. "On the Choice of Boundary Conditions for One-Dimensional Models of Estuarine Water Quality." (See complete entry in Section VI.)
- Obishi, S., and Nishimura, T. "Study or Fortex Duniert in Strait with Benete-Secure:" InSector Lete entry in Secturn 2010.

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tOonishi, Y. 1979. "Water Exchange Between Adjacent Vortices Under an Additional Oscillatory Flow," Journal of Oceanographical Society of Japan, 35(3-4):136-140.

It is shown that the coupling effect of the steady vortices and the Eulerian oscillatory flow yields the 8-shaped Lagrangian motion through which adjacent vortices intercommunicate, inducing water exchange between them. The water exchange coefficient is fairly large. This coupling effect is considered to play an important role in the water exchange across the narrow strait which is accompanied with a strong tidal current and a pair of tidal residual circulations.

- †Oonisni, Y. "A Numerical Study on the Tidal Residual Flow." (See complete entry in Section VI.)
- Orlob, G. T. "Water Quality Modeling of Estuaries." (See complete entry in Section VI.)
- Outlaw, D. G. 1982. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 1, Prototype Data Acquisition and Analysis," Technical Report HL-82-2, Report 1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Prototype tidal elevation, current, and wind data were acquired and analyzed as a part of a study to evaluate the effects of the Lake Pontchartrain and Vicinity Hurricane Protection Plan on (a) tidal prism and circulation in Lake Pontchartrain, (b) hurricane surge levels in Lake Pontchartrain and vicinity, and (c) water quality in Lake Pontchartrain. Results of the analysis of prototype tidal elevation and current data will be used during verification of a numerical tidal circulation model. Data were included in the analysis from (a) an intensive tidal elevation and current data acquisition program for a duration of approximately 30 days; (b) a water quality program immediately following the intensive program, for monitoring tidal elevations, and, on a less extensive basis, currents, temperature, and conductivity in Lake Pontchartrain; and (c) a supplemental tidal elevation and current data acquisition program to provide additional data for numerical model verification. A water quality transect survey was conducted during both the intensive program and the supplemental survey for dissolved oxygen, pH, temperature, and conductivity. The intensive program also included a 25-hour current boat survey at six ranges in the tidal passes to Lake Postchartrain and in the Inner Harbor Navigation Canal. Tidal analysis results show that the diurnal O1 and K' constituent: have the largest amplitude in Lakes. Entshartmann and Porgraph and problems that the duarnal todes on lake Ecotomantham

are co-oscillating with little change in constituent amplitude over the lake. Data from the water quality program were limited due to generally low velocities in Lake Pontchartrain and low salinity levels during most of the observation period. References (9 items).

- Owen, A. "Effect on the M_2 Tide of Permeable Tidal Barrages in the Bristol Channel." (See complete entry in Section VI.)
- Owen, M. W., and Thorn, M. F. C. "Effect of Waves on Sand Transport by Currents." (See complete entry in Section II.)
- Owens, M. "Severn Estuary--An Appraisal of Water Quality." (See complete entry in Section IV.)
- Özsoy, E., and Ünlüata, Ü. 1982. "Ebbtidal Flow Characteristics near Inlets," <u>Estuarine, Coastal and Shelf Science</u>, 14(3):251-263.

The characteristics of turbulent jets issuing from tidal inlets are analyzed by taking into account lateral mixing and entrainment, bottom friction, onedimensional bathymetric changes, and ambient currents. In the absence of depth variations, the jet expansion is exponential as a result of bottom friction. Increasing depths significantly counteract the rapid expansion due to friction, and there are circumstances in which the jet can go through stages of expansion and contraction with distance. Cross-currents in the receiving water body reduce the jet expansion rate and deflect it sideways. These and other results are discussed under the light of qualitative observations. References (26 items).

- Ozturk, Y. F. "Mathematical Modeling of Dispersion in Mixed Estuaries." (See complete entry in Section VI.)
- Pape, E. H., III, and Garvine, R. W. "The Subtidal Circulation in Delaware Bay and Adjacent Shelf Waters." (See complete entry in Section VI.)
- Partch, E. N., and Smith, J. D. "Time Dependent Mixing in a Salt Wedge Estuary." (See complete entry in Section III.)
- Partheniades, E. "Ecologic and Thermal Problems in Estuaries." (See complete entry in Section IV.)
- Partheniades, E. "Engineering Properties of Estuarine Sediments." (See complete entry in Section II.)
- Partheniades, E., and Scarlatos, P. 1978. "Validity of Harmonic Approximation in Rectanguar Channels Subject to

Co-Oscillating Tides," <u>Proceedings, Inter-</u> <u>national Conference on Water Resources</u> <u>Engineering</u>, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:315-330.

The harmonic approximation of tides has been applied to a number of rectangular closed-end channels where the real flow conditions are assumed to be given by the finite element analysis. The main objectives of this investigation are (a) the correlation of the amplitude-damping coefficient μ and of the wave number k with the channel friction coefficient, the channel dimensions, and the relative amplitude, and (b) the deviation between the values of tides and tidal velocities as predicted by the harmonic approximation and by the finite element analysis. The first conclusive results of this study are presented in this paper. References (3 items).

- Pearce, B. R., Fidler, B. R., and Humphreys, A. C. "A 3-D Model for Penobscot Bay, Maine." (See complete entry in Section VI.)
- Pearson, C. 1979. "Far-Field Matching for Tidal Calculations in Nearshore Regions," WSG 79-1, Department of Oceanography Contribution 1061, University of Washington, Seattle.

Tidal current calculations in bays and estuaries show that the solution is sensitive to the tidal boundary condition imposed at the mouth of the bay. The difficulty is resolved by replacing the boundary condition at the mouth of the bay by a matching requirement between far field and nearshore solutions; for tidal problems, such a procedure is complicated by the importance of the Coriolis term as well as by bathymetric and topographic complexities. A number of matching methods which can be used are described. These methods are based on integral equation, finite elements, variational methods, transform methods, series solution, or on a combination of such methods. References (8 items).

- Pethick, J. S. "Long-Term Accretion Rates on Tidal Salt Marshes." (See complete entry in Section II.)
- Pethick, J. S. "Velocity Surges and Asymmetry in Tidal Channels." (See complete entry in Section VI.)
- Petrie, B., and Drinkwater, K. 1978. "Circulation in an Open Bay," <u>Journal of the</u> <u>Fisheries Research Board of Canada</u>, <u>35(8):1116-1123.</u>

The circulation of St. Georges Bay, Nova Scotia, under stratified conditions is

presented. The mean surface circulation is characterized by a clockwise eddy with velocities of about 10 cm/s. Bottom (30-m) flow at the mouth is found to be <2 cm/s out of the bay. Depth-averaged currents still exhibit the clockwise eddy. References (8 items).

Philip, N. A. 1978. "Coastal Processes and the Wagonga Inlet Breakwaters," <u>Managing</u> <u>the Coast, Fourth Australian Conference on</u> <u>Coastal and Ocean Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:201-206.

It was anticipated that construction of breakwaters at the entrance to the Wagonga estuary (south coast, New South Wales) would cause considerable local changes to the area by interference with the coastal processes. The coastal processes and the subsequent effects were postulated, and a comprehensive data collection program was implemented. Beach, offshore, and estuary channel sand movements were monitored, tidal level variations measured, regular vertical aerial photography flown, and sediment samples taken. A sediment budget for the monitored area was developed, and the morphological effects of the breakwaters were demonstrated. The hydraulic data is yet to be reduced and interpreted. The applicability of the extensive data collected to more general research problems involving onshore/offshore transfer, sand transport in estuaries, has not yet been explored. References (3 items).

- Pickett, E. B., and Greer, H. C. "Los Angeles Harbor and Long Beach Harbor: Prototype Data Acquisition and Observations." (See complete entry in Section VIII.)
- Pickrill, R. A., Irwin, J., and Shakespeare, B. S. "Circulation and Sedimentation in a Tidal-Influenced Fjord Lake: Lake McKerrow, New Zealand." (See complete entry in Section II.)
- Pingree, R. D., and Griffith, D. K. "A Numerical Model of the M_2 Tide in the Gulf of St. Lawrence." (See complete entry in Section VI.)
- Praagman, N. "Comparison of Numerical Models for the Computation of Residual Currents in Coastal Seas." (See complete entry in Section VI.)
- Prandle, D. "Co-Tidal Charts for the Southern North Sea." (See complete entry in Section VIII.)
- Prandle, D. "Hydrodynamic Modelling of the Southern North Sea." (See complete entry in Section VI.)

- Prandle, D. "Modelling of Tidal Barrier Schemes; An Analysis of the Open-Boundary Problem by Reference to AC Circuit Theory." (See complete entry in Section VI.)
- Prandle, D., and Wolf, J. "The Interaction of Surge and Tide in the North Sea and River Thames." (See complete entry in Section VI.)
- Price, W. A., Motyka, J. M., and Jaffrey, L. J. "The Effect of Offshore Dredging on Coastlines." (See complete entry in Section V.)
- Pritchard, D. W. "Hydrodynamics Models; Section 1: Three-Dimensional Models." (See complete entry in Section VI.)
- Pritchard, D. W. "Hydrodynamics Models; Section 2: Two-Dimensional Models." (See complete entry in Section VI.)
- Proehl, J. A., and Rattray, M., Jr. "Low-Frequency Response of Wide Deep Estuaries to Non-Local Atmospheric Forcing." (See complete entry in Section VI.)
- Provis, D. G., and Lennon, G. W. "Eddy Viscosity and Tidal Cycles in a Shallow Sea." (See complete entry in Section VI.)
- Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)
- Pugh, D. 1974. "High Tides," <u>New Scien-</u> <u>tist</u>, 63:152.

Author discusses a previous comment by F. J. Wood concerning observed peak water levels during the period 9-12 January and 9-11 February 1974 on the south coast of England. In the surge levels the contributions by barometric surge and the residual wind surge are discerned. Reference (1 item).

Pugh, D. T., and Rayner, R. F. 1981. "The Tidal Regimes of Three Indian Ocean Atolls and Some Ecological Implications," <u>Estuarine, Coastal and Shelf Science</u>, 13(4):389-407.

Coral atolls are areas of high biological productivity, supporting diverse and largely closed ecosystems. Cycling of nutrients within such systems and the input of additional nutrients from ocean waters are strongly influenced by wave and tidally induced water exchange. Tidal water exchange exerts a stabilizing effect on the physical and chemical characteristics of a lagoon. Tides affect the residence time of lagoon water, and the amount by which lagoon temperatures exceed ocean surface water temperatures, typically 2° C in cloud-free windless weather. Lagoon excess temperatures are independent of depth but vary inversely with the tidal range, with significant spring-neap modulations, but harmonic variations of lagoon temperatures at diurnal and semidiurnal periods are small except in very shallow lagoons. The effects on lagoon winds are also small, implying that measured winds are representative of open ocean conditions. The growth and zonation of corals and other organisms inhabiting shallow reef flats may be affected by the phase of the solar semidiurnal tide (S_2) , which determines the time of day at which extremely low tidal levels occur. Measurements at three Indian Ocean atolls are used to illustrate these effects. References (19 items).

Pugh, D. T., and Vassie, J. M. 1978. "Extreme Sea Levels from Tide and Surge Probability," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE,</u> 1:911-930.

This paper considers a method of deriving the probability of occurrence of extreme sea levels by combining the probability functions of surge and tide. As a result, the quantity of data required is less than with traditional methods. The philosophy of the method is discussed, and the conditions under which the theory can be applied are examined. Finally, the technique is applied to a number of ports in the United Kingdom, and the results are compared with known estimates of extreme levels. References (8 items).

Ramming, H.-G. 1978. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe," <u>Papers,</u> <u>7th International Harbour Congress,</u> K.V.I.V. (Royal Society of Flemish Engineers), Antwerp, Belgium, 22-26 May 1978, I:3.02/1-3.02/17.

The navigational channels in most of the tidal rivers will have to be dredged. On the one hand, ships are becoming bigger and one has to provide for sufficient depth; and on the other hand, erosion and the sedimentation of sand change the bottom topography, particularly within and near the waterway. The dredged sand must be pumped on an island or elsewhere. The deposit of sand is a permanent problem in tidal rivers with navigational channels, not only from the economical point of view but also in regard to the hydrological influence. Such changes of the bottom topography require careful consideration. The case described deals with the question whether the "Schwarztonnensand" in the river Elbe will be linked to the back of the river or not. A two-dimensional numerical model was applied. The problem was thoroughly investigated with recail to the reconstant matrimational and

hydrological conditions. The computed tidal currents and the water levels of an undisturbed normal tide were in good agreement with observations. After checking this assumption, the two abovementioned cases were then investigated. The essential results are the following: If the "Schwarztonnensand" is linked to the bank, the tidal currents will change their directions up to 35-40 degrees and the magnitude of the velocities will increase up to 35 percent. The area in which changes occur is remarkably large and remains nearly unchanged during a tidal period. It may be concluded that this part of the river Elbe is particularly sensitive to coastal structures. In the long run, further morphological changes may occur and influence the dynamic balance. The disturbances described will not take place if there is no linkup with the bank and no narrowing of the river. The influences of coastal structures have to be known because the navigational channel always has to be in working condition. References (11 items).

- Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: A Numerical Model for Tidal Circulation." (See complete entry in Section VI.)
- Renger, E. 1978. "Two-Dimensional Stability Analysis of Tidal Basins and Tidal Flats of Larger Extent," <u>Proceedings, Six-</u> teenth Coastal Engineering Conference, <u>August 27-September 3, 1978, Hamburg, Ger-</u> many, ASCE, II:1971-1985.

Stability studies of a natural tidal basin system demand a regime-oriented analysis and a characteristic quantification of the morphological values. Hence it was necessary to create relative form parameterization dependent on the location by means of a two-dimensional system of natural coordinates (z = elevation , s = gully length coordinate). The underlying logic for the determination of the equilibrium of the tidal basins and tidal flats is as follows: When the continuity equation for nonsteady flow at any cross section (s; z_i) of a tidal basin within the mean tidal ränge is applied, a dimensionless relationship between horizontal and vertical cross sections (A and F) and tidegenerated mean velocities of current (±u) and tidal rise and fall (±v) can be derived with an accuracy of more than 90 percent:

 $\frac{u}{v} \approx \frac{A}{F}$

The analysis of the term on the right-hand side of this equation showed a characteristic vertical distribution of the relationship for all investigated tidal basins of the German Bight which look rather similar. The reference values of the corresponding relationships depend on the area of the tidal basin (E) at MHW and the mean tidal range (H). The influence of the horizontal extent has been elaborated by varying the line of intersection systematically along the gully length coordinate (s). In addition it was possible to point out the differences between the characteristics of stable and (well-known) nonstable conditions by means of a twodimensional analysis of the dammed-off tidal river Eider/German Bight. The relations derived may prove to be useful in the planning of future constructions and even in understanding and influencing the disadvantageous changes in running systems. References (10 items).

Renger, E., and Partenscky, H. W. 1980. "Sedimentation Processes in Tidal Channels and Tidal Basins Caused by Artificial Constructions," <u>Proceedings, Seventeenth</u> <u>Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia</u>, ASCE, III:2481-2494.

The knowledge of morphological changes to be expected in tidal rivers and basins as a result of man-made constructions such as dikes, dams, and tidal control barriers is of high interest for future decisions in tidal regions of agricultural and economical value. It was the aim of this paper to present two empirical approaches by means of which a prediction of the morphological reaction of a tidal system and an estimate of expected sedimentation rates are possible. By using prototype measurements from the Eider River, it could be shown that the observed sedimentation rates were in fairly good agreement with obtained theoretical values from the two empirical approaches. Although further systematic research is needed in this respect, it seems that the two methods discussed in this paper promise to be a good tool in the prediction of sedimentation rates to be expected in tidal basins and tidal rivers due to artificial constructions in the tidal regime. References (12 items).

- Richards, D. R., and Gulbrandsen, L. F. "Low Freshwater Inflow Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Riedel, H. P., and Gourlay, M. R. 1980. "Inlets/Estuaries Discharging into Sheltered Waters," <u>Proceedings, Seventeenth</u> <u>Coastal Engineering Conference, March 23-</u> <u>28, 1980, Sydney, Australia</u>, ASCE, <u>III:2550-2564</u>.

Tidal prism/cross-sectional area relationships and tidal velocities have been measured for inlet entrances and along the length of the estuary for four creeks entering the sheltered waters on the South East Queensland coast, Australia. It has been found that the inlet entrance tidal prism/cross-sectional area relationship is controlled by the magnitude of littoral drift. The tidal prism/cross-sectional area relationship along the estuary is believed to be common to all tidal estuaries landward of the region where littoral drift has an influence. For tidal inlets on sheltered coasts with tidal prisms of the order of 10^6 m³, the mean maximum velocity during spring tides at the inlet entrance is about 0.3 to 0.4 m/s. References (11 items).

- Roberts, H. H. "Physical Processes and Sediment Flux Through Reef-Lagoon Systems." (See complete entry in Section II.)
- Robinson, I. S. "A Tidal Flushing Model of the Fleet--An English Tidal Lagoon." (See complete entry in Section VI.)
- Robinson, I. S., Warren, L., and Longbottom, J. F. "Sea-Level Fluctuation in the Fleet, an English Tidal Lagoon." (See complete entry in Section VI.)
- Rodenhuis, G. S., Kjaer, O. B., and Bertelsen, J. A. "A North Sea Model That Can Provide Detailed Hydrographic Information." (See complete entry in Section VI.)
- Rodger, J. G. "Simulation of Stratified Flows in Estuaries." (See complete entry in Section II.)
- Scheffner, N. W., et al. "Verification of the Chesapeake Bay Model; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Schwarze, H., and Falldorf, W. "Influence on Temperature Increases in Tidal Rivers Caused by Waste Heat Injections with Respect to Tidal Cycles and Storm Surges." (See complete entry in Section VI.)
- Seabergh, W. C. "Jetty Design for Little River Inlet, South Carolina." (See complete entry in Section V.)
- Seabergh, W. C. "Model Testing of Structures at a Tidal Inlet." (See complete entry in Section VI.)
- Seabergh, W. C., and Sager, R. A. "Supplementary Tests of Masonboro Inlet Fixed-Bed Model; Hydraulic Model Investigation." (See complete entry in Section VI.)
- Seelig, W. M., and Sorensen, R. M. "Numerical Model Investigation of Selected Tidal Inlet-Bay System Characteristics." (See complete entry in Section VI.)
- Seibert, G. H. 1980. "Tidally Forced Circulation in the Saguenay Fjord," <u>Proceedings</u>, Second International Symposium on

<u>Stratified Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:647-657.

The Saguenay Fjord in Quebec branches off the St. Lawrence Estuary at the inner end of the Laurention channel. Two principal sills separate the deep inner basin from the waters of the St. Lawrence. The shallowest of these sills (maximum depth of. 25 m) is located at the mouth of the fjord. The second sill, some 22 km upstream from the first, is 70 m deep. As a consequence of the high stratification, bottom topography, and the large tidal currents (sectional averages) of 0.5 ms⁻¹ and 0.25 ms^{-1} , one can observe a hierarchy of internal responses. On a flooding tide, the internal response behind the outer sill takes on the characteristics of a large-amplitude trapped lee wave which can inject heavy water from sill depth to subsurface levels. On an ebbing tide, the flow across the outer sill seems to be strong enough to prevent any significant blocking, and a substantial portion of the previous flood inflow is withdrawn to sill level where it is mixed with low-salinity surface waters of the flord and the remnant mixture of cold intermediate water from the St. Lawrence Estuary remaining over from the previous flood cycle. The response near the inner sill is not as strong as at the outer sill. This paper gives a preliminary description of current meter and CTD data obtained in the Saguenay Fjord. References (12 items).

- Sengupta, S., Lee, S., and Bland, R. A. "Three-Dimensional Model Development for Thermal Pollution Studies." (See complete entry in Section VI.)
- Sengupta, S., Lee, S. S., and Miller, H. P. "Three-Dimensional Numerical Investigations of Tide and Wind-Induced Transport Processes in Biscayne Bay." (See complete entry in Section VI.)
- Sharp, J. J. <u>Hydraulic Modelling</u>. (See complete entry in Section VI.)
- Sheng, Y. P. "Mathematical Modeling of Three-Dimensional Coastal Currents and Sediment Dispersion: Model Development and Application." (See complete entry in Section VI.)
- Siefert, W. 1978. "On Storm Tides in Rivers" ("Über das Sturmflutgeschehen in Tideflüssen"), Leichtweiss-Institut für Wasserbau, Technischen Universität Braunschweig, Mitteilungen No. 63:33-165 (In German).

The runoff of tide and storm surges in the Elbe, Weser, Ems, Thames, Westerschelde, St. Lawrence, and Delaware rivers during the twentieth century is analyzed. The theory includes formulas for system numbers including the damping coefficient. Factors which influence runoff are presented as changing wind conditions, increasing storm tide heights, an increase in normal tide propagation velocity due to changes in riverbeds, and propagation velocities of both mean and storm tides increasing with higher freshwater discharge, due to greater water depths. The influence of weirs in storm surges and the wind situation above tidal rivers is briefly discussed. References (45 items).

Siefert, W., and Barthel, V. 1980. "The German 'MORAN' Project," <u>Proceedings,</u> <u>Seventeenth Coastal Engineering Con-</u> <u>ference, March 23-28, 1980, Sydney,</u> <u>Australia</u>, ASCE, III:2927-2937.

The project MORAN (Morphological Analyses of the North-Sea-Coast) is an extensive program in order to try and combine all knowledge of the morphologic behavior of a transitional zone of 5- to 7-km width with weather, tide, current, and wave data. The area to be considered is about 9,000-km² size. The program started in 1979 and will probably continue until 1984. References (7 items).

- Signorini, S. R. "A Three-Dimensional, Finite Element Numerical Model of Circulation and Diffusion-Advection Processes for Estuarine and Coastal Application (With Application to Bay of Ilha Grande, Brazil)." (See complete entry in Section VI.)
- Simon, M. B. "Prediction of Tidal Currents at Brest (Prédiction De La Marée Á Brest)." (See complete entry in Section VIII.)
- Simpson, J. E., and Britter, R. E. 1980. "Experiments on the Dynamics of the Front of a Gravity Current," <u>Proceedings, Second</u> <u>International Symposium on Stratified</u> <u>Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:174-183.

Measurements are made of the structure and mixing at the heads of laboratory gravity currents between fresh and salt water. The currents are run at different fractional depths both by a lock-exchange method and in an apparatus in which they are brought to rest by an opposing flow. An analysis includes the observed mixing at the head and is based on a momentum balance and on the position of the stagnation point at the front of the gravity current head. Types of current considered are (a) with slip at the boundary, such as small-scale surface ocean or estuarine currents, and (b) with no slip along a horizontal floor. These are extended

to include the effect of opposing and following flows, and results are compared with some corresponding flows in the ocean and in the atmosphere. References (9 items).

Simpson, J. H., Hughes, D. G., and Morris, N. C. G. 1977. "The Relation of Seasonal Stratification to Tidal Mixing on the Continental Shelf," <u>A Voyage of Discovery;</u> George Deacon 70th Anniversary Volume, M. Angel, ed., Pergamon Press, Oxford, 327-340.

A stratification parameter $\bar{\nu}$, defined as the amount of mechanical energy required to bring about vertical mixing, has been calculated for an extensive region of the shelf using available data. The distribution of $\overline{\nu}$ during the summer months is compared with a tidal mixing theory which suggests that the parameter h/u^3 (h = depth , $u_s = tidal stream ampli-tude at springs) controls the occurrence$ of stratification. The results lend qualitative support to the model, although plots of $\tilde{\nu}$ versus h/u_{S}^{3} show a large degree of scatter which is interpreted as being largely due to variations in wind and wave mixing and surface heat input. Much of the structure of the \overline{v} and h/u³ distributions is apparent in recently available infrared images of the sea surface. References (6 items).

Simpson, J. H., and Nunes, R. A. 1981. "The Tidal Intrusion Front: An Estuarine Convergence Zone," <u>Estuarine, Coastal and</u> <u>Shelf Science</u>, 13(3):257-266.

Freshwater discharge in a small estuary flows seaward as a density current which is forced back into the estuary during the flood phase of the tidal streams. The development of the two-layer flow and the associated frontal structure is described. The front exhibits a V configuration with an isolated point convergence at its apex and an associated gyre system. References (9 items).

- Smith, N. P. "A Comparison of Tidal Harmonic Constants Computed at and near an Inlet." (See complete entry in Section VIII.)
- Smith, N. P., and Kierspe, G. H. "Local Energy Exchanges in a Shallow, Coastal Lagoon: Winter Conditions." (See complete entry in Section VI.)
- Smith, R. "Effect of Salt Upon Hot-Water Dispersion in Well-Mixed Estuaries." (See complete entry in Section III.)
- Smith, T. J. "On the Representation of Reynolds Stress in Estuaries and Shallow Coastal Seas." (See complete entry in Section VI.)

- Smith, T. J., and O'Connor, B. A. "A Two-Dimensional Model for Suspended Sediment Transport." (See complete entry in Section VI.)
- Sorensen, R. M. 1980. "The Corps of Engineers General Investigation of Tidal Inlets," <u>Proceedings, Seventeenth Coastal</u> Engineering Conference, March 23-28, 1980, Sydney, Australia ASCE, III:2565-2580.

During the past decade, the US Army Corps of Engineers has been conducting a General Investigation of Tidal Inlets (GITI). The GITI was an applied research program through which a wide range of inlet phenomena relating to Corps responsibilities for coastal navigation and recreation, prevention of beach erosion, and control of coastal flooding were investigated. The program was managed by the US Army Coastal Engineering Research Center (CERC); specific research projects were conducted by CERC, the US Army Engineer Waterways Experiment Station (WES), private consultants, and universities. The various GITI research efforts can be divided into five categories: (a) field studies of the hydraulics and sedimentary dynamics of selected inlets, (b) analysis of historic field data, (c) numerical models of inlet hydraulics, (d) movableand fixed-bed physical inlet models, and (e) other miscellaneous inlet studies. Research results are being published in a special report series. The number, title, author, and date of each report are listed in the Appendix - GITI Reports. The intent of this paper is to summarize GITI research efforts and, based on key results of this research as well as recent Corps field experience, to recommend new areas for research. References (7 items).

Soulsby, R. L. 1980. "Selecting Record Length and Digitization Rate for Near-Bed Turbulence Measurements," <u>Journal of</u> <u>Physical Oceanography</u>, 10(2):208-219.

Measured values of turbulence parameters (such as mean, variance, or covariance of velocity) depend on the record length and digitization rate chosen for their computation. The following six factors, governing the accuracy of the measurements, are discussed in the context of the tidal bottom boundary level in Start Bay, southwest England: loss of low- and highfrequency contributions, stationarity, statistical variability, sensor response, and size of data set. Estimates of the errors associated with the factors, which are of general validity for the tidal bottom boundary layer, are presented and their differing relative importance for different turbulence parameters discussed. Methods of compensating for some of the sources of error are suggested. The six factors produce conflicting requirements for record length and digitization rate.

so a compromise must usually be made based on a tradeoff of the calculated errors associated with each factor. References (27 items).

Soulsby, R. L., and Dyer, K. R. 1981. "The Form of the Near-Bed Velocity Profile in a Tidally Accelerating Flow," Journal of Geophysical Research, 86(C9):8067-8074. In a time-dependent turbulent flow, the near-bed velocity profile departs from the usual logarithmic profile. This is an effect of acceleration. An acceleration length, Λ , defined by the ratio of $u_{\pm}|u_{\pm}|$ to du_{\pm}/dt , is a measure of the thickness of a layer in which the acceleration effect is much smaller than the friction effect. The authors introduce another parameter, γ . $\gamma |u_{\#}|$ may be interpreted as the average propagation velocity of eddies. To the first-order approximation, the velocity profile consists of two parts the usual logarithmic term and the modification, a term linearly proportional to the vertical distance from the bottom, $z/\gamma \Lambda$. Field measurements were carried out in bays in depth of 14 m and 17 m. Apparent values of von Karman's constant, κ , friction velocity, $u_{{\bm w}}$ and bed roughness length, z_0 obtained by the usual method from the field data should be corrected by taking the effect of $-z/\gamma\Lambda$ into consideration. It is found that both u_{*} and z_{o} are underestimated (overestimated) in an accelerating (decelerating) current. The value of K decreases slightly with increasing boundarylayer-thickness-to-roughness-length ratio.

- Spaulding, M. L. "A Vertically Averaged Circulation Model Using Boundary-Fitted Coordinates." (See complete entry in Section VI.)
- Stacey, M. W. 1984. "The Interaction of Tides with the Sill of a Tidally Energetic Inlet," <u>Journal of Physical Oceanography</u>, 14(6):1105-1117.

The interaction of the tides with the sill of a tidally energetic inlet, Observatory Inlet, British Columbia, is studied. Because of temporal variations in the stratification of the inlet, a substantial seasonal variation is observed in the power withdrawn from the barotropic tide. Vigorous, nonlinear, internal motions occur in the region of the sill, but most of the withdrawn tidal power is fed into a progressive, linear internal tide. The first two modes, which contain almost all of the energy, respond very differently to changes in stratification. The energy flux of the first mode is insensitive to changes in surface stratification but increases dramatically as a result of deep water renewal. The energy flux of the second mode exhibits the reveise behavior, being insensitive to the occurrence of

deep water renewal but being a strong positive function of the surface stratification. Even though the inlet has a distinct surface layer in summer and appears to be a two-layer system, the second mode contains almost as much power as the first, a characteristic not indicative of simple two-layer flows. The nonlinear sill processes induce a significant baroclinic flow at the beat frequency of the M. and S₂ tides. This flow is most vigorous near the surface of the inlet where it is greater in magnitude than the M₂ barotropic current. References (9 items).

- Stark, K. P. "Simulation and Probabilities of Tide and Cyclonic Storm Surges." (See complete entry in Section VI.)
- Stephens, H. S., and Stapleton, C. A., ed. 1981. Papers Presented at the Second International Symposium on Wave and Tidal Energy, September 23-25, 1981, Cambridge, England, BHRA Fluid Engineering, Cranfield, Bedford, England.

The conference includes sessions on wave power, tidal power, air turbines, and barrages with case studies. References are included at the end of each paper.

- Sternberg, R. W., et al. "Aquatic Disposal Field Investigations, Columbia River Disposal Site, Oregon; Appendix A: Investigations of the Hydraulic Regime and Physical Nature of Bottom Sedimentation." (See complete entry in Section V.)
- Stigebrandt, A. 1981. "A Mechanism Governing the Estuarine Circulation in Deep, Strongly Stratified Fjords," <u>Estuarine,</u> <u>Coastal and Shelf Science</u>, 13(2):197-211.

The estuarine circulation in deep, strongly stratified fjords is discussed. It is argued that a two-layer description of the stratification in the fjord is correct in very wide fjords (wide compared to the width of the mouth) and possibly also in narrow fjords with high runoff and/or weak mixing. A theory for the thickness and the salinity of the brackish layer in a wide fjord was earlier developed by the present author (and published in Swedish, 1975) and it is presented here. Among other findings in that theory we may mention that the thickness of the brackish layer is primarily determined by the internal hydraulic control for high specific runoff (runoff/unit horizontal surface area of the fjord) and weak mixing. In the other extreme, with low specific runoff and strong mixing, the thickness of the brackish layer is found to be proportional to the Monin-Obukhov length. The circulation in not very wide fjords is also discussed. It is found that recirculation in the brackish layer may be expected whereby a two-layer description of the flow field breaks down at least

locally. A critical Rayleigh number that seems to control the recirculation of brackish water within the fjord is found. A theory for the density difference between the mouth and the head in the brackish layer in the fjord is developed from the critical Rayleigh number condition. It is found that this density difference normally is proportional to the density difference between the brackish water at the mouth and the underlying seawater provided that the river runoff is not too heavy and/or the mixing is not too weak. This prediction is confirmed by extensive measurements from the Nordfjord. References (16 items).

Stigebrandt, A. 1980. "A Mechanism tnat Regulates the Mean Longitudinal Density Gradient in the Brackish Layer in Fjords with Topographical Control at Their Mouths," Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:105-117.

The estuarine circulation in deep fjords is discussed. It is argued that a twolayer description of the stratification in the fjord may be adequate in very wide fjords (wide compared to the width of the mouth) and, possibly, also in narrow fjords with high runoff and/or weak mixing. The circulation in narrow fjords with lower runoff and/or stronger mixing is discussed. It is found that recirculation in the brackish layer may be expected whereby a two-layer description of the flow becomes incorrect at least locally. A hydraulic theory for the density difference between the mouth and the head in the brackish layer is developed. This density difference is found to be proportional to the density difference between the brackish water at the mouth and the underlying seawater. This prediction is very nicely confirmed by extensive measurements from the Nordfjord. References (9 items).

Stigebrandt, A. 1980. "Some Aspects of Tidal Interaction with Fjord Constrictions," Estuarine and Coastal Marine Science, 11(2):151-166.

Tidal interaction with fjord constrictions is discussed. Two typical cases are thoroughly analyzed. The first is the socalled tidal choking problem where the effect of vertical stratification is insignificant. In the second case, the influence of vertical stratification is crucial and the forcing barotropic tide generates internal waves at the constriction (a sill in this case). Some theoretical gaps in the field of tidal interaction with fjord constrictions are filled. First, a theory for tidal choking in a fjord with freshwater runoff is presented. A table is given which can be used for a guick determination of tidal cheking offects in

almost any fjord. Second, a simple theory for internal wave generation by tides in a linearly stratified fjord is developed. The predictions are compared with measurements from the Herdlafjord (from Fjeldstad) with encouraging results. References (18 items).

- Suga, K. "Field Phenomena of Salt-Wedge and Features of Internal Vortex." (See complete entry in Section III.)
- Sündermann, J., and Elahi, K. Z. "Constructional Effects on the Dynamical Processes in a Tidal Inlet." (See complete entry in Section VI.)
- Sündermann, J., and Holz, K.-P., ed. 1980. <u>Mathematical Modelling of Estuarine Phy-</u> <u>sics, Lecture Notes on Coastal and Estu-</u> <u>arine Studies</u>, Vol. 1, Springer-Verlag, New York.

Mathematical Modelling of Estuarine Physics is the first volume in the new series Lecture Notes on Coastal and Estuarine This volume was derived from Studies. contributions made at the Symposium on Mathematical Modelling of Estuarine Physics held at Hamburg, August 1978. Contents: "Basic Hydrodynamics and Thermodynamics," by W. Krauss, References (8 items); "Mathematical Modelling of Turbulence in Estuaries," by W. Rodi, References (18 items); "Fundamental Principles for Numerical Modelling," by M. B. Abbott, References (2 items); "Application of Finite-Difference Methods to Estuary Problems," by C. B. Vreugdenhil, References (15 items); "Finite Elements, A Flexible Tool for Modelling Estuarine Processes,' by K.-P. Holz, References (13 items); "Mathematical Modelling of Fluid Flow Using the Boundary Element Method," by C. A. Brebbia and L. C. Wrobel, References (7 items); "Spectral Method for the Numerical Solution of Three-Dimensional Hydrodynamic Equations for Tides and Surges," by N. S. Heaps, References (11 items); "On the Formation of Salt Wedges in Estuaries," by E. Maier-Reimer, References (9 items); "On Currents in the German Bight," by J. Backhaus, References (5 items); "Tide-Induced Residual Flow," by J. van de Kreeke, References (10 items); "Simulation of Tidal River Dynamics," by K.-P. Holz, References (6 items); "Analysis of Tide and Current Meter Data for Model Verification," References (5 items); "Mathematical Modelling of Tidal Flats: A Few Remarks," by H. Holsters, References (7 items); "On Storm Surge Phenomena," by M. Laska, References (25 items); "Meterological Problems Associated with Numerical Storm Surge Prediction," by E. Roeckner, References (6 items); "A Coastal Ocean Numerical Model," by A. F. Blumbers and G. L. Mellor, References (15 items); "Modelling

and Verification of Circulation in an Arctic Barrier Island Lagoon System - An Ecosystem Process Study," by J. B. Matthews, Reference (1 item); "Salinity Intrusion Models," by K. Fischer, Reference (12 items); "A Point of View: Physical Processes on the Continental Shelf and Their Implications for Numerical Circulation Models," by C. N. K. Mooers; "Ob-" servations of Continental Shelf Circulations and Their Relation to Model Verification and Application." by B. Magnell: "Mathematical Models of Sediment Transport in Canalised Estuaries," by J. G. Rodger, References (9 items); "Numerical Modelling of Sediment Transport in Coastal Waters, by J. Sündermann and W. Puls, References (11 items).

Sündermann, J., Vollmers, H., and Berndt, D. 1978. "Protection Against Storm Surges in a Tidal River," <u>Proceedings, International</u> <u>Conference on Water Resources Engineering,</u> Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:465-476. Due to its geographical position, the German North Sea coast is often afflicted by heavy storm surges. This is true above all for the Elbe River, on which the main German port of Hamburg is situated. In the flood disaster of 1962, more than 300 people were killed. In the following years the dike line was shortened by damming up lateral tidal flats. However, the extremely high storm surges of 1976 have given rise to the assumption that the damming up has also a negative consequence: a higher rising and a faster propagation of the flood wave in the narrowed crosssection area. Therefore, a study program is being carried out to examine the relation between lateral geometrical and hydrodynamical changes in a tidal river, and also in view of further constructions. The study is performed by two models: a mathematical and a hydraulic one. References (4 items).

- Sündermann, J., Vollmers, H., and Puls, W. "The Influence of Dune and Flow Parameters on the Friction Factor." (See complete entry in Section VI.)
- Svasek, J. N., and Versteegh, J. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries." (See complete entry in Section VI.)
- Swakon, E. A., Jr., and Wang, J. D. "Modeling of Tide and Wind Induced Flow in South Biscayne Bay and Card Sound." (See complete entry in Section VI.)
- Swenson, E. M., and Chuang, W.-S. "Tidal and Subtidal Water Volume Exchange in an Estuarine System." (See complete entry in Section VIII.
- Swift, M. R. "Spatially Varying Turbulence Production in Tidal Channels." (See complete entry in Section VI.)
- Swift, M. R., and Brown, W. S. "Distribution of Bottom Stress and Tidal Energy Dissipation in a Well-Mixed Estuary." (See complete entry in Section VIII.)
- Therriault, J. C., Ladurantaye, R. de, and Ingram, R. G. "Particulate Matter Exchange Across a Fjord Sill." (See complete entry in Section II.)
- Thimakorn, P., and Gupta, A. D. "Concentration of Suspended Clay in Tidal Estuary." (See complete entry in Section II.)
- Thompson, R. O. R. Y. "Low-Pass Filters to Suppress Inertial and Tidal Frequencies." (See complete entry in Section VII.)
- Timmerman, H. 1979. "Forecasting Meteorological Effects on Water Levels on a Routine Basis with a Numerical Model," <u>Deutsche Hydrographische Zeitschrift</u>, 32(5):190-203.

In this article the suitability of a numerical model for forecasting the meteorological effects on water levels at the five main Dutch gage stations is investigated. Mean values and standard deviations of differences between observed and forecast meteorological effects during high and low tide for different forecast periods were determined for the period 1 October 1977 to 1 April 1978, and compared with persistence, i.e., a previously observed setup. Since the skill of the model highly depends on its behavior under extreme conditions, a selection was made of those cases with a considerable meteorological effect (12 dm or more at Vlissingen, Hoek van Holland and Den Helder, 15 dm or more at Harlingen and Delfzijl); and this selection was studied as well. Examining the persistence, it turned out that the observed meteorological effect is also influenced by inaccuracies in the tidal values. The skill of the model appeared to be satisfactory, especially when used as a warning system 12 to 24 hours in advance. References (11 items).

- Tocker, P. "Stop Father Thames Flooding." (See complete entry in Section V.)
- Trawle, M. J. "Effects of Depth on Dredging Frequency; Report 2, Methods of Estuarine Shoaling Analysis." (See complete entry in Section V.)
- Trump, C. L. "A Current-Induced Ekman Spiral in the St. Lawrence Estuary." (See complete entry in Section VIII.)

- Tucci, C. E. M., and Chen, Y. H. "Unsteady Water Quality Model for River Network." (See complete entry in Section VI.)
- Turner, K. A., and Durham, D. L. "Documentation of Wave-Height and Tidal Analysis Programs for Automated Data Acquisition and Control Systems." (See complete entry in Section VI.)
- Uncles, R. J. "A Note on Tidal Asymmetry in the Severn Estuary." (See complete entry in Section VI.)
- Uncles, R. J. 1984. "Hydrodynamics of the Bristol Channel," <u>Marine Pollution Bulle-</u> <u>tin</u>, 15(2):47-53.

This paper considers tidal and residual currents separately and uses these results to review what is known of the effects of tidal stress on the seabed and on vertical mixing followed by their effects on dispersion of salt and other solutes. References (40 items).

- Uncles, R. J. "Residual Currents in the Severn Estuary and Their Effects on Dispersion." (See complete entry in Section VI.)
- Uncles, R. J., and Jordan, M. B. "A One-Dimensional Representation of Residual Currents in the Severn Estuary and Associated Observations." (See complete entry in Section VI.)
- Uncles, R. J., et al. "Salinity of Surface Water in a Partially-Mixed Estuary, and Its Dispersion at Low Run-off." (See complete entry in Section III.)
- US Army Engineer Division, New England. "Long Island Sound, Thamesville Tidal-Flood Management Water Resources Study, Norwich, Connecticut." (See complete entry in Section V.)
- Unlüata, Ü. A., and Özsoy, E. 1977. "Tidal Jet Flows Near Inlets," <u>Hydraulics in the</u> <u>Coastal Zone, Proceedings, 25th Annual Hy-</u> <u>draulics Division Specialty Conference,</u> <u>Texas A&M University, College Station,</u> <u>Texas, August 10-12, 1977</u>, ASCE, 90-98.

Turbulent jets issuing from tidal inlets during the ebb flows are analyzed, and the effects of bottom friction and onedimensional depth variations are shown to change the jet behavior in a drastic way. Jets on a constant bottom with friction expand in an explosive manner. When the depth increases in the offshore direction, the expansion rate of the jet is greatly reduced. The analytical solutions are verified against field evidence and preliminary experiments. References (11 items).

- Vallianos, L. "Barden Inlet, N.C.: A Case Study of Inlet Migration." (See complete entry in Section V.)
- van de Kreeke, J., and Chiu, A. A. 1981. "Tide-Induced Residual Flow in Shallow Bays," Journal of Hydraulic Research, 19(3):231-249.
- The generation of residual flow is considered. For the computation of the tidal flow, a space-staggered grid is used. This approximation is second order in space, and first order in time. Although it is reported that the finite difference formulation considerably influences the residual flow, alternative difference approximations are not studied. A major topic of the paper is the nature of the secondary boundary condition along boundaries. Taking the velocity component parallel to the boundary equal to zero leads to an inacceptable flow pattern. A zero normal derivative of this velocity component, or treatment by means of backward difference, performs considerably better. The residual flow is calculated by averaging the computed tidal flow over the tidal period. Good agreement with an analytical solution is found. The applications are restricted to problems with very simple geometry.
- van de Ree, W. J., Voogt, J., and Leendertse, J. J. "A Tidal Survey for a Model of an Offshore Area." (See complete entry in Section VII.)
- Vincent, C. L., and Corson, W. D. 1981. "Geometry of Tidal Inlets; Empirical Equations," <u>Journal, Waterway, Port,</u> <u>Coastal and Ocean Division</u>, ASCE, 107(WW1):1-9.

The geometry of tidal inlet ebb shoal, main channel, and cross section is investigated. Formulae interrelating depths, length, and area parameters show a high degree of coherence in inlet geometry, with the cross-sectional area of the inlet a fundamental parameter. References (3 items).

Vongvisessomjai, S., and Srikanthan, R. 1978. "The Regimen of Takuapa Tidal Channel," <u>Proceedings, International</u> <u>Conference on Water Resources Engineering, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:277-295.</u>

Outflow features resulting from the interaction of channel with ocean tide are of importance to engineering works to be undertaken on a channel whose inlet is characterized by sediment flow and tidal flow regimen. The Takuapa channel, located on the west coast of Southern Thailand, is a classic example of a channel experiencing both ocean tide and flows of river sediment as well as sediment derived from tin mining nearby. A comprehensive hydrodynamic and sediment survey was made in the channel and inlet. Analysis was then taken which involved a numerical model, based on the equations of unsteady flow in open channels for computation of the tidal currents at several sections in the channel. The model used an implicit finite difference scheme in its computation. Sediment deposition and erosion were then estimated in the channel at various points from the knowledge of current velocity and characteristics of sediment. The stability of the inlet was also examined by using the simple tidal prism-area relationship and the more fundamental tidal prism-littoral drift ratio. References (10 items).

Vreugdenhil, C. B. 1978. "Application of Finite-Difference Methods to Estuary Problems," Publication No. 209, Waterloopkindig Laboratorium, Delft Hydraulics Laboratory, Delft, The Netherlands. Paper also presented at the Symposium, Mathematical Modelling of Estuarine Physics, August 24-26, 1978, Hamburg, Germany.

Some basic issues must be considered when choosing numerical methods for the study of estuarine physics. Examples are given concerning wave propagation in hyperbolic systems, representation of flow patterns, parabolic systems and the treatment of boundaries, especially fixed walls. Some current research projects will be used to illustrate the above-mentioned subjects: (a) two-layer flow in two horizontal dimensions, to be used, for example, for salt intrusion in an estuary; (b) a vertical two-dimensional model of tidal flow in an estuary, which may or may not take into account density stratification; and (c) a vertical two-dimensional quasi-steady model of suspended sediment transport, to be used, for example, for the study of sedimentation of dredged trenches in a tidal region. References (15 items).

Wada, A., and Miyaike, Y. 1978. "Characteristics of Circulation in Bay Waters due to Wind Action," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2730-2745.</u>

This report concerns investigations into the three-dimensional mechanism of flow motion in the seawater of Mikawa Bay for the purpose of elucidating the effect of wind, tidal current, and topographical features on oceanic environmental fluctuations among factors related to the diffusion process in the bay. On the assumption that dynamics of the bay water would be affected by the tidal currents and the flow caused by the wind, a numerical simulation analysis of the flow motion phenomenon in the bay water was conducted on

the basis of the meteorological and oceanographical observation data collected at the points in the investigated sea region, so as to examine the circulation mechanism of the bay water caused by the abovementioned factors. As the results of the simulation analysis by the numerical models, large-scale eddies caused by the tidal reciprocating current as well as the constant current as the tidal residual current can be seen in the bay. Also, in the winter when the distribution of atmospheric pressure is stable, some circulation currents are formed in the bay by the wind-generating current. Accordingly, it is considered that the formation of these currents has a considerable effect on the diffusion characteristics of substances in the bay. References (3 items).

Wadsworth, J. R., Jr. 1980. "Geomorphic Characteristics of Tidal Drainage Networks in the Duplin River System, Sapelo Island, Georgia," Ph. D. Dissertation, University of Georgia, Athens.

A highly detailed drainage map, prepared from tide-controlled, color infrared aerial photography, was used to study geomorphology of tidal drainage networks in the Duplin River system, Sapelo Island, Georgia. Four principal drainage types were distinguished through intrasystemic variation in drainage density and channel reticulation: discrete, dense semidiscrete, sparse semidiscrete, and reticulated. In addition, five important anomalous drainage types were recognized locally: pirated and underfit streams and ponded, annular, and complex drainage. Dense semidiscrete drainage undergoes rapid headward erosion and network extension, and channels gradually become interconnected, forming reticulated drainage. Low rates of general surficial sedimentation and rapid lateral migration promote reticulated drainage through retention of pirated channels. Relatively high rates of storm-related sedimentation in the seaward end of the Duplin yield locally higher slopes and development of discrete drainage. Infrequent tidal flooding and high permeability characteristic of the high marsh subervironment produce sparse semidiscrete drainage. Although in general the Duplin system is youthful, extensive areas of reticulated drainage are in equilibrium with the environment and are not evolving. Testing of characteristic fluvial geomorphic relationships against data for discrete drainage in the Duplin system reveals important differences between the two systems, largely resulting from bidirectional flow, environmental nonuniformity, and rapid episodic deposition in the discrete drainage zone.

Wadsworth, J. R., Jr. 1981. "Structural Control of Drainage Morphology of Sait

Marshes on St. Catherine's Island, Georgia," Technical Report 82-1, Department of Geology, University of South Florida, Tampa.

The purpose of this study was to identify the effects of structural control exerted by relict Holocene beach ridges on morphology of tidal drainage networks on St. Catherine's Island, Georgia. Like many barrier islands on the Georgia coast, St. Catherine's consists of a core of Pleistocene material, surrounded by an extensive series of Holocene salt marshes and relict beach ridges. These marshes are very dynamic sedimentary systems, and have extensive and intricate drainage networks that are constantly changing through processes of lateral migration, stream capture, and channel blockage and fill. The extent and manner in which these processes operate depend upon such regional variables as tidal range, climate, and sediment type, as well as upon many local influences. Among the most significant local influences affecting the development of tidal drainage morphology is structural control. Only when the effects of this control have been evaluated is it possible to interpret the true response of drainage morphology to regional variables and to make legitimate comparisons between the tidal drainage morphologies of widely separated localities. Effects of local structural control on salt marsh drainage networks on St. Catherine's Island were studied using photogrammetric methods along with field investigation and topographic analysis. Initial topographic analysis was used to check the validity of the photogrammetric approach, and to help select morphologic variables for subsequent measurement. Aerial photography of the study area was examined, and measurements describing the morphology of several tidal drainage networks were made. field investigation was used to check photo identification of drainage features and provided close-up observation of some specific control mechanisms. References (22 items).

- Walters, R. A. "Low-Frequency Variations in Sea Level and Currents in South San Francisco Bay." (See complete entry in Section VIII.)
- Walters, R. A., and Cheng, R. T. "A Two-Dimensional Hydrodynamic Model of a Tida! Estuary." (See complete entry in Section VI.)
- Walters, R. A., and Heston, C. "Removing Tidal-Period Variations from Time-Series Data Using Low-Pass Digital Filters." (See complete entry in Section VIII.)
- Walther, A. W. 1980. "Hydraulic Research in the Oosterschedle Estuary." <u>Proceedings, Seventeenth Coastal Engineering</u>

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Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2360-2376.

In 1974 a major policy change was made to the Delta plan to close the Oosterschelde (East Scheldt). For ecological reasons it was decided to replace the originally planned barrier dam with a storm surge barrier. This could be opened to allow normal tidal movement or closed during storm surges. Instead of complet-ing the dam in 1978, the new structure would be finished in 1985. The vertical tidal movement in the estuary would be reduced to about 80 percent of the original tidal range, while under storm surge conditions the storm surge barrier (with a cross-sectional area of about 15,000 sq m) could be closed, thus serving both ecology and safety at the same time. This new concept required a large number of new investigations in coastal engineering and soil mechanical fields. This paper gives a general description of some of the hydraulic investigations. References (7 items).

- Walton, R., Granat, M. A., and Shubinski, R. P. "Calibrating the Chesapeake Bay Circulation Model?" (See complete entry in Section VI.)
- Wang, Y.-H. "Satellite Applications on a Coastal Inlet Stability Study." (See complete entry in Section VII.)
- Ward, G. H., Jr. "Pass Cavallo, Texas; Case Study of Tidal-Prism Capture." (See complete entry in Section V.)
- Ward, L. G. "Hydrodynamics and Sediment Transport in a Salt Marsh Tidal Channel." (See complete entry in Section II.)
- Weggel, J. R., Roberts, J., and Hagar, J. "Wave Action on the Savannah Tide Gates." (See complete entry in Section V.)
- Welch, J. M., and Parker, B. B. 1979. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina," NOAA Technical Report No. 80, National Oceanic and Atmospheric Administration, Rockville, Md.

The results from the harmonic analysis of the data from tide and current stations in the lower Cape Fear River are presented in the form of tables, cotidal and corange charts, and charts illustrating the relationships among various harmonic constituents. Salinity and temperature data are presented in the form of contours of longitudinal transects and time series stations covering full tidal cycles. Instrumentation, data products, and the various methods of analysis are described. The implications from the results of the various methods of analysis of the circulation and hydrodynamics of the lower Cape Fear River are discussed. A simple one-dimensional model is presented to help describe the tidal hydrodynamics of a long, narrow estuary. The nontidal rise and fall of the water surface of the river as a result of the meteorological forces of wind and barometric pressure are discussed. National Ocean Survey historical data, a physical description of the area, and approximate values of transport through several cross sections are given. It has been concluded that the tidal wave in the Cape Fear River is close to being a pure damped progressive wave with a partial reflection in the narrowing channel around Wilmington, N.C. The considerable amount of dredging that has taken place in the past 100 years has resulted in significant physical parameter changes. The flow regime in the Cape Fear River is the result of gravitational effects caused by salinity intrusion, freshwater riverflow, the river bathymetry, and channel structure. Salinity data indicate that the river changes from being partially mixed vertically to well mixed vertically as one progresses up the river. References (19 items).

West, J. R., Knight, D. W., and Shiono, K. 1984. "A Note on Flow Structure in the Great Ouse Estuary," <u>Estuarine, Coastal</u> <u>and Shelf Science</u>, 19(3):271-290.

Field measurements of vertical profiles of velocity and salinity along with turbulence measurements have been used to examine the effect of density gradients on the flow structure in the Great Ouse estuary. During the flood tide, shear and longitudinal density gradients cause well-mixed conditions in the lower part of the water column. In the upper part of the water column, secondary flow effects induced by transverse density gradients, and acceleration effects can contribute to the formation of stable vertical density gradients. On the ebb tide, the vertical density gradient appears to be the dominant factor which determines the structure of the flow. The velocity and shear stress data show the evidence of large-scale motions which are consistent with the postulated flood and ebb flow structures. References (21 items).

Whalin, R. W. "Los Angeles Harbor and Long Beach Harbor: Plan of Study." (See complete entry in Section VI.)

Whalin, R. W. "Los Angeles Harbor and Long Beach Harbor: Summary of Results and Future Plans." (See complete entry in Section VI.)

Wilkinson, D. L. "Periodic Flows from Tidal Inlets." (See complete entry in Section VI.)

- Williamson, A. N. "Movement of Suspended Particles and Solute Concentrations with Inflow and Tidal Action." (See complete entry in Section VIII.)
- Winterwerp, J. C. "Decomposition of the Mass Transport in Narrow Estuaries." (See complete entry in Section III.)
- Wiseman, W. J., Jr. "Hypersaline Bottom Water: Peard Bay, Alaska." (See complete entry in Section III.)
- Wong, K.-C. 1981. "Subtidal Volume Exchange and the Relationship to Atmospheric Forcing in Great South Bay, New York," Ph. D. Dissertation, Marine Sciences Research Center, State University of New York, Stony Brook.

Great South Bay is a very shallow barbuilt estuary located on the south shore of Long Island, N.Y. The bay communicates with the adjacent shelf waters through a total of five inlets. Seasonal variations in both the intensity of volume exchange between the bay and the shelf at subtidal frequencies and the relation to local and nonlocal atmosphere forcing are examined through time series analysis of records of sea level, current, wind, and atmospheric pressure. Numerical simulations using a vertically integrated finite element model have provided a quantitative assessment of the characteristics of volume exchange processes at subtidal frequencies within the bay and the partitioning of the total volume flux among each of the inlets. Subtidal sea level fluctuations within the bay are strongly coupled to coastal sea level fluctuations at time scales longer than 3 days during both winter and summer. During the winter, coastal Ekman forcing induced by longshore wind stress is the most important mechanism for producing subtidal fluctuations in coastal sea level; the variance in sea level is confined to time scales longer than 3 days. The inverted barometer effect accounts for approximately 25 percent of the variance in coastal subtidal sea level in the winter, and it tends to counteract coastal Ekman effect at time scales longer than 5 days. During the summer, the wind stress is less stationary, and the response of coastal sea level to wind forcing is more complex. The inverted barometer effect accounts for approximately 30 percent of the variance in

coastal sea level; it tends to counteract Ekman forcing at time scales between 3 and 7 days and reinforces Ekman forcing at time scales longer than 7 days. The intensity of subtidal sea level fluctuations is much higher in the winter than in the summer due primarily to the overall increase in the variance of wind stress during the winter. The intensity of the subtidal volume exchange between the bay and the shelf during the winter is higher than during the summer, especially at time scales between 2 and 10 days where the variance in total subtidal volume flux in winter is more than double of that in summer. References (38 items).

Wong, K.-C., and Wilson, R. E. 1979. "An Assessment of the Effects of Bathymetric Changes Associated with Sand and Gravel Mining on Tidal Circulation in the Lower Bay of New York Harbor," Special Report 18, Marine Sciences Research Center, State University of New York, Stony Brook.

Present sand and gravel mining operations within the Lower Bay of New York Harbor are restricted to the east bank of Ambrose Channel and to the vicinity of Chapel Hill North Channel because of the concern that mining in other areas might adversely affect water quality and shore erosion. part of an evaluation of environmental effects associated with expanded sand and gravel mining, the authors have simulated numerically tidal circulation patterns and tidal elevations in Lower Bay for a number of altered bathymetries corresponding to hypothetical mining operations. Results suggest that tidal currents will decelerate over the mined region and accelerate outside of them, and that the tidal stream will be deflected towards the region. It is also clear that the mining near the mouth of the bay could increase tidal range along Staten Island substantially. References (6 items).

- Wood, T. "Discrete-Time Modelling of Dispersion in Estuaries." (See complete entry in Section VI.)
- Yakuwa, I., Takahashi, S., and Ohtani, M. "Behaviors of the Salt Wedge and the Salinity Distribution at Estuaries." (See complete entry in Section III.)
- Yoshida, S. "Mixing Mechanisms of Density Current System at a River Mouth." (See complete entry in Section III.)

SECTION II. SEDIMENTATION

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Sources, identification, transportation, deposition, flocculation, and physical and chemical properties of sediment found in tidal waterways. The upland river is excluded unless specifically concerned as a source and agent of transport of tidal sediment.

- Aston, S. R., and Stanners, D. A. "Americium in Intertidal Sediments from the Coastal Environs of Windscale." (See complete entry in Section IV.)
- Aston, S. R., and Stanners, D. A. "Gamma Emitting Fission Products in Surface Sediments of the Ravenglass Estuary." (See complete entry in Section IV.)
- Aston, S. R., and Stanners, D. D. "The Transport to and Deposition of Americium in Intertidal Sediments of the Ravenglass Estuary and its Relationship to Plutonium." (See complete entry in Section IV.)
- Aston, S. R., et al. "Plutonium Occurrence and Phase Distribution in Sediments of the Wyre Estuary, Northwest England." (See complete entry in Section IV.)
- Baliga, B. R., and Hudspeth, R. T. "Evaluation of Sand Waves in an Estuary." (See complete entry in Section IV.)
- Bartholdy, J. "Transport of Suspended Matter in a Bar-Built Danish Estuary." (See complete entry in Section VI.)
- Bohlen, W. F. "Factors Governing the Distribution of Dredge-Resuspended Sediments." (See complete entry in Section VIII.)
- Bohlen, W. F., and Marine Sciences Department, University of Connecticut. 1980.
 "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events," <u>Proceedings, Seventeenth Coastal Engineering Conference,</u> <u>March 23-28, 1980, Sydney, Australia,</u> ASCE, II:1700-1707.

Field observations indicate that the effect of dredge-induced resuspension on sediment transport within small estuaries is generally negligible in comparison to the transport induced by natural storm events. Data obtained in the Thames River, near New London, Connecticut, show dredge-induced resuspension to be essentially a near field phenomenon. The resultant plume of material increases total suspended load in the river by approximately 25 percent but extends over less than 2.5 percent of the total estuarine area. In contrast, storms are observed to increase total suspended load by a factor of three, influencing concentration levels throughout the estuary. These factors, in combination with the lower frequency of dredging vis-a-vis significant storm events, appear to effectively limit the influence of dredge-induced resuspension. References (4 items).

Bottin, R. R., Jr., and Earickson, J. A. "Buhne Point, Humboldt Bay, California, Design for the Prevention of Shoreline Erosion; Hydraulic and Numerical Model Investigations." (See complete entry in Section VI.)

Boyden, C. R., Aston, S. R., and Thornton, I. 1979. "Tidal and Seasonal Variations of Trace Elements in Two Cornish Estuaries," <u>Estuarine and Coastal Marine</u> <u>Science</u>, 9(3):303-317.

Tidal and seasonal changes in trace element concentrations have been studied in solution, suspended particulates, and bottom sediments at locations in two Cornish estuaries. Results show that considerable differences in concentrations and behavior of trace elements occur on a tidal and seasonal basis. These differences have been related to the influences of freshwater input from mineralized catchments and discussed in terms of mixing of runoff with saline waters during diurnal and annual cycles. References (13 items).

- Brazier, A., and Strachan, W. V. "Swansea Channel--A Study of Waterways Management." (See complete entry in Section V.)
- Callender, E., and Hammond, D. E. 1982. "Nutrient Exchange Across the Sediment-Water Interface in the Potomac River Estuary," <u>Estuarine, Coastal and Shelf</u> <u>Science</u>, 15(4):395-413.

The flux of ammonia, phosphate, silica and radon-222 from Potomac tidal river and estuary sediments is controlled by processes occurring at the sediment-water interface and within surficial sediment. Calculated diffusive fluxes range between 0.6 and 6.5 mmol m^{-2} day⁻¹ for ammonia, 0.020 and 0.30 mmol m^{-2} day⁻¹ for phosphate, and 1.3 and 3.8 mmol m^{-2} day⁻¹ for silica. Measured in situ fluxés range between 1 and 21 mmol m^{-2} day⁻¹ for ammonia, 0.1 and 2.0 mmol m^{-2} day $^{-1}$ for phosphate, and 2 and 19 mmol m^{-2} day $^{-1}$ for silica. The ratio of in situ fluxes to diffusive fluxes (flux enhancement) varied between 1.6 and 5.2 in the tidal river, between 2.0 and 20 in the transition zone, and from 1.3 to 5.1 in the lower estuary. The large flux enhancements from transition zone sediments are attributed to macrofaunal irrigation. Nutrient flux enhancements are correlated with radon flux enhancements, suggesting that fluxes may originate from a common region and that nutrients are regenerated within the upper 10-20 cm of the sediment column. The low fluxes of phosphate from tidal river sediments reflect the control benthic sediment exerts on phosphorus through sorption by sedimentary iron oxyhydroxides. In the tidal river, benthic fluxes of ammonia and phosphate equal one-half and one-third of the nutrient input of the Blue Plains sewage treatment plant. In the tidal Potomac River, benthic sediment regeneration

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supplies a significant fraction of the nutrients utilized by primary producers in the water column during the summer months. References (66 items).

<u>Coastal Sediments '77, Fifth Symposium of</u> <u>the Waterway, Port, Coastal and Ocean</u> <u>Division of ASCE</u>, Charleston, South Carolina, November 2-4, 1977, ASCE.

The functional design of structural and nonstructural solutions of shore protection and inlet stabilization is discussed. Among the issues covered are beach fill design; dredging; anticipated and unanticipated effects of coastal structures on adjacent shores; sediment transport under waves; coastal processes and inlets; design and effects of groins on beaches and channels; sand bypass systems at coastal inlets; onshore transport sediment; overwesh hydraulics and sediment response; mathematical predictions of dredging quantities; effectiveness of beach deposit nourishment; effects of jetties; the role of wave reflection in coastal processes; low-cost shore protection; inlet design and offshore breakwaters; beach study techniques; and US Army Corps of Engineers data collection programs. References (811 items).

- Colman, R. S. "The Modification of a Natural Drainage System and the Subsequent Effects on a Small Estuary and its Surrounding Beaches." (See complete entry in Section V.)
- Connell, D. W., et al. "Effects of a Barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland." (See complete entry in Section V.)
- Connolly, J. P., Armstrong, N. E., and Miksad, R. W. "Adsorption of Hydrophobic Pollutants in Estuaries." (See complete entry in Section IV.)
- Czerniak, M. T. 1976. "Engineering Concepts and Environmental Assessment for the Stabilization and Sand Bypassing of Moriches Inlet, New York," Tetra Tech, Inc., Pasadena, Calif.

This report examines the conditions at Moriches Inlet, New York. In recent years, the changing inlet conditions have resulted in the severe erosion of the barrier island and shoaling in some areas of the inlet. Unless action is taken to change conditions at Moriches Inlet, the ecological, economic and recreational resources dependent on the inlet will be jeopardized. The purpose of this study was to develop engineering concepts for the stabilization and sand bypassing of Moriches Inlet, and to provide a preliminary environmental impact assessment of these actions. The study shows that Moriches Inlet can be stabilized against

further rapid change with a minimum of physical alteration. Sand bypassing measures are feasible, but the plan must include provisions for trapping sand on both sides of the inlet. Both beneficial and nonbeneficial environmental impacts would result from these actions, but the resources provided by the inlet will be protected. References (47 items).

- Dennis, W. A., Lanan, G. A., and Dalrymple, R. A. "Case Studies of Delaware's Tidal Inlets: Roosevelt and Indian River Inlets." (See complete entry in Section VI.)
- DeWall, A. E., et al. 1984. "Inlet Processes at Eel Pond, Falmouth, Massachusetts," Miscellaneous Paper CERC-84-9, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report describes a combined office and field study designed to define the causes of a shoaling problem at the entrance to a small craft harbor. The office study consisted of an evaluation of the history of inlet development and an analysis of available wind, current, and wave data. In addition, a one-dimensional numerical model was used to predict stability with varying inlet geometry and the addition of stabilizing structures. Field measurements used in model calibration included water level, current velocity, beach and nearshore sediment samples, bathymetric surveys, and bed form measurements. Inlet hydraulics were found to be dominated by flood tidal flow through Eel Pond into the adjoining Waquoit Bay, causing the pond to act as a sediment sink. Several modifications to the inlet geometry are proposed for reducing inlet shoaling rates. References (32 items).

Drapeau, G., and Fortin, G. 1978. "Tidal Sedimentation in Gros-Cacoura Barton," <u>Proceedings, Sixteenth Coastal Engineering</u> <u>Conference, August 27-Septemter 3, 1978,</u> <u>Hamburg, Germany, ASCE, 11:1981-2000.</u>

The harbor of Gros-Cacoura or the south shore of the St. Lawrence Estuary has been silting at the rate of 3' on year since it was dredged at the depth of 14 m in 1968. Measurements of temperature, salinity, turbidity, current speed, and direction were carried out as well as tortom sampling and reflection seismin profiling. model of suspended sediment transport combines the tidal volumes and the current profiles at the harbor entrance. Furing a period of high turbidity (spring) in the St. Lawrence Estimy, 54.2 tens of suspended sediments entered the barbor during the flood phase, while 4'.' tors were parnied out during the obt these of a semidia-urral tide, leaving 13 1 the contract perts in the barbury The transfer of story of t 18 Mille inder ander inder inner seinen ub inner

suspended sediment load settles in the harbor during one tidal cycle. In September, the turbidity is low in the estuary and the suspended sediment budget in the harbor is four times smaller but the ratio of deposited sediments versus the total quantity of sediments transported in suspension is the same. References (11 items).

- Druery, B. M. "Estuarine Response to Dredging in the Tweed River, Australia." (See complete entry in Section V.)
- Druery, B. M., and Nielsen, A. F. 1980. "Mechanisms Operating at a Jettied River Entrance," <u>Proceedings, Seventeenth</u> <u>Coastal Engineering Conference, March 23-</u> <u>28, 1980, Sydney, Australia</u>, ASCE, III:2607-2626.

Between October 1976 and July 1977, a northern rubble mound jetty was constructed at the mouth of the Hastings River, transforming the entrance from a single- to a double-jettied system. Prior to the jetty construction, the entrance was characterized by the presence of a substantial swash bar (alternatively called an ebb delta marginal shoal), which was a continuous feature over 100 years of hydrographic survey records. However, construction of the northern jetty triggered an unprecedented onshore movement of the swash bar. This movement was well documented by a field monitoring program incorporating hydrosurveys, aerial photographs, tidal gagings, sediment sampling, float tracking, and nearby wave rider buoy information. A semiquantitative model was developed to aid understanding and quantification of the macrosedimentary processes associated with this phenomenon. The model demonstrated that the sudden reduction of the swash bar was due to the disruption of a circulation of sand which had previously aided the dynamic stability of the bar. The quantitative predictions of the model agreed well with subsequent en-trance behavior. The philosophical development of the model and its findings are discussed in detail. In the literature there is a general lack of attempts to quantify the sediment transport relationships between the gross morphologic features of tidal entrances. This paper presents a methodology for assessing the sedimentary process at tidal entrances. References (9 items).

Dyer, K. R. 1984. "Sedimentation Processes in the Bristol Channel/Severn Estuary," <u>Marine Pollution Bulletin</u>, 15(2):53-57.

In view of the small subtidal prism in the estuary above the Holms, it is possible that the system is more or less in balance and that any further sediment input would be deposited outside the Holms. The major sediment supply seems to be of fine-grained material from the rivers, but because of the very high tidal energy, the existing sediments are continually being reworked and redistributed. Any major alteration of the topography or the tidal regime would disrupt this regime. Because of the large quantity of fine sediment in motion and its affinity for pollutants, it is important to understand the processes by which the high concentrations settle, erode and mix. References (29 items).

- Elsinger, R. J., and Moore, W. D. "226Ra and ²²⁸Ra in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze River and Delaware Bay Estuaries." (See complete entry in Section IV.)
- Escoffier, F. F. "Hydraulics and Stability of Tidal Inlets." (See complete entry in Section I.)
- Everts, C. H. 1980. "A Method to Predict the Stable Geometry of a Channel Connecting an Enclosed Harbor and Navigable Waters," Technical Paper 80-6, US Army Coastal Engineering Research Center, Ft. Belvoir, Va.

A desirable design criterion for an enclosed harbor is that the channel connecting it with navigable waters be selfmaintaining. This condition will prevail where sediment movement is negligible, or in the case of moving sediment, where tidal or river discharge is sufficient to maintain acceptable channel dimensions. method to predict the stable configuration of such a channel is presented in this paper. A relationship between stable channel cross-sectional area, crosssectional shape, and bottom elevation of the channel and the water discharge through the channel is determined using the geometric characteristics of nearby natural channels and the hydraulic regimes that sustain those channels. References (8 items).

- Everts, C. H. "Design of Enclosed Harbors to Reduce Sedimentation." (See complete entry in Section V.)
- Falconer, R. A. "Mathematical Model Study of Mass Transport in Harbours." (See complete entry in Section VI.)
- Ferentinos, G., and Collins, M. 1980. "Effects of Shoreline Irregularities on a Rectilinear Tidal Current and Their Significance in Sedimentation Processes," Journal of Sedimentary Petrology, 50(4):1081-1094.

Detailed tidal current information collected in the embayments along the coastline of the central northern Bristol Channel, using both Eulerian and Lagrangian techniques, has demonstrated the existence ard a brown spectral boosted a boosted a boosted boosted and a boosted

of tidally induced eddies. These eddies are considered by the authors to be the result of flow separation downstream of the headlands, due to the interaction between the coastal irregularities and the offshore rectilinear tidal current system. Supplementary tidal current observations. adjacent to the coastal discontinuities in the area under investigation, are indicative of the formation of similar eddies. The tidally induced eddies along the northern Bristol Channel coastline are related to the formation of either mud or sand (sand ridge) deposits, which occur along the coastal boundary. The eddies lead to the deposition of fine-grained material at their center, due to a reduction in the magnitude of the current speed, bed shear stress, and turbulence. The mud deposits are without any relief; therefore, the eddies are the sole mechanism responsible for their formation and maintenance. In contrast, the presence of appreciable relief in the sand deposits (sand ridges) introduces secondary flows and brings other hydraulic mechanisms into play. The fact that the main axes of the sand ridges are subparallel to the tidal flow suggests that Smith's and Huthnance's mechanisms are also operational and therefore enhancing the maintenance and evolution of the sand ridges. Sand ridges in the English Channel which occur off promontories are also related to tidally induced eddies. References (40 items).

FitzGerald, D. M., Fico, C., and Hayes, M. O. 1979. "Effects of the Charleston Harbor, S.C., Jetty Construction on Local Accretion and Erosion," <u>Coastal Struc-</u> <u>tures 79: A Specialty Conference on the</u> <u>Design Construction, Maintenance and Per-</u> <u>formance of Port and Coastal Structures,</u> March 14-16, 1979, Alexandria, Va., ASCE, II:641-661.

The stabilization of a tidal inlet interrupts the natural sediment transport patterns of the ebb-tidal delta and adjacent beaches. The resulting erosionaldepositional changes to both onshore and offshore areas are caused by an adjustment of this system to new hydraulic and wave energy conditions. The morphological changes which have occurred due to jetty construction at Charleston Harbor, S. C., have been caused by the redirection of the main ebb-channel; the confinement of the ebb-tidal currents to the jettied channel causing the transport of sand to deeper waters; the prevention of natural sediment bypassing mechanisms; and a redistribution of wave energy and tidal currents. The ebb-tidal delta and adjacent beaches have responded to these conditions by adding sediment to the updrift barrier and offshore region, accelerating the erosion of the downdrift barrier and redistributing the ebb-tidal delta sediments to the old

channel location and to the barrier island systems to the south. A substantial amount of sediment was deposited in the offshore region downdrift of jetties between 1921 and 1965. The source of this accretion is believed to be sand that has been transported seaward through a secondary ebb-channel located next to the jettied channel. References (30 items).

- Foster, D. N., McGrath, B. L., and Bremner, W. "Rosslyn Bay Breakwater, Queensland, Australia." (See complete entry in Section VI.)
- Gatto, L. W. "Estuarine Processes and Intertidal Habitats in Grays Harbor, Washington; A Demonstration of Remote Sensing Techniques." (See complete entry in Section I.)
- Gibbs, R. J. 1977. "Suspended Sediment Transport and the Turbidity Maximum," <u>Estuaries, Geophysics, and the Environ-</u> <u>ment</u>, National Academy of Sciences, Washington, D.C., 104-109.

The suspended materials that are discharged by rivers into estuaries and oceans transport many pollutants and are the natural material that fills our channels and harbors. From the biological and health viewpoint, the suspended materials are seen as the natural food of the filter feeding organisms; therefore, pollutants can adversely affect many varieties of seafood. References (18 items).

- Giese, E. H. T. "Use of an Estuary Mobile Bed Model to Investigate Natural Sedimentation Processes." (See complete entry in Section V.)
- Gordon, D. C., and Longhurst, A. R. "The Environmental Aspects of a Tidal Power Project in the Upper Reaches of the Bay of Fundy." (See complete entry in Section V.)
- Gourlay, M. R., and Hacker, J. L. 1978.
 "The Interaction Between Fluvial and Tidal Processes in the Pioneer River Estuary," <u>Managing the Coast, Fourth Australian Con-</u> ference on Coastal and Ocean Engineering, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:34-38.

Sedimentological analyses of riverbed samples together with data obtained from surveys and aerial photographs have confirmed that the Pioneer River is actively contributing sediment to the estuary area near Mackay. The sand supplied by the river is redistributed within the estuary by the tidal currents while the gravel remains as an armor layer only disturbed in flood time. Significant changes in the location of both the river mouth and the foreshore south of it are the result of interaction between flood flows and new beach and dune systems constructed by waves and wind from sediments supplied by the river. Mangrove colonization is an essential part of the consequent natural reclamation process. These natural processes in the Pioneer estuary have been modified by engineering works such as training walls, bridges, and their associated embankments. References (5 items).

Greer, M. N., and Madsen, O. S. 1978. "Longshore Sediment Transport Data: A Review," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, II:1563-1576.

Siltation rates anticipated at harbor entrances, in navigation channels, and at inlet structures as well as possible adverse effects caused by these and other coastal engineering constructions are often assessed based on considerations of longshore sediment transport rates. The ability to predict the longshore sediment transport rate is consequently of considerable importance in many coastal engineering problems. The engineering need for an ability to predict longshore sediment transport rates is evidenced by the fact that the development of empirical relationships preceded, by decades, any attempts at rigorous analyses of the mechanics of sediment transport processes in the surf zone. The review emphasizes a critical evaluation of the different methods used for the determination of the longshore sediment transport rate. The assumptions underlying the use of a particular method are discussed and the degree to which these assumptions are violated or not is investigated from the reported data. References (7 items).

Hale, J. 1979. "Emergency Erosion Protection and Contingency Planning for Los Angeles County," <u>Shore and Beach</u>, 47(2):31-34.

After considerable wave damage to shoreline property in the winter of 1978, the County of Los Angeles drew up an erosion contingency plan for protection assistance for private property owners. The program aims to make shoreline statistics available to provide engineers with information about how the beach characteristics vary between seasonal storms. The statistics include the prediction of tides, the monitoring of waves, and the compilation of beach profiles (showing both the maximum and minimum size). References (4 items).

Hales, L. Z. "Erosion Control of Scour During Construction; Report 8, Summary Report." (See complete entry in Section V.)

- Hawley, N. "Intertidal Sedimentary Structures on Macrotidal Beaches." (See complete entry in Section I.)
- Hayes, M. O., Kana, T. W., and Barwis, J. H. "Soft Designs for Coastal Protection at Seabrook Island, S.C." (See complete entry in Section VIII.)
- Heathershaw, A. D., Carr, A. P., and Blackley, M. W. L. 1981. "Swansea Bay (SKER) Project, Topic Report 8; Coastal Erosion and Nearshore Sedimentation Processes," Report No. 118, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

This is the final report in a series describing the results of a research project to study the sedimentation regime in Swansea Bay in relation to the erosion of sand on the foreshore. Previous reports have treated various aspects in detail; this one attempts to give a broad overview and to draw conclusions of wider relevance. Thus the report falls into two parts, the first dealing with purely regional aspects of the sediment circulation pattern and budget in Swansea Bay, and the second concerned with those aspects of the study which are of more general scientific interest and relevance to the coastal engineering community and which have a bearing on coastal erosion processes in general. References (68 items).

- Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations and Their Response to Meteorological Conditions." (See complete entry in Section I.)
- Heathershaw, A. D., and Hammond, F. D. C. 1979. "Swansea Bay (SKER) Project, Topic Report 6; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data," Report No. 93, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

Measurements of sediment transport rates and circulation patterns in Swansea Bay are given. The relative magnitudes of suspended and bed-load transport are determined with the aim of identifying the processes involved in this transport. References (54 items).

Helwick, S. J., and Bryant, W. R. 1977. "Geology and Geotechnical Characteristics of Sediments in East Bay Area, Mississippi Delta," <u>Marine Geotechnology</u>, 2:161-175.

Deltaic sedimentation has produced an accumulation of clay and silt with a maximum thickness of 90 m in East Bay area. Sediments in the upper 50 m grade from interbedded sand, silt, and clay near South Pass and Southwest Pass to predominantly - X COR - EXECTED - XXXXX - XXXXX - XXXXX - XXXXX

clay in the central part of the area. The variation in the types of sediments and rates of deposition greatly affected the engineering properties of these deposits. Sediments from boreholes in the central part of the area have shear strengths of less than 10 kPa to a depth of at least 50 m. Near the distributaries, shear strength increases with depth; values as high as 43 kPa were measured in sediments in the upper 50 m. These sediments are generally stronger and coarser, and have a lower water content and liquid limit than do sediments at comparable depths in the central part of the area. References (8 items).

- Higgs, K., Treloar, P. D., and Lawson, N. V. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Prototype Data in Botany Bay." (See complete entry in Section V.)
- Hodgson, R. T., Pettibone, B., and Sullivan, S. M. 1978. "Siltation Study of Humboldt Bay Marina, California," Shore and Beach, 46(1):21-27.

The salinity of the studied area is neither vertically mixed nor highly stratified, implying that it is a partially mixed estuary. The predominant water motion in the area is tidal. Flow predominance calculations show (a) the zone of no net movement approached the bottom at the furthest station upstream, an area which does appear to be subject to rapid sedimentation; and (b) a flood channel exists between Daby Island and the mainland. The sediment which reaches Eureka Channel from Eureka Slough may be transported into Arcata Bay through this flood channel. Therefore, the sedimentation rate of Eureka Channel should be relatively low. The continual maintenance of depth by Eureka Channel, as compared to Eureka Slough, without the influence of dredging supports this hypothesis. References (13 items).

- Hubbard, D. K., Oertel, G., and Nummedal, D. "The Role of Waves and Tidal Currents in the Development of Tidal-Inlet Sedimentary Structures and Sand Body Geometry: Examples from North Carolina, South Carolina, and Georgia." (See complete entry in Section I.)
- Hurtt, A. C., and Quinn, J. G. 1979. "Distribution of Hydrocarbons in Narragansett Bay Sediment Cores," Environmental Science & Technology, 13(7):829-836.

Twenty cores were analyzed to provide data on the distribution of sedimentary hydrocarbons from various areas of Narragansett Bay. There was a decrease in surface (0-5 cm) sediment hydrocarbons from the Providence River to the mouth of the bay and the concentrations also decreased with

depth in the cores, generally levelling off at 20-25 cm. This depth is probably related to increased petroleum utilization at the end of the 19th century. Several areas of the bay showed increasing hydrocarbons with depth, but the exact cause of this phenomenon could not be determined. The results of this study indicate that the major source of anthropogenic hydrocarbons in bay sediments is the Providence River. These compounds are introduced into the bay via tidal transport of suspended material from the river and undergo gradual sedimentation throughout the estuary. References (27 items).

- Indlekofer, H. "On Numerical Stability of One-Dimensional Sediment Transport Models for Unsteady and Tidal Flows." (See complete entry in Section VI.)
- Jain, S. C. "Movable-Bed Tidal Inlet Model." (See complete entry in Section VI.)
- Jenkins, S. A., Inman, D. L., and Bailard. J. A. "Opening and Maintaining Tidal Lagoons & Estuaries." (See complete entry in Section VI.)
- Jones, G. 1981. "Effects of Dredging and Reclamation on the Sediments of Botany Bay." Australian Journal_of Marine and Freshwater Research, 32(3):369-377.

Bottom sediments in Botany Bay were surveyed and analyzed for particle size using a wet-sieving volumetric determination. Sediments are predominantly clean sands, although substantial changes in sediment type have occurred in the northern region of the bay since 1968. Large areas which were formerly clean sand now contain significant amounts of mud. This increase in fine sediments is particularly marked in the dredged areas protected by the Port Botany revetment and the Kingsford-Smith Airport runway extension. These changes have not been the result of exposure by dredging of silt and clay lenses within the underlying sediments, but have probably been caused by the combined effects of deposition of fine material discharged during dredging and reclamation and increased deposition of fluvial suspended matter due to changes in tidal circulation following the development of port and airport facilities. Sediments in the Port Botany harbor area are expected to become progressively more muddy. Water turbidity in turn may increase as a result of resuspension of fine material by shipping movements. References (8 items).

Kai, Y. 1980. "Some Aspects of Coastal Engineering Research Works in China," Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, II:1735-1741.

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A brief description is presented of research on the sedimentation of harbors along silty and sandy coasts as well as research on estuary regulation and wave protection.

- Kawahara, M. "Periodic Finite Elements in Two-Layer Tidal Flow." (See complete entry in Section I.)
- Kelley, J. T. 1983. "Composition and Origin of the Inorganic Fraction of Southern New Jersey Coastal Mud Deposits," <u>Geological Society of America Bulletin</u>, 94(6):689-699.

The decreasing areal extent of Cape May Peninsula lagoons in historical times and surfaceward-increasing concentrations of anthropogenically released heavy metals in lagoonal sediment suggest that the Atlantic coastal marshes of southern New Jersey are rapidly accumulating fine-grained sediment. Potential sources of sediment to this area include Pleistocene mud deposits on the continental shelf, fine sediment moving from north to south with the longshore drift, and Delaware Bay mud escaping the estuary on ebb tides. To determine the origin of the modern coastal muds of south New Jersey, sediment from each source was compared with suspended sediment entering Cape May Peninsula tidal inlets on flood tides. Although suspended sediment was considerably finer grained than material from other locations, the mud fraction of all sediment samples possessed a primary mode of ~0.5 μm and a secondary mode of ~8 μm . All samples exhibited great variation in mineralogy with grain size but possessed similar relative abundances of minerals within fractionated size classes. In general, feldspar dominated the silt fraction, with increasing quantities of illite, chlorite, and montmorillonite found in progressively finer sizes. On the basis of mineralogy, bottom sediment from northeast Delaware Bay, the Atlantic inner continental shelf, and mud from New Jersey beaches cannot be differentiated and ultimately may be derived from the same material--the eroding, Pleistocene-age Cape May Formation. The mineralogy of suspended sediment exiting Delaware Bay on ebb tides and entering Cape May Peninsula inlets on flood tides is identical, and it differs from bottom sediment by possessing slightly more feldspar and biotite and less chlorite. A consideration of the water circulation around Cape May Peninsula and evaluation of all available Landsat imagery of the area suggest that resuspension of northeast Delaware Bay bottom sediment, augmented by contributions from the Delaware River, provides most of the fine-grained sediment to the Atlantic coastal marshes of Cape May Peninsula. References (40 items).

- Kerssens, P. J. M., Prins, A., and Van Rijn, L. C. "Model for Suspended Sediment Transport." (See complete entry in Section VI.)
- Kerssens, P. J. M., Van Rijn, L. C., and Van Wijngaarden, N. J. "Model for Non-Steady Suspended Sediment Transport." (See complete entry in Section VI.)
- Kieslich, J. M. 1977. "A Case History of Port Mansfield Channel, Texas," GITI Report 12, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents a case history and analysis of Port Mansfield channel, an artificial, jettied inlet between the Gulf of Mexico and Laguna Madre, Texas. Deposition has occurred in the channel entrance since its opening. Seaward migration of the updrift beach and shoaling in the channel entrance indicate that sand is bypassing the jettied entrance. Shortterm predictions of inlet stability using the O'Brien prism-area relationship, Escoffier's stability criteria, and Bruun and Gerritsen ratio of tidal prism to the gross annual longshore transport rate. correctly predict the unstable nature of the channel. Tidal exchange volumes and velocities are not large enough to maintain the design cross-sectional area in the presence of the existing longshore transport. References (14 items).

Kirby, R., and Parker, W. R. 1982. "A Suspended Sediment Front in the Severn Estuary," Nature, 295(5848):396-399.

A zone of marked local gradient in the regional suspended solids field has been located along the axis of the Severn Estuary. This front occupies virtually the same position on ebb and flood and on spring and neap tides, although the amplitude of the gradient fluctuates. Thermohaline fronts have been described in coastal waters; suspended sediment fronts associated with the discharge of major rivers into the sea are common; while fronts caused by convergence of secondary circulations within estuaries have also been reported. References (12 items).

Kjerfve, B., ed. 1978. <u>Estuarine Transport</u> <u>Processes</u>, University of South Carolina Press, Columbia, S. C.

This book consists of 18 papers which were presented during 1976 at a symposium primarily concerned with the movement of water, salt, and fine-grained sediments in estuaries. Contents: "What Have Recent Observations Obtained for Adjustment and Verification of Numerical Models Revealed About the Dynamics and Kinematics of Estuaries," by Donald W. Pritchard; "Mixing Processes in Estuaries," by Kenneth F. Bowden; "Theoretical Aspects of Estuarine 48

Circulation," by Peter Hamilton and Maurice Rattray, Jr.; "Some Simplified Tidal Mixing and Circulation Flux Effects in Estuaries," by Charles B. Officer; "A Study of Turbulent Diffusion by Dye Tracers: A Review," by Harry H. Carter and Akira Okubo; "Role of Lateral Gradients and Longitudinal Dispersion in the Salt Balance of a Shallow, Well-Mixed Estuary," by Stephen P. Murray and Absornsuda Siripong: "Micrometeorological Fluxes in Estuaries," by Shih-Ang Hsu; "The Balance of Suspended Sediment in the Gironde and Thames Estuaries," by Keith R. Dyer; "Suspended Solids Transport in a Salt Marsh Creek--An Analysis of Errors," by John D. Boon III; "Vertical Transport of Suspended Sediment in Upper Chesapeake Bay," by Jerry R. Schubel, Robert E. Wilson, and Akira Okubo; "Aggregation of Suspended Particles in Estuaries," by Ray B. Krone; "Sediment and Chemical Exchanges Between Salt Marshes and Coastal Waters," by Leonard R. Gardner and Wiley Kitchens: "Some Aspects of Puget Sound's Circulation and Water Properties," by Clifford A. Barnes and Curtis C. Ebbesmeyer; "Winter Replacement of Bottom Water in Puget Sound," by Glenn A. Cannon and Curtis C. Ebbesmeyer; "Deep Water Exchange in Alaskan Subarctic Fjords," by Robin D. Nuench and David T. Heggie; "Physical Processes in the Mediterranean Basins," by Thomas S. Hopkins; "A Refined Method of Tidal Analysis," by Alberto dos Santos Franco; "Epilogue: Where Do We Go From Here?" by Bjorn Kjerfve, Keith R. Dyer, and Jerry R. Schubel. References at end of each paper.

- Knap, A. H., and Williams, P. J. LeB. "Experimental Studies to Determine the Fate of Petroleum Hydrocarbons from Refinery Effluent on an Estuarine System." (See complete entry in Section VI.)
- Knebel, H. J., et al. 1981. "Sedimentary Framework of the Potomac River Estuary, Maryland," <u>Geological Society of America</u> <u>Bulletin</u>, Part I, 92(8):578-579.

Analyses of seismic reflection profiles, sediment cores, grab samples, and sidescan sonar records, along with previously collected borehole data, reveal the characteristics, distribution, and geologic history of the shallow strata beneath the Potomac River estuary. The lowermost strata are sediments of the Chesapeake Group (lower Miocene to lower Pleistocene) that crop out on land near the shore but are buried as much as 40 m below the floor of the estuary. The top of these sediments is an erosional unconformity that outlines the Wisconsinan valley of the Potomac River. This valley has a sinuous trend, a flat bottom, a relief of 15 to 34 m, and axial depths of 34 to 54 m below present sea level. During the Holocene transgression of sea level, the ancestral

valley was filled with as much as 40 m of sandy and silty, fluvial-to-shallow estuarine sediments. The fill became the substrate for oyster bars in the upper reach and now forms most marginal slopes of the estuary. Since sea level approached its present position (2,000 to 3,000 years ago), the main channel has become the locus of deposition for watery, gray to black clay or silty clay, and waves and currents have eroded the heterogeneous Quaternary sediments along the margins, leaving winnowed brown sand on shallow shoreline flats. Pb-210 analyses indicate that modern mud is accumulating at rates ranging from 0.16 to 1.80 cm/year, being lowest near the mouth and increasing toward the head of the estuary. This trend reflects an increased accumulation of fine-grained fluvial sediments near the turbidity maximum, similar to that found in nearby Chesapeake Bay. The present annual accumulation of mud is about 1.54 million metric tons; the cumulative mass is 406 million metric tons. References (33 items).

- Knox, S., et al. "Statistical Analysis of Estuarine Profiles: II Application to Arsenic in the Tamar Estuary (S.W. England)." (See complete entry in Section IV.)
- Komar, P. D. <u>Beach Processes and Sedimenta-</u> <u>tion</u>. (See complete entry in Section I.)
- Kraft, J. C., John, C. J., and Maurmeyer, E. M. 1978. "Morphology of Coastal Barriers, Delaware, U.S.A.," <u>Proceedings,</u> <u>Sixteenth Coastal Engineering Conference,</u> <u>August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1232-1244.</u>

The Atlantic Coast of Delaware consists of four separate but continuous segments including (from north to south): (a) a northward-projecting spit complex (Cape Henlopen); (b) eroding Pleistocene headlands; (c) a linear coastal washover barrier; and (d) an area of migrating inlets with associated modern and relict ebb and flood tidal deltas. Coastal process studies show that continuing coastal erosion is accompanied by longshore transport of sand eroded from headlands, offshore transport to the nearshore marine area, and overwash processes transporting sand landward across the barrier. Studies of the adjacent nearshore marine area show that the barrier and its various geomorphic elements lay at the outer edge of the continental shelf approximately 12,000 years ago, and migrated landward and upward to the present position as the Holocene marine transgression continued. The sequence of coastal sediments of the barrier system consists of (landward to seaward) tidal marsh fringe, lagoonal muds and sands, barrier sands (including

washover, dune, and beach deposits), and shallow nearshore sand and gravel. Drillhole studies provide information on the subsurface configuration of the barrier from which the three-dimensional structure and stratigraphy of coastal sedimentary environmental lithosomes may be defined. References (14 items).

Lake, C. A., and MacIntyre, W. G. 1977.
"Phosphate and Tripolyphosphate Adsorption by Clay Minerals and Estuarine Sediments," Bulletin 109, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

This investigation sought to provide additional needed information on overenrichment of estuarine areas by examining the extent to which phosphate nutrients are taken up by clay sediments in estuarine and marine environments. Examined specifically was the adsorption of orthophosphate and tripolyphosphate by the four clay minerals most commonly found in 'irginia estuaries. A factorial analysis was applied to the design of the experiments in order to examine statistically the effect of pH, salinity, temperature, and initial phosphate concentration on orthophosphate adsorption. The main effects of pH and initial phosphate concentration were statistically important to orthophosphate adsorption. The amount of orthophosphate adsorbed by each of the clays increased in the following order: montmorillonite < kaolinite < illite < chlorite. The orthophosphate adsorption by synthetic clay demonstrated the generality of the adsorption experiments, for similar amounts were adsorbed by both synthetic and natural clays. When the source of phosphorus was tripolyphosphate rather than orthophosphate, each clay adsorbed more phosphorus under similar reaction conditions. References (53 items).

- Leenknecht, D. A., Earickson, J. A., and Butler, H. L. "Numerical Simulation of Oregon Inlet Control Structures' Effects on Storm and Tide Elevations in Pamlico Sound." (See complete entry in Section VI.)
- Lees, B. J., and Heathershaw, A. D. 1981. "Sizewell-Dunwich Banks Field Study, Topic Report 5; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data," Report No. 123, Institute of Oceanographic Sciences, Crossway, U.K. (Unpublished Manuscript).

Observed and predicted transport rates have indicated that for sand-size particles ($d_{50} = 2.90$, 130 µm), sediment is moved mainly in the suspended mode. Grain size analyses and subsequent calculations of transport rates for separate sand fractions show that the material transported is predominantly very fine sand. Logarithmic and power law relationships were used to predict bed-load sediment transport rates from midwater current meter data. Comparison with tracer experiment results showed that of five widely used sediment transport formulae, Yalin's (1963) equation gives the best predictions. References (54 items).

- Lentsch, J. W., et al. "Stable Manganese and Manganese-54 Distributions in the Physical and Biological Components of the Hudson River Estuary." (See complete entry in Section IV.)
- Lepetit, J. P., and Davesne, M. 1980. "Dynamics of Silt in Estuary, Residual Current or Flocculation Which Prevails?" <u>Proceedings, Seventeenth Coastal Engineer-</u> <u>ing Conference, March 23-28, 1980, Sydney,</u> <u>Australia</u>, ASCE, III:2861-2873.

The transport of fine suspended sediment in a partly mixed estuary has been simulated on a physical model of a schematic estuary reproducing the main geometrical and hydrodynamical characteristics of the Gironde Estuary (France). The natural sediment consisting of silt and clay is simulated using a light and fine material, gilsonite, and the flocculation processes in salt water and under turbulence induced by tidal currents have been reproduced by adding to salt water a flocculating salt solution (sodium pyrophosphate). Then the formation of the turbidity maximum surveyed in the field and its upstreamdownstream migration in response to varying river discharge have been successfully simulated and the results of different series of tests lead to the following conclusions: (a) Flocculation processes, which are responsible for the variation of the settling velocity with salinity and turbulence, have to be reproduced to explain the formation of the turbidity maximum. (b) After high river discharges, the convergence of bottom residual currents (null point) due to the salinity intrusion creates a trap for suspended sediments supplied by the river flood which accumulate in the form of the turbidity maximum. Without salinity intrusion, a large amount of sediment would escape out of the estuary to the sea. (c) During low river flows, a part of the suspended sediment migrates upstream, but the amplitude of this migration is small compared with the displacement of the upstream limit of the salinity intrusion. (d) The upstream migration of the turbidity maximum is increased when a transverse bottom morphology (existence of a deeper navigation channel) is represented. Reference (1 item).

Lepetit, J. P., and Hauguel, A. 1978. "A Numerical Model for Sediment Transport," EXCENSION SECTOR SUCCESSION

Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1715-1724.

A numerical two-dimensional model for sediment transport which permits the computation of the impact of a coastal structure on the bottom evolution is presented in this paper. A simple kinematical study of the sediment transport equation has shown how the ripples propagation can be obtained. It has also allowed a numerical integration on a computer. The characteristic response time of the surface wave propagation compared to the characteristic response time of the bottom evolution put a stop to any sort of computation of the disturbed current in the classical way. The introduction of current disturbance and several assumptions permit the computation of the bottom evolution during a long time. This kinematical and mathematical aspect almost understood, studies are going on a more physical and dynamical point of view to determine the influence of the different parameters in transport relationship and to find a best dynamical approximation of the current disturbance. At the same time, a means of averaging the tide in tidal problems is investigated. References (5 items).

- Lin, P., Dai, Z., and Li, K. "Unsteady Flow Studies in China." (See complete entry in Section I.)
- Lin, P., and Shen, H. 1984. "Two-D Flow with Sediment by Characteristics Method," <u>Journal, Hydraulic Engineering</u>, ASCE, 110(5):615-626.

The theory of characteristics is applied to analyze two-dimensional unsteady flow over a bed of fine sediment. The sediment is assumed to be so fine that suspension is the predominant mode of transport. An additional equation for sediment diffusion is introduced. As a result, the number of characteristics is increased, but the characteristic directions can be determined without solving high-degree algebraic equations. Results from a onedimensional version of this procedure agreed reasonably well with known data. References (9 items).

Liou, Y.-C., and Herbich, J. B. 1977. "Velocity Distribution and Sediment Motion Induced by Ship's Propeller in Ship Channels," <u>Hydraulics in the Coastal Zone,</u> <u>Proceedings, 25th Annual Hydraulics Divi-</u> <u>sion Specialty Conference, Texas A&M Uni-</u> <u>versity, College Station, Texas, August</u> <u>10-12, 1977</u>, ASCE, 228-235.

A numerical model using the momentum theory of the propeller and Shields' diagram was developed to study sediment movement induced by a ship's propeller in a restricted waterway. The velocity distribution downstream of the propeller was simulated by the Gaussian normal distribution function. The shear velocity and shear stress were obtained using Sternberg's formulas. Once the ship's speed, depth of the waterway, RPM and diameter of the propeller, and draft of the ship are given, the velocity distribution and the grain size of the initial motion could be obtained from this model. Case studies are presented to show the influence of significant factors on sediment movement at the channel bottom induced by a ship's propeller. References (7 items).

- Ludwick, J. C. "Jet-Like Coastal Currents and Bottom Sediment Transport off Virginia Beach, Virginia." (See complete entry in Section VIII.)
- Ludwick, J. C., and Johnson, P. B. "Hydraulic Sensor Instrumentation in a Shore Face in a Tidal-Nontidal Coastal Convergence Zone, Cape Henry, Virginia." (See complete entry in Section VII.)
- Lundgren, H. "Struggle of Physics and Mathematics." (See complete entry in Section I.)
- McAnally, W. H., Jr., et al. "Application of Columbia Hybrid Modeling System." (See complete entry in Section VI.)
- McAnally, W. H., Jr., et al. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth." (See complete entry in Section VI.)
- McCann, S. B., Reinson, G. E., and Armon, J. W. "Tidal Inlets of the Southern Gulf of St. Lawrence, Canada." (See complete entry in Section I.)
- McKay, G. R., and Tranberg, C. H. "The Development of a Dredged Estuarine Harbour--A Case Study." (See complete entry in Section V.)
- Macpherson, J. M. 1979/80. "Response to Urbanization of the Avon-Heathcote Estuary, Christchurch, New Zealand," <u>Environ-</u> <u>mental Geology</u>, 3(1):23-27.

The Avon-Heathcote is a small, microtidal, predominantly intertidal, weatherdominated estuary. It has experienced large alterations to its physical environment as a result of the establishment and growth of the adjacent Christchurch City, on what was previously a swampy, dunebordered coastal plain. During the first 25 years of settlement the volume of the tidal compartment of the estuary decreased from 7.7 $\cdot 10^6$ m³ to about 5 $\cdot 10^6$ m³. A combination of rapid drain laying in the 1880s and 1890s and the conversion of much of the catchment of the estuary to urban uses altered the sediment yields and runoff characteristics of the area and resulted in a reversal of the early trend. By 1925 the tidal compartment had returned to its original volume, and by 1975 it had reached a volume of 10.93×10^6 m³. The early decrease was accompanied by widespread deposition of a 30- to 60-cm-thick layer of muddy sediment, some of which remains. The estuary inlet underwent major adjustments to accommodate the increasing tidal flow and now appears to be approaching a new, posturban equilibrium. References (18 items).

Madsen, O. S., and Grant, W. D. 1976. "Sediment Transport in the Coastal Environment," Technical Report No. 209, Massachusetts Institute of Technology, Cambridge, Mass.

The subject of sediment transport in the coastal zone is investigated, and the answers to some of the basic questions of sediment transport in unsteady, oscillatory flow are presented. A general numerical model is developed for the sediment transport and topographical changes resulting from spatially varying wave and current conditions. A simple numerical example of the evaluation of the topographical changes in the vicinity of the tip of a long straight breakwater is presented for periodic waves normally incident on the breakwater and a current parallel to the breakwater. References (43 items).

Magoon, O. T., and Baer, D. C. 1978. "Maintenance of Santa Cruz Harbor, California, USA," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE,</u> II:1276-1281.

In planning and operating coastal harbors subjected to shoaling, it is imperative that the characteristics and regime of the sediments which deposit in the harbor entrance be quantified to the maximum extent possible in order that the economic impacts of shoaling in the channel and along adjacent shores may be evaluated. This paper presents a brief progress report on the study of a coastal harbor in an area subjected to shoaling. References (5 items).

Milliman, J. D., et al. 1984. "Tidal Phase Control of Sediment Discharge from the Yangtze River," <u>Estuarine, Coastal and</u> <u>Shelf Science</u>, 19(1):119-128.

Tidal phase plays a major role in controlling sediment discharge from the Yangtze River estuary in eastern China. Direct measurements indicate that during spring tide in mid-November 1981 approximately three times the sediment passed down the main channel of the river as during the next neap tide, 3 days later. The estuary presumably acts as a conduit for riverine sediment during spring tide but as a sink during neap tide. Tidal phase control of sediment discharge appears to be primarily dependent upon tidal range relative to estuarine depth rather than river discharge or absolute tidal range per se.

- Mills, D. A., Colman, R. S., and Dandy, G. C. "Water Movement in a Complex Estuarine Embayment--A Methodology for Data Collection and Analysis." (See complete entry in Section VII.)
- Monahan, D. 1976. "Morphology and Sediments of Sand Waves in the St. Lawrence Estuary," Maritime Sediments, 12(1):1-7.

Submarine sand waves have been reported from so many parts of the world that their occurrence is virtually commonplace. Nevertheless, the mechanism of their formation is not very well understood, and the numerous reports of various studies of sand waves present confusing and sometimes conflicting evidence. Generally, it has been reported that sand waves studied under natural conditions (a) migrate under the influence of the stronger tide or current; (b) reverse their asymmetrical orientation with change in tidal orientation; (c) contain some degree of selective sorting of grains within them; and (d) occur only where the bottom material is wellsorted sand. This paper reports on a short investigation of these phenomena as observed in the St. Lawrence estuary downstream from Quebec City. References (11 items).

Nakagawa, H., Tsujimoto, T., and Nakano, S. 1982. "Characteristics of Sediment Motion for Respective Grain Sizes of Sand Mixtures," <u>Bulletin of the Disaster Prevention Research Institute</u>, Kyoto University, Kyoto, Japan, Part 1, 32(286):1-32.

In sediment transport of sand mixture, the characteristic quantities of sand motion are different for each grain size, and it follows that temporal and spatial changes of bed constitution must be caused thereby. Therefore, the characteristic quantities of sand motion for each grain size should be clarified in relation to bed constitution to describe sediment transport process and subsequent phenomena in alluvial beds composed of sand mixtures. At first, mechanical properties of rough bed composed of sand mixture are investigated in relation to grain size distribution, and particularly the statistical properties of relative height and angle of escape of exposed particles are inspected by a simulation method. Next, the so-called critical tractive force for each grain size, which is one of the most fundamental quantities, is here

theoretically investigated. On its estimation, the equivalent sand roughness of mixed sand bed is necessary, and a new model using the concept of equivalent size of nonuniform particulate materials is proposed. Moreover, the other characteristic quantities of sediment motion for each grain size are inspected based on a film analyzing method. These research projects must give important information to describe various kinds of alluvial phenomena observed in natural rivers of which beds are composed of widely distributed sands and gravels. References (20 items).

Nasner, H. 1978. "Time-Lag of Dunes for Unsteady Flow Conditions," <u>Proceedings</u>, <u>Sixteenth Coastal Engineering Conference</u>, <u>August 27-September 3, 1978, Hamburg, Germany</u>, ASCE, II:1801-1817.

In this paper, the time-dependent behavior of dunes as a function of the governing hydraulic conditions has been described. The results can be summarized as follows: (a) It has been proved that it is difficult to apply the results from experiments on models to natural rivers. A clear-cut relationship between bed form properties and flow conditions may be given for steady circumstances. In nature where unsteady flows prevail, the bed configuration adjusts itself to the changing hydraulic conditions with a time lag. However, also for significant dunes in deepwater rivers, this is a short-term process. (b) The knowledge gathered from laboratory tests, according to which for low Froude numbers and increasing velocities, higher dunes will be established, obviously applies to limited water depths only. The governing parameter for rivers of greater depths is the flow velocity which determines the limiting dune height depending on the sediment characteristics. In spite of the low Froude numbers, the river bottom may be situated in the transition zone. The dunes become smaller by erosion for increasing discharges and flow velocities. In case of falling water levels and lower current velocities, the bed forms may be enlarged again by sedimentation. (c) The investigations revealed that the river bottom shows a very sensitive reaction to changed discharge and flow conditions. The variations of the dune height are of a remarkably greater order of magnitude than the fluctuations of the mean water level. On principle, the dunes cause a stabilization of the bottom so that the sediment removal is reduced. Compared with a flat bed, the sand transport is considerably reduced by the merely local redistribution of the bed material. In this respect, the dune height is of minor significance, as the height, as well as the migration velocity,

of the bed forms is governed by the mean velocity of the flow and not inversely. References (15 items).

- Nece, R. E., and Forsyth, G. W. "Annotated Bibliography on Tidal Flushing and Circulation in Marinas." (See complete entry in Section I.)
- Nielsen, A. F., and Gordon, A. D. "Tidal Inlet Behavioural Analysis." (See complete entry in Section I.)
- Nihoul, J. C. J., ed. <u>Marine Forecasting;</u> <u>Predictability and Modelling in Ocean</u> <u>Hydrodynamics; Proceedings, 10th Interna-</u> <u>tional Liege Colloquium on Ocean Hydrody-</u> <u>namics</u>. (See complete entry in Section I.)
- Nishimura, J. K., and Lau, L. S. "Structure for Automatic Opening of Closed Stream Mouths." (See complete entry in Section V.)

Nishimura, J. K., and Lau, L. S. 1979. "Structure for Automatic Opening of Sediment Plugs," <u>Coastal Structures 79, A Spe-</u> cialty Conference on the Design Construction, Maintenance and Performance of Port and Coastal Structures, March 14-16, 1979, Alexandria, Virginia, ASCE, II:1106-1123.

Closure of stream mouths by littoral sediment is a natural condition of numerous small streams on islands like Oahu, Hawaii. Flood damages induced by floodwater flowing over banks before the blockage is either breached or overtopped can be substantial especially in urbanized areas. Solutions to the problem may be achieved by preventing the formation by using jetties or other similar structures or by removing or breaching the blockage in time before flooding. The first approach is often infeasible for small streams. Mechanical dredging is expensive and effective only if done in time and only for a limited period of time. There are in use hydraulic structures that utilize the hydraulic forces of the early arriving storm flow to breach the blockage. A new design of a hydraulic structure with nonmoving parts for automatic opening of coastal sediment plugs at small stream mouths has been developed. When positioned properly in the stream mouth, the structure will induce piping and erosion of the sediment plug progressing from the ocean side toward the stream and resulting in prompt failure of the sediment plug and passage of the flood flow. References (8 items).

Novak, P., and Čábelka, J. <u>Models in</u> <u>Hydraulic Engineering; Physical Principles</u> <u>and Design Applications</u>. (See complete entry in Section VI.) Nummedal, D., and Fischer, I. A. 1978. "Process-Response Models for Depositional Shorelines: The German and the Georgia Bights," <u>Proceedings, Sixteenth Coastal</u> Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1215-1231.

Sediment dispersal patterns in tidal inlets within the German and the Georgia Bights are found to be controlled by three major environmental factors: (a) the tide range, (b) the nearshore wave energy, and (c) the geometry of the back-barrier bay. Both embayments chosen for study are characterized by high wave energies and low tide ranges on their flanks, and low wave energies and high tide ranges in their centers. The spatial variability in inlet morphology, therefore, contains information on the relative role of tides and waves in inlet sediment dispersal. The paper concludes by proposing a simple model for inlet morphologies for successively greater relative role of tidal currents in the sediment dispersal. References (25 items).

- O'Brien, M. P. "Comments on Tidal Entrances on Sandy Coasts." (See complete entry in Section I.)
- O'Connor, D. J., and Lung, W. "Suspended Solids Analysis of Estuarine Systems." (See complete entry in Section VI.)
- O'Connor, D. J., Mueller, J. A., and Farley, K. J. "Distribution of Kepone in the James River Estuary." (See complete entry in Section IV.)
- Odd, N. V. M., and Baxter, T. "Port of Brisbane Siltation Study." (See complete entry in Section VI.)
- "Old Laboratory Tests Large Coastal Models." (See complete entry in Section VI.)
- Olsen, C. R., et al. "Reactor-Released Radionuclides and Fine-Grained Sediment Transport and Accumulation Patterns in Barnegat Bay, New Jersey, and Adjacent Shelf Waters." (See complete entry in Section IV.)
- Onishi, Y. "Sediment-Contaminant Transport Model." (See complete entry in Section VI.)
- Onishi, Y., et al. 1981. "Critical Review: Radionuclide Transport, Sediment Transport, and Water Quality Mathematical Modeling; and Radionuclide Adsorption Desorption Mechanisms," NUREG/CR-*322, PNL-2901, US Nuclear Regulatory Commission, Washington, D.C.

This report describes the results of a detailed literature review of radionuclide

transport models applicable to rivers, estuaries, coastal waters, the Great Lakes, and impoundments. Some representative sediment transport and water quality models were also reviewed to evaluate if they can be readily adapted to radionuclide transport modeling. References (1,112 items).

Owen, M. W., and Thorn, M. F. C. 1978. "Effect of Waves on Sand Transport by Currents," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, II:1675-1687.

The effect of waves on the transport of sand in suspension by currents can be especially important in the outer regions of estuaries and tidal inlets. This paper presents two series of field experiments carried out to investigate the transport of sand under the combined action of waves and currents.

- Özsoy, E., and Ünlüata, Ü. "Ebb-tidal Flow Characteristics near Inlets." (See complete entry in Section I.)
- Partheniades, E. 1973. "Engineering Properties of Estuarine Sediments," <u>NATO Ad-</u> <u>vanced Study Institute on Estuary Dyna-</u> <u>mics</u>, Lecture No. 16, Laboratório Nacional de Engenharia Civil, Lisbon, Portugal.

This paper presents the importance of sedimentation in estuaries, general formulation of the sediment transport and deposition, physicochemical properties of cohesive sediments related to their depositional and erosional behavior, and erosion and deposition of cohesive soils. The most important engineering properties of fine estuarine sediments which affect their hydrodynamic behavior on a flow field have been summarized and formulated in a simplified mechanistic form to explain the observed erosional and depositional phenomena. It was concluded that the net attractive interparticle forces play a dominant role in erosion and deposition of cohesive soils by providing the main resistance to erosion and the principal mechanism for flocculation. References (38 items).

Pethick, J. S. 1981. "Long-Term Accretion Rates on Tidal Salt Marshes," <u>Journal of</u> <u>Sedimentary Petrology</u>, 51(2):571-577.

Long-term variations in salt marsh accretion rates were estimated using data collected on the marshes of the North Norfolk coast, England. Fourteen discrete marsh areas were sampled, all lying within i 20-km stretch of coast. The age of each marsh had previously been determined using radiocarbon or archival evidence for the date of vegetation inception on each marsh surface. Marsh ages ranged from 10 years 54

to +2,000 years. The elevation of each marsh surface was determined in the field using levelling techniques. The relationship between age and surface elevation was assumed to be a function of the rate of marsh accretion within this area of coast. Statistical tests showed this to be a highly significant relationship while the accretion rates calculated from the age/ height curve agree closely with field measurements on these marshes. Accretion rates were found to vary from 1.7 cm/year on 10-year-old marshes to less than 0.002 cm on marshes older than 500 years. The age/height relationship describes an asymptotic curve with the asymptote lying 0.8 m below the level of the highest spring tides, and appears to be controlled by the frequency of tidal maxima which peaks at 0.8 m below the maximum value and declines sharply above that height. References (14 items).

- Philip, N. A. "Coastal Processes and the Wagonga Inlet Breakwaters." (See complete entry in Section I.)
- Pickrill, R. A., Irwin, J., Shakespeare, B. S. 1981. "Circulation and Sedimentation in a Tidal-Influenced Fjord Lake: Lake McKerrow, New Zealand," <u>Estuarine,</u> <u>Coastal and Shelf Science</u>, 12(1):23-37.

Lake McKerrow is a tide-influenced fjord lake, separated from the open sea by a Holocene barrier spit. Fresh, oxygenated waters of the epilimnion overlie saline, deoxygenated waters of the hypolimnion. During winter, water from the Upper Hollyford River interflows along the pycnocline, depositing coarse silt on the steep delta and transporting finer sediment down lake. An extensive sublacustrine channel system on the foreset delta slope is possibly maintained by turbidity currents. Saline waters of the hypolimnion are periodically replenished. During high tides and low lake levels, saline water flows into the lake and downslope into the lake basin as a density current in a welldefined channel. References (27 items).

- Price, W. A., Motyka, J. M., and Jaffrey, L. J. "The Effect of Offshore Dredging on Coastlines." (See complete entry in Section V.)
- Pruszak, Z., and Zeidler, R. B. 1978. "Sediment Transport and Ripples Due to Waves and Currents," <u>Proceedings, Six-</u> <u>teenth Coastal Engineering Conference,</u> <u>August 27-September 3, 1978, Hamburg, Ger-</u> <u>many</u>, ASCE, II:1638-1655.

Water velocities and shear stresses have been determined for a laminar boundary layer of a progressive wave travelling over a regular series of ripples. The Lavrentiev variational method was used to transform conformally the water area with ripples into a strip with flat bottom, while the Lin approach permitted solution of the boundary layer equation. The theoretical prediction of the bed friction was verified experimentally with a new mechanical apparatus. By coupling the theoretical shear stress at the rippled bed with laboratory data for ripple parameters, one can expose the friction conditions that control the growth and decay of ripples. If waves develop higher values of shear stress, the rippled bed becomes gradually washed out. For known shear stresses, based on the Frijlink-Bijker formula, one can compute sediment transport rates. In the respective diagram, a curve of sediment transport rate versus bottom friction consists of two branches. The stages of the growth and decay of ripples are reflected in the lower and upper branches of the curve. For identical ripple height, there are two values of sediment transport rate, for two different wave intensities, likely to differ by as much as 25 percent. Three-dimensional ripples have been analyzed with regard to bed friction and compared with twodimensional conditions. References (6 items).

- Ramming, H.-G. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe." (See complete entry in Section 1.)
- Rashid, M. A., and Reinson, G. E. 1979. "Organic Matter in Surficial Sediments of the Miramichi Estuary, New Brunswick, Canada," <u>Estuarine and Coastal Marine Science</u>, 8(1):23-36.

The surficial sediments of the Miramichi Estuary, New Brunswick, contain a much higher quantity of organic matter than would be expected to occur in an estuary of this type, which is shallow and well mixed. The organic carbon distribution in general corresponds with the distribution of fine-grained sediment, although higher concentrations occur in sediments of the drowned river channel than in sediments of the bay portion of the estuary. The high quantity of organics in all the sediments and differences in concentrations between river channel and bay sediments are the direct result of the discharge of pulp mill effluent into the upper reaches of the estuary. The organic carbon isotopic composition of sediments suggests that land-derived material is the predominant source of organics throughout the estuary. Marine organic material is restricted to the sediments near the estuarine mouth. Dispersal of the organic matter is achieved largely by transport in the upper freshwater effluent layer, and by settling through the water column when transport energies are reduced. Settling of organic matter is highest in areas where

deposition of fine-grained inorganics prevails. References (26 items).

- Renger, E., and Partenscky, H. W. "Sedimentation Processes in Tidal Channels and Tidal Basins Caused by Artificial Constructions." (See complete entry in Section I.)
- Renwick, W. H., and Ashley, G. M. "Sources, Storages, and Sinks of Fine-Grained Sediments in a Fluvial-Estuarine System." (See complete entry in Section IV.)
- Roberts, H. H. 1980. "Physical Processes and Sediment Flux Through Reef-Lagoon Systems," <u>Proceedings, Seventeenth Coastal</u> <u>Engineering Conference, March 23-28, 1980,</u> <u>Sydney, Australia, ASCE, I:946-962.</u>

Studies of physical processes in reeflagoon systems continue to emphasize the importance of waves and wave-induced currents at the reef crest as agents of sediment transport to back reef environments. These across-the-reef currents are also largely responsible for driving back reef lagoon circulation. Rapid energy transformations associated with the process of wave breaking at the reef crest are responsible for strong reef-normal surge currents. Estimates of energy loss, as determined by wave height changes caused by wave breaking, can be as high as 70-80 percent for discontinuous reefs and >90 percent for continuous examples. The amount of energy loss is related to depth of water over the reef crest, a function of reef topography and tidal regime. Lowtide conditions promote the greatest incident wave modification and attenuation as a result of increased breaking wave intensity. Under trade wind conditions found in the Caribbean, surge currents of 50-80 cm/sec for durations of 2-6 sec are common in a low to moderate wave energy setting (4- to 6-sec input waves, 40- to 50-cm average heights). Sediments through the sand sizes up to pebbles are easily transported lagoonward by these periodic bursts of energy. Flow in shallow back reef lagoons (generally <3 km wide) is driven largely by across-the-reef currents resulting from breaking waves. Long, unbroken reefs tend to induce axial currents in the back reef lagoon which flow roughly parallel to the reef trend. Side-scan sonographs indicate that large bed forms define a region of bottom sediment migration related to strong currents down the lagoon axis, presumably activated during periods of abnormal wave activity on the reef. Localized and discontinuous shallow reefs tend to store coarse sediments in the back reef in sand bodies oriented at high angles to the reef trend. Combined effects of wave refraction and tidal exchange around the flanks of these localized reef masses give rise to

tombololike sediment accumulations in the shallow back reef area. Back reef sand bodies associated with continuous linear reefs tend to be oriented parallel to the reef trend. Lagoonal sediments are transported through tidal passes to the forereef shelf, where sediment sinks commonly develop behind actively growing shelf margin reefs. Side-scan sonar and high-resolution subbottom data confirm both sediment sinks and preferential offshelf transport routes on narrow, roughbottomed forereef shelves. In trade windisland systems (e.g., Grand Cayman and St. Croix), sediments are stored in large quantities on the forereef shelf at the downwind flanks of the islands. Forereef shelf morphology indicates that at these same locations, routes for offshelf sediment transport are optimized. References (19 items).

Rodger, J. G. 1980. "Simulation of Stratified Flows in Estuaries," <u>Proceedings,</u> <u>Second International Symposium on Stratified Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:707-721.

The transport of suspended material or dissolved salt or pollutant in an estuary depends on two main fluid processes: advection and vertical mixing. In a shear flow, different rates of advection of concentrates then lead to longitudinal dispersion. It is not possible to model water movement separately from the transport processes if the flow field is influenced by the density effects of suspended or dissolved substances. Although the dominant fluid motion in an estuary is still governed by the tide in the sea and the fluvial discharge in the upper estuary, density gradients between the sea and the estuary can generate a gravitational circulation with a net flow in the landward direction near the bed of the estuary. This gravitational circulation plays an important role in the distribution of sediments in many estuaries. In addition, vertical density gradients reduce the vertical mixing, so tending to preserve the vertical and horizontal structure of the flow. These secondary effects play an important role in the transport processes; and in order to simulate them, a twodimensional laterally averaged model of estuarine flow was developed at the Hydraulics Research Station (Miles 1977). This paper describes a general twodimensional laterally averaged model of salt intrusion and sediment transport incorporating a general expression for vertical turbulent exchange in a partially mixed estuary. Because of the method used to integrate the governing equations, this type of model is cometimes referred to as a multilayer model. The paper als

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describes some results of the model's first application to a real estuary. References (8 items).

- Seabergh, W. C. "Weir Jetty Performance: Hydraulic and Sedimentary Considerations; Hydraulic Model Investigation." (See complete entry in Section V.)
- Seabergh, W. C., and Lane, E. F. "Improvements for Little River Inlet, South Carolina; Hydraulic Model Investigation." (See complete entry in Section VI.)
- Seabergh, W. C., and Sager, R. A. "Supplementary Tests of Masonboro Inlet Fixed-Bed Model; Hydraulic Model Investigation." (See complete entry in Section VI.)
- Seelig, W. M., and Sorensen, R. M. "Numerical Model Investigation of Selected Tidal Inlet-Bay System Characteristics." (See complete entry in Section VI.)
- Sengupta, S., Lee, S. S., and Miller, H. P. "Three-Dimensional Numerical Investigations of Tide and Wind-Induced Transport Processes in Biscayne Bay." (See complete entry in Section VI.)
- Sharp, J. J. <u>Hydraulic Modelling</u>. (See complete entry in Section VI.)
- Shelley, P. E. 1976. "Sediment Measurement in Estuarine and Coastal Areas," NASA CR-2769, National Aeronautics and Space Administration, Wallops Island, Va.

The discussion begins with a survey of uses of estuarine and coastal areas. Problems associated with these uses are discussed, and data needs for intelligent management of these valuable areas are outlined. Suspended sediment measurements are seen to be one of the greatest needs. To help understand the complexity of the problem, a brief discussion of sediment mechanics is given, including sediment sources, characteristics, and transport. The impact of sediment mechanics on its direct measurement (sampling and analysis) is indicated, along with recommendations for directly obtaining representative data. Indirect measurement of suspended sediment by remote sensors is discussed both theoretically and in the light of some recent experiences. The need for an integrated, multidisciplinary program to solve the problem of quantitatively measuring suspended sediment with remote sensors is stressed, and several important considerations of such a program and benefits to be derived therefrom are briefly. addressed. It is recommended that the present, very preliminary look be expanded into a full-blown program plan for developing a timely and affordable solution to the problem Reference of them.

- Sheng, Y. P. "Mathematical Modeling of Three-Dimensional Coastal Currents and Sediment Dispersion: Model Development and Application." (See complete entry in Section VI.)
- Siefert, W., and Barthel, V. "The German 'MORAN' Project." (See complete entry in Section I.)
- Smith, N. P., and Kierspe, G. H. "Local Energy Exchanges in a Shallow, Coastal Lagoon: Winter Conditions." (See complete entry in Section VI.)
- Smith, T. J., and O'Connor, B. A. "A Two-Dimensional Model for Suspended Sediment Transport." (See complete entry in Section VI.)
- Sorensen, R. M. "The Corps of Engineers General Investigation of Tidal Inlets." (See complete entry in Section I.)
- Sorensen, R. M., and Schmeltz, E. J. "Closure of the Breach at Moriches Inlet." (See complete entry in Section V.)
- Stephens, H. S., and Stapleton, C. A., ed. <u>Papers Presented at the Second Interna-</u> <u>tional Symposium on Wave and Tidal Energy</u>, <u>September 23-25, 1981, Cambridge, England</u>. (See complete entry in Section I.)
- Sternberg, R. W., et al. "Aquatic Disposal Field Investigations, Columbia River Disposal Site, Oregon; Appendix A: Investigations of the Hydraulic Regime and Physical Nature of Bottom Sedimentation." (See complete entry in Section V.)
- Stevens, H. H., et al. "Model for Sediment Transport Through an Estuary Cross Section." (See complete entry in Section VI.)
- Streif, H. 1978. "A New Method for the Representation of Sedimentary Sequences in Coastal Regions," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany</u>, ASCE, II:1245-1256.

Coastal lowlands usually consist of a body of unconsolidated sediments of up to 300-m thickness which have been deposited under the influence of a rising sea level. These lowlands increasingly are acquiring importance for industrial plants, harbor construction, pipelines, and the exploration of mineral resources. Geological mapping at a scale of 125,000 is f fundamental emportance in the planning that is required which will permit at economic exploitation of the clastal vere The newest type of genuepte maps--the and internet the streng the strength of the st 1.1.1

range of application covers tidal flat areas, marshes, and coastal bogs. Combined with a documentation system of the field data and the techniques of automatic data processing, this type of map offers new aspects which by far exceed the possibilities of conventional geological mapping. References (8 items).

Stumpf, R. P. 1983. "The Process of Sedimentation on the Surface of a Salt Marsh," <u>Estuarine, Coastal and Shelf Science</u>, 17(5):495-508.

An unditched salt marsh-creek drainage basin (Holland Glade Marsh, Lewes, Delaware) has a sedimentation rate of 0.5 cm year -1. During normal, storm-free conditions, the creek carries negligible amounts of sand and coarse silt. Of the material in the waters flooding the marsh surface, over 80 percent disappears from the floodwaters within 12 m of the creek. About one-half of the lost material is theoretically too fine to settle, even if flow were not turbulent; however, sediment found on Sparting stems can account for the loss. The quantity of suspended sediment that does reach the back marsh during these normal tides is inadequate to maintain the marsh surface against local sea leve, rise. This suspended sediment is also much finer than the deposited sediments. Additionally, remote sections of low marsh, sections flooded by only the highest spring tides, have 15-30 cm of highly inorganic marsh muds. This evidence indicates that normal tidal flooding does not produce sedimentation in Holland Glade. Study of the effects of two severe storms, of a frequency of once per year, suggests that such storms can deposit sufficient sediment to maintain the marsh. The actual deposition of finegrained sediments (fine silt and clay) appears to result primarily from biological trapping rather than from settling. In addition, this study proposes that the total sedimentation on mature marshes results from a balance between tidal and storm sedimentation. Storms will control sediment supply and movement on micro- and meso-tita. marshes, and will have less influence on macro-tidal marshes. Refererces (3' items).

Surdermann, J., and Holz, K.-E., ed. <u>Mathematical Modeling of Estuarice Physics</u> <u>Lecture Notes on Coastal and Estuarine</u> <u>Studies</u> (See complete entry in Section 1.)

Surdermann, J., and Krohn, J. 1977. "Numerical Simulation of Tida. laused Sand Transport in Coastal Waters," <u>Proceedings</u>, <u>Seventeenth Congress of the International</u> Association for Hydraulic Research; Hy-<u>irau.ic Engineering for Improved Water</u> Management, <u>15-19</u> August 1977. Baden-Baden, Federal Republic of Germany, 1:173-181.

A numerical model of the large-scale horizontal sediment transport caused by tidal currents is developed. The investigations are based on a two-dimensional horizontal model which produces the tidal velocity field depending on space and time within one $(M, + S_{2})$ tidal cycle. These velocities are reduced to the acting shear stress velocities near the bottom. For the beginning and the end of the sediment transport, different critical shear stresses are assumed depending on the grain sizes. After integration over one spring-neap cycle, the net transport and the material budget for various coastal regions of the North Sea are calculated. References (7 items).

- Sundermann, J., Vollmers, H., and Puls, W. "The Influence of Dune and Flow Parameters on the Friction Factor." (See complete entry in Section VI.)
- Svasek, J. N., and Versteegh, J. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries." (See complete entry in Section VI.)

Therriault, J. C., Ladurantaye, R. de, and Ingram, R. G. 1984. "Particulate Matter Exchange Across a Fjord Sill," Estuarine, Coastal and Shelf Science, 18(1):51-64. Recent studies have indicated the existence of a considerably higher planktonic biomass in the deep waters of the Sagueray Fjord as compared to corresponding depths in the adjacent St. Lawrence Estuary or the other side of a shallow sill. The hypothesis that has been put forward to explain this phenomenon is related to the advection of near-surface estuarine waters, at times very rich in particulate matter, over the entrance sil. 10to the deeper waters of the fjord. Mixing processes associated with the development of a density flow, the presence of a hydraulic jump, or other mechanisms are assured to be responsible for the common occurrence of lower density subsurface water within the basin as compared to that peretrating over the sill. The exchange processes between the estuary and the fjord are described and an estimate made of the estimative water volume that peretrates into the lower layer of the fjord over a semiduarial tide cycle. From these calculations, the replacement time for the outer basis was estimated to make between t and 4 days - the biological characteristion of this water were used to establish a sudget for particulate matter exchange which showed, in early August, a typical Her crout of 188 ters of parts offate organics carbon into the deep waters of the

- Thienpont, M., and Berlamont, J. "Mathematical Modelling of The small Discharge in Rivers and Estuaries." (See complete entry in Section VI.)
- Thimakorn, P., and Gupta, A. D. 1978. "Concentration of Suspended Clay in Tidal Estuary," <u>Proceedings, International Conference on Water Resources Engineering,</u> Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:173-192.

In the tidal estuary of a large river where the bed materials are of soft clay, the sediments are carried in suspension. The suspended load transports are estimated from the known values of the concentration of the suspended solid and the velocity of tidal current. The values of the suspended solid concentration used in the estimation can be obtained from field measurements. Such data are always available only for short duration because of the time limitation allowed for field observation. Information on the amount of sediment transport is always required on a long-term basis; therefore, data on the concentration of the suspended solid obtained from the field alone may not be adequate for that purpose. As such, the field data of limited duration have to be extrapolated to obtain the values which are not available to facilitate the estimation of the long-term sediment transport. A method to extrapolate the limited number of field data of the suspended solid concentration in a tidal estuary is developed by correlating the average concentration over a cross section of the estuary with the velocity of the current. Since the suspended sediment entering an estuary is carried along by the riverflow and the amount of the riverflow has direct effect on the sediment transport, the effect of riverflow variation is indicated in the extrapolation process. Data obtained from the field measurements which had been conducted at time intervals over a period of 1 year in the four estuaries in Thailand are used in the analysis. The result thus obtained shows that the data extrapolation method proposed would be applicable for the estuary having similar characteristics, considered in this study. References (7 items).

- Thompson, G. B., and Yeung, S. K. "Phosphorus and Organic Carbon in the Sediments of a Polluted Subtropical Estuary, and the Influence of Coastal Reclamation." (See complete entry in Section IV.)
- Thorn, M. F. C. 1979. "The Effect of Waves on the Tidal Transport of Sand," HRS Notes, Hydraulies Research Station, Wallingford, Exfordation, England, 21:4-5.

The construction by the Department of the Environment of a survey tower on the edge of the Maplin Sands in the Outer Thames estuary has now provided a means by which the tidal transport of sand can be measured under varying wave conditions. Over a period of 2 years, data were collected during storms and calms to provide a broad basis of assessment of the relative impor-. tance of wave action in tidal sediment transport. The results have led to the definition of a threshold condition below which wave effect can be ignored, and they have also shown that the wave action above the threshold causes a substantial increase in the flux of sand transported by the tide. They thus provide the basis for a better estimation of long-term estuarine transport of sand and consequential siltation from conventional survey data. The range of data was restricted by the naturally occurring wave climate at Maplin Sands. The effect of larger waves is being investigated elsewhere.

- Vallianos, L. "Barden Inlet, N.C.: A Case Study of Inlet Migration." (See complete entry in Section V.)
- van de Kreeke, J., and Haring, J. 1980. "Stability of Estuary Mouths in the Rhine-Meuse Delta," <u>Proceedings, Seventeenth</u> <u>Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2627-2639.</u>

The Rhine-Meuse Delta in the southwestern part of The Netherlands consists of sediment deposits of the Rhine and the Meuse in which tides and riverflow have scoured an intricate system of channels. The four major estuaries are from south to north Eastern Scheldt, Brouwershavense Gat, Haringvliet, and Rotterdam Waterway. The connection between estuaries and rivers is formed by a system of branching channels, referred to as tidal rivers. The flow in the tidal rivers is constrained by dikes. revetments, and groins. It is in this region where most of the sand fraction of the sediments carried by the rivers Rhine and Meuse is deposited. Extensive maintenance dredging is required to maintain a sufficiently large cross section for navigation. The mud fraction (all sediments with grain size (62μ) of the river sediments is carried further seaward and is partly deposited in the estuaries and partly in the offshore underwater delta. Average tidal ranges at the seaward boundary of the delta decrease going from south to north and vary between 3.78 m at Flushing to 1.58 m at Hook of Holland. The ratio of average tidal range to average spring tidal range is approximately 0.86. Tides are predominantly semidiurnal. The average annual discharges of the Rhine and Meuse are respectively 2,200 m³ see and 250 m³ sec. Discharges of both rivers

show seasonal fluctuations with a maximum in the winter and a minimum at the end of the summer. The river water is distributed over the estuaries in varying proportions; e.g., in 1959 the ratios of the average river volume to the average flood volume for the estuaries Eastern Scheldt. Brouwershavense Gat, Haringvliet, and Rotterdam Waterway were respectively 0, 0, 0.25 and 0.53. In the offshore region there exists a longshore sand motion to the north with a transport rate on the order of 50,000 m³/year. Associated with the longshore motion is a fining of the bottom sand when going from south to north. Typical values for the mean grain diameter of the sand are 200 μ for the mouth of the Eastern Scheldt and 150 µ for the mouth of the Haringvliet (Terwindt 1973). The present shape of the delta is to a large extent the result of man's interference with the natural sedimentation processes, the expansion of the port of Rotterdam, maintenance dredging, and in particular the delta project. The delta project envisions the closure of the Eastern Scheldt, Brouwershavense Gat, and Haringvliet. To properly manage the delta and in particular to minimize maintenance dredging and to prevent dike calamities, it is important to be able to predict scour and shoaling associated with the various man-made modifications. For this purpose, empirical relations between characteristics of cross section and flow are derived using observations in the Rhine-Meuse Delta, prior to the delta project. References (8 items).

- Van Vleet, E. S., and Quinn, J. G. "Input and Fate of Petroleum Hydrocarbons Entering the Providence River and Upper Narragansett Bay from Wastewater Effluents." (See complete entry in Section IV.)
- Vongvisessomjai, S., and Srikanthan, R. "The Regimen of Takuapa Tidal Channel." (See complete entry in Section I.)
- Vreugdenhil, C. B. "Application of Finite-Difference Methods to Estuary Problems." (See complete entry in Section I.)
- Wade, T. L., and Quinn, J. G. "Incorporation, Distribution and Fate of Saturated Petroleum Hydrocarbons in Sediments from a Controlled Marine Ecosystem." (See complete entry in Section IV.)
- fWadsworth, J. R., Jr. "Geomorphic Characteristics of Tidal Drainage Networks in the Duplin River System, Sapelo Island, Georgia." (See complete entry in Section I.)
- Wadsworth, J. R., Jr. "Structural Control of Drainage Morphology of Salt Marshes on St. Catherine's Island, Georgia." (See complete entry in Section I.)

- Wang, Y.-H. "Satellite Applications on a Coastal Inlet Stability Study." (See complete entry in Section VII.)
- Ward, G. H., Jr. "Pass Cavallo, Texas; Case Study of Tidal-Prism Capture." (See complete entry in Section V.)
- Ward, L. G. 1978. "Hydrodynamics and Sediment Transport in a Salt Marsh Tidal Channel," <u>Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3,</u> <u>1978, Hamburg, Germany</u>, ASCE, II:1953-1969.

Processes and sediment transport were investigated in a salt marsh drainage system at Kiawah Island, South Carolina. A general survey of the tidal current was done in the major tidal channel (Bass Creek) for a 10-tidal-cycle period in August 1977. Detailed determinations of current velocity, discharge, and suspended load were conducted during 15 tidal cycles in March 1977 and again during 8 tidal cycles in July-August 1977. For each of these periods, mass budget for the total suspended load was computed. The tidal currents have a pronounced time velocity asymmetry with the maximum current velocity occurring nearer high slack water and the peak ebb velocity being 20-30 percent stronger than the flood. Suspended load transport is significantly affected by the time velocity asymmetry. Peak current occurring nearer high slack water causes a net displacement of suspended material in an ebb or seaward direction under normal conditions. This process is enhanced by the stronger ebb currents. Mass budgets reflect the ebb dominance of the system showing a net export of combustible (organic) material during the March sampling period and a net export of both noncombustible (inorganic) and combustible material during the July-August period. Also important to suspended load transport in marsh systems are stressed meteorological conditions. High winds or heavy rains increase suspended load concentration and can cause significant import or export of fine-grained material. References (22 items).

Wells, J. T., Coleman, J. M., and Wiseman, W. J., Jr. 1978. "Suspension and Transportation of Fluid Mud by Solitary-Like Waves," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, II:1932-1952.

The suspension and transportation of fluid muds in the nearshore zone by shallowwater, solitary-like waves have been investigated along the coast of Surinam, South America. Accumulations of fluid mud which front the coast at a spacing of 30-60 km affect incoming swell by changing the wave profile from sinusoidal to 60

solitary-like and by preventing wave breaking except for occasional spilling. Simultaneous time-series measurements of wave height and period, fluid-mud density, and tide elevation, along with results of suspended-sediment measurements, indicate that in cases when the bulk density is less than 1.20 g/cm^3 and where water depths are less than 5 m, fluid mud is suspended from the bottom in two frequency modes: wave-by-wave suspension (~10 sec) and tide-related suspension (~12.4 hr). Surface-water suspensate concentrations exceed 3.4×10^3 mg/t as up to 0.5 m of fluid mud is periodically removed from the bottom. High concentrations of suspended fluid mud, together with solitary-like waves from the northeast throughout the year, can lead to extraordinarily high sediment transport volumes. Calculations based on solitary wave theory and on data obtained from this study indicate that $15-65 \times 10^6$ m³ of mud can move alongshore each year without involving breaking waves, the concept of radiation stress andsa nearshore circulation cell, or bedload transport. These values are 10 to 100 times greater than typical transport rates along sandy coasts. References (26 items).

- Williamson, A. N. "Movement of Suspended Particles and Solute Concentrations with Inflow and Tidal Action." (See complete entry in Section VIII.)
- Wong, G. T. F., and Moy, C. S. 1984. "Cesium-137, Metals and Organic Carbon in the Sediments of the James River Estuary, Virginia," <u>Estuarine, Coastal and Shelf</u> <u>Science</u>, 18(1):37-49.

A wide variety of sedimentary subenvironments are found within a 10-km stretch of James River including a flood-dominated channel (Rocklanding Channel) and its bank (Rocklanding Shoal), a shoal with a water depth of 1 m separating two channels (Point of Shoals), an ebb-dominated channel (Burwell Bay Channel) and its bank (Burwell Bay Bank), and a tributary (Warwick River). The concentrations of Cs-137, copper, lead, zinc, and organic carbon in the fine-grained sediments (i.e., <63 um) and the amount of finegrained sediments in eight cores covering these subenvironments were determined. The sedimentation rates, estimated by Cs-137 geochronology, range from 0.4 to >3 cm year -1. The sedimentation rates in the Burwell Bay region are two or more times those in the Point of Shoals and in the Rocklanding Channel and Shoal, reflecting the weaker currents in the Burwell Bay region. These sedimentation rates agree well with those obtained independently by measuring changes in the bathymetry of this area between 1873 and 1943. The concentrations of Cs-137,

copper, lead, zinc, and organic carbon in surface sediments vary by a factor of two to three. The concentrations are higher in the Burwell Bay region, probably as a result of the higher rates of accumulation of recently formed sediments in these subenvironments. The inventories of finegrained sediments and of Cs-137, copper, lead, zinc, and organic carbon accumulated since 1954 are also up to an order of magnitude higher in the Burwell Bay region. Although the concentrations of finegrained sediments in three cores obtained in this region are similar, the inventories still vary by a factor of two to three. The inventories of Cs-137, copper, lead, zinc, organic carbon, and finegrained sediments correlate well with each other indicating that Cs-137 can be a useful tracer for studying the fate of these metals and organic carbon in estuarine environments. The inhomogeneity of the concentrations and inventories of the different elements along a 10-km segment of a river suggests that a closely spaced sampling program is essential for characterizing the sedimentary provinces within an estuary. The concentrations of Cs-137, metals, and organic carbon in the coarsegrained sediments (i.e., >63 µm) are considerably lower than those in fine-grained sediments. Thus, the contribution of coarse-grained sediments to the total inventory of these elements is small. References (43 items).

Yarbro, L. A., et al. 1983. "A Sediment Budget for the Choptank River Estuary in Maryland, U.S.A.," <u>Estuarine Coastal and</u> <u>Shelf Science</u>, 17(4):555-570.

A sediment budget for the Choptank River, one of the three largest estuaries on the eastern shore of Chesapeake Bay, was developed from measurements of sediment carried in upland runoff, shore erosion, sedimentation, and levels of suspended sediments in estuarine waters. Shore erosion was the major source of sediment $(340 \times 10^6 \text{ kg year}^{-1})$, contributing seven times more sediment than upland runoff. Low relief, the rural character of the Coastal Plain drainage basin, and the susceptibility of poorly consolidated shoreline materials to erosion contributed to the dominance of shore erosion over runoff as a sediment source. Box modelling indicated a net annual flux ('4-44 - ') kg year 71) of sediment from the Choptank River to Chesapeake Bay. A mass balance estimate of sedimentation, calculated as the difference between total inputs and loss at the mouth of the est ary 350 - 106 kg year-on, agreed well with an estimate based or a Pb profiles (34) - 105 kg year to measured as mightne congstuding axis of the estuary. Lead-. ' sed.mentation nates correspond to an unit of rates of the 1.4 mm war . وودا فالمراجع فالهوجا 13th thomas

Youakim, S., and Reiswig, H. M. 1984. "The Distribution and Flux of Particulate Matter in the Bideford River Estuary, Prince Edward Island, Canada," <u>Estuarine, Coastal</u> <u>and Shelf Science</u>, 18(5):511-525.

The temporal and spatial distribution of total and organic particulate matter is investigated in the Bideford River estuary. Particulate matter is homogenously distributed in both the water column and the surface sediment, due to high rates of resuspension and lateral transport. The measured mean sedimentation rate for the estuary is 183.5 g of particulate matter m^{-2} day⁻¹, of which more than half is due to resuspension. The surface sediment of the estuary is quantitatively the dominant reservoir of organic matter, with an average of 902.5 g of particulate organic carbon (POC) m^{-2} and 119.5 g of particulate organic nitrogen (PON) m⁻². Per unit surface area, the sediment contains 450 times more POC and 400 times more PON than the water column. Terrestrial erosion contributes high levels of particulate matter, both organic and inorganic, to the estuary from the surrounding watershed. Low rates of sediment export from

the estuary result in the accumulation of the terrigenous material. The allochthonous input of terrigenous organic matter masks any relationship between the indigenous plant biomass and the organic matter. In the water column, a direct correlation exists between the organic matter, i.e., POC and PON, concentration and the phytoplankton biomass as measured by the plant pigments. Resuspension is responsible for the residual organic matter in the water column unaccounted for by the phytoplankton biomass. The particulate content of the water column and the surface sediment of the estuary is compared to that of the adjacent bay. Water-borne particulate matter is exported from the estuary to the bay, so that no significant differences in concentration are noted. The estuarine sediment, however, is five to six times richer in organic and silt-clay content than the bay sediment. Since sediment flux out of the estuary is restricted, the allochthonous contribution of terrigenous particulate matter to the bay sediment is minor, and the organic content of the bay sediment is directly correlated to the autochthonous plant biomass. References (26 items).

SECTION III. SALINITY EFFECTS

Saltwater intrusion, locks separating bodies of fresh and salt water, salinity currents, saltwater barriers, and contamination by salt water as distinguished from contamination from other sources.

- Abbott, M. B., Schrøder, H., and Warren, I. R. "Modelling of the Salinity Intrusion in the Sound Between Denmark and Sweden." (See complete entry in Section VI.)
- Abraham, G. "On Internally Generated Estuarine Turbulence." (See complete entry in Section I.)
- Anwar, H. O. 1980. "Measurements on Entrainment Through a Front," <u>Proceedings,</u> <u>Second International Symposium on Stratified Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 1:143-153.

The flow of a freshwater front over a saltwater mass at rest was produced when a partition, dividing these two fluids, was raised quickly. The moving layer was steady and was separated from the salt water by a stable interface. This type of flow can occur at the mouth of an estuary when high freshwater flow predominates over tidal flow. A study was made on the flow structure and the entrainment process of an advancing freshwater front flowing two-dimensionally over a pool of salt water. The leading front was wedge shaped with a pointed tip. At a certain distance from the tip, there was a rapid growth in the layer thickness associated with an increase in saltwater concentration, mainly due to the development of a highly turbulent flow having a large-scale structure. In this region a large amount of the underlying salt water was entrained across the interface. The turbulence intensity of salt water and of velocity fluctuation was large. Beyond this region the large-scale structure fragmented; the turbulence was no longer active, with very little, if any, entrainment. The density and the velocity profiles in the active and nonactive turbulent regions were selfsimilar. The coefficient of entrainment decreases rapidly as the Richardson number rises. References (6 items).

- Anwar, H. O. "Turbulence Measurements in Stratified and Well-Mixed Estuarine Flows." (See complete entry in Section I.)
- Anwar, H. O., and Weller, J. A. 1981. "An Experimental Study of the Structure of a Freshwater-Saltwater Interfacial Mixing," La Houille Blanche, 36(6):405-412.

This paper describes the results of an experimental study of fresh water which flows two-dimensionally over a still pool of salt water. This type of flow can be observed when heated cooling water is discharged from a power station horizontally onto the surface of a lake or reservoir, or in an estuary where the outflow of fresh water mixes with underlying salt water: the flux of brackish water increases with the distance downstream from the head of the estuary. In these types of flow, the depth of the lighter fluid at the mouth is usually high, being of the order of 2-3 m; and the mouth densimetric Froude number (defined later) is about unity or less, indicating that the mixing process of the surface layer is dominated mainly by buoyancy rather than momentum. In most previous laboratory studies, measurements were carried out for jet-type flow, for which the densimetric Froude number was high with a shallow depth of flow at the inlet. The object of the present investigation is to study the cases in which the densimetric Froude number is low, varying between 0.5 and 2, and the depths of fresh water, which are relatively large, vary between 0.08 m and 0.12 m. It is assumed that the flow structure and the turbulent mixing process that occur in this study are similar to those occurring in nature. Experimentally fresh water was released two-dimensionally from a wide channel onto the surface of stationary salt water with density of 1,025 kg/m³ held in a wide, deep flume. During the experimental runs, salt water was supplied gently at a constant rate along the bottom of the flume in order to obtain a steady surface flow. Mean velocity and density profiles, together with their turbulence intensities, were measured at various sections downstream from the inlet. Entrainment was measured directly from saltwater supply, and it was also determined from density profiles. References (37 items).

- Boyden, C. R., Aston, S. R., and Thornton, I. "Tidal and Seasonal Variations of Trace Elements in Two Cornish Estuaries." (See complete entry in Section II.)
- Breusers, H. N. C., and van Os, A. G. "Physical Modelling of the Rotterdamse Waterweg Estuary." (See complete entry in Section VI.)
- Brown, W. D., and Arellano, E. "The Application of a Segmented Tidal Mixing Model to the Great Bay Estuary, N.H." (See complete entry in Section VI.)
- Chu, W.-S., and Willis, R. "Mathematical Modeling of Humboldt Bay." (See complete entry in Section VI.)
- Chu, W.-S., and Yeh, W. W-G. "Parameter Identification in Estuarine Modeling." (See complete entry in Section VI.)
- Chu, W.-S., Yeh, W. W-G., and Kristof, R. C. "Mathematical Modeling and Parameter Identification in a Two-Dimensional Estuary: Case Study of the Hydraulic Model of the San Francisco Bay and Delta." (See complete entry in Section VI.)

- Coastal Sediments '77, Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE. (See complete entry in Section II.)
- Connell, D. W., et al. "Effects of a Barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland." (See complete entry in Section V.)
- Crout, R. L., and Murray, S. P. "Shelf and Coastal Boundary Layer Currents, Miskito Bank of Nicaragua." (See complete entry in Section VIII.)
- Dandy, G. C., Mills, D. A., and Hinwood, J. B. "Water Movement Studies Required for Port Planning." (See complete entry in Section I.)
- Devine, M. "Some Features of the Dynamic Structure of a Deep Estuary." (See complete entry in Section VI.)
- Drapeau, G., and Fortin, G. "Tidal Sedimentation in Gros-Cacouna Harbor." (See complete entry in Section II.)
- Dyer, K. R. 1982. "Mixing Caused by Lateral Internal Seiching Within a Partially Mixed Estuary," <u>Estuarine, Coastal and</u> <u>Shelf Science</u>, 15(4):443-457.

The salinity fluctuations at an STD near the halocline in Southampton Water have been spectrally analyzed. Mixing is shown to commence at a layer Richardson number of about 20. The predominant energy inputs have periods of 7-9 and 3.5-4.5 min. These motions arise from lateral internal seiching and it is considered that they are produced by interaction of the surface seiche with the shallow side of the estuary. The wavelengths of the standing wave are calculated to be about 120 and 60 m, respectively, and these compare well with echo-sounding surveys of the elevation of the halocline. References (22 items).

- Dyer, K. R. "The Mixing Processes in a Partially Mixed Estuary: Southampton Water." (See complete entry in Section VII.)
- Edinger, J. E., and Buchak, E. M. "Estuarine Laterally Averaged Numerical Dynamics: The Development and Testing of Estuarine Boundary Conditions in the LARM Code." (See complete entry in Section VI.)
- Fiadeiro, P. M. "Study of Water Quality in the Tagus Estuary." (See complete entry in Section I.)
- Fischer, H. B., et al. <u>Mixing in Inland and</u> <u>Coastal Waters</u>. (See complete entry in Section I.)

- Fischer, K. "Numerical Salinity Intrusion Models." (See complete entry in Section VI.)
- Fischer, K. "Numerical Tidal-Salinity Models of the Ems Estuary." (See complete entry in Section VI.)
- Gardner, G. B., and Smith, J. D. "Observations of Time-Dependent, Stratified Shear Flow in a Small Salt-Wedge Estuary." (See complete entry in Section I.)
- Garofalo, D. 1980. "The Influence of Wetland Vegetation on Tidal Stream Channel Migration and Morphology," <u>Estuaries</u>, 3(4):258-270.

Average relative stream channel migration rates of 0.21 m per year (0.72 ft per year) for saline tidal wetland stream channels, and 0.32 m per year (1.04 ft per year) for freshwater tidal wetland channels were calculated for a 32-year period (1940 to 1972) using photogrammetric techniques. Saline wetland stream channels averaged higher indices of sinuosity, i.e., the ratio of total channel length to linear downstream distance (1.95), when compared with sinuosities of freshwater tidal channels (1.46). The difference is attributed to differences in vegetation types and consequent soil holding capacity between saline and freshwater tidal wetland environments. Saline channels become entrenched because the banks are supported by dense root systems, while freshwater tidal channels flow through a more homogenous substrate and behave much like channels which cross mudflats in the intertidal zone. Higher average meander amplitudes (one-half the peak to trough distance of a given meander wave) for saline channels (171 m) versus lower amplitudes for freshwater channels (114 m) suggest that meander loops for saline channels are determined primarily by the erosional characteristics of streambanks and by other local factors rather than by hydrodynamic factors such as flow velocity or discharge. It has been stated that meander migration features do not occur in homogenous soil materials (Leopold, et al., 1964); the tendency of saline channels to form these features is attributed to differential erosion caused by variations in root system density. Conversely, the morphology of freshwater tidal channels is influenced by hydrodynamic factors including discharge, and is due to the existence of more homogenous materials, i.e., muddy soils devoid of extensive root systems. An analysis of ebb and flood discharge data arrived at for each tidal channel using existing tidal current velocity and upland discharge records supports the fact that relatively greater erosive forces occur in salt marsh than in fresh tidal marsh areas. A poor

statistical correlation between rates of stream channel migration and hydraulic stream flow data such as velocity and discharge must be accepted with caution due to the method of approximating tidal discharge values. The correlation suggests that under normal tidal conditions both saline and freshwater tidal channels migrate little, if any, and thus represent an apparently balanced relatively low energy system. For this reason it is believed that most stream channel migration in both saline and freshwater wetlands occurs as a result of increased forces due to storms. References (17 items).

Garvine, R. W. 1977. "River Plumes and Estuary Fronts," <u>Estuaries, Geophysics,</u> <u>and the Environment</u>, National Academy of Sciences, Washington, D.C., 30-35.

The manner in which fresh water flows down to the sea and mixes with it is one that varies greatly in nature. The extremes of the possibilities are marked, on the one hand, by a wide estuary where sea water moves inland well upstream of the mouth to meet the fresh water and, on the other hand, by a river whose lower valley is narrow, which confines its discharge so that the fresh water is forced out at its mouth to mix with salt water only offshore. This latter condition, in which a distinct plume of brackish water is produced beyond the mouth, is the principal concern of this paper. References (10 items).

- Gibbs, R. J. "Currents on the Shelf of North-eastern South America." (See complete entry in Section I.)
- Gibbs, R. J. "Suspended Sediment Transport and the Turbidity Maximum." (See complete entry in Section II.)
- Grabemann, I., Krause, G., and Siedler, G. 1983. "Long-Time Changes of Salinity in the Lower Weser" ("Langzeitige Änderung des Salzgehaltes in der Unterweser"), <u>Deutsche Hydrographische Zeitschrift,</u> 36(2):61-77 (In German).

Ever since construction has altered the estuary of the Weser River to make it more navigable, regular water samples have been collected at several stations along the river. Salinities were determined in order to assess possible changes as a consequence of the engineering activities. For almost 100 years the sampling scheme remained unaltered. Today this unique data set is of more than local interest. Whereas drastic changes of tidal phenomena are obvious from tidal gage measurements, natural fluctuations of salinity hide respective changes of the salinity distribution. An attempt has been made to

separate the natural from the man-made fluctuation of salinity using two simple models to eliminate known causes of natural fluctuations. Difficulties encountered were the incompleteness of the data set and the absence of data averaged over cross sections. Nevertheless it was possible to eliminate, approximately, the influence of the catchment area and salinity variations of the adjacent sea. Salinity variations as a consequence of the engineering works depend on the quantity $K = H^2/(\overline{A} \cdot \zeta_0)$, where H is the depth of a cross section with area \overline{A} averaged over the tides, and $2\zeta_0$ is the tidal elevation. Because of long-term changes of the tides in the North Sea, it was not possible to isolate the influence of the engineering works. Conclusions include consequences for modern sampling strategies to determine trends of water quality. References (25 items).

- Granat, M. A., and Gulbrandsen, L. F. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Hamilton, A. D. "Nontidal Circulation and Mixing Processes in the Lower Potomac Estuary." (See complete entry in Section I.)
- Hamilton, P. "Survey of Marine Wetland and Estuarine Water Quality and Ecological Problems in Corps of Engineers Field Offices." (See complete entry in Section V.)
- Hamrick, J. M. 1981. "Baroclinic Circulation and Dispersion in Estuaries," <u>Pro-</u> ceedings, Specialty Conference, Water Forum '81, San Francisco, Calif., August 10-14, 1981, ASCE, I:383-390.

The equations governing residual baroclinic circulation in partially stratified estuaries are derived and scaled for perturbation solution. A one-dimensional tidal cycle averaged mass transport equation is developed to close the baroclinic circulation solutions. In the onedimensional mass transport equation the longitudinal dispersion coefficient is decomposed into baroclinic and tidal driven or barotropic components. Relationships are given for calculating the dispersion coefficients, and applications of the mass transport equation for salinity intrusion and pollutant dispersion analyses are discussed. References (8 items).

Harper-Owes. "Duwamish Waterways Navigation Improvement Study: Analysis of Impacts on Water Quality and Salt Wedge Characteristics." (See complete entry in Section IV.)

- Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations and Their Response to Meteorological Conditions." (See complete entry in Section I.)
- Hickel, W. 1980. "The Influence of Elbe River Water on the Wadden Sea of Sylt (German Bight, North Sea)," <u>Deutsche</u> <u>Hydrographische Zeitschrift</u>, 33(4):43-52.

The transportation period of Elbe River water, admixed with the North Frisian coastal water, from the estuary to the outer Wadden Sea of Sylt was investigated using Elbe River floods (January 1975). The time difference between maximum salinity decrease at light-vessel "Elbe 1" off the Elbe estuary and that off List (Wadden Sea of Sylt) is 1 month. This is equivalent to a mean residual current velocity of 4.8 cm/sec, under the condition of winds from south-southwest with an average speed of 10.8 m/sec, and assuming that the Elbe water travels the shortest way north. Taking this transportation period into consideration, the quantitative relationship between the salinity off List (Y) (from 3 years' measurements) and both Elbe water discharge volumes (X,) (of the previous month) and local freshwater surplus (X_2) was calculated. It could be shown that the multiple linear regression function $Y = a + b_1X_1 + b_2X_2$ describes the relationship optimally (multiple and partial correlation coefficients significant at the 0.1 percent level). The partial regression coefficient b2 of this equation is by one order of magnitude higher than b_1 ; 10 m³/sec of local freshwater surplus would decrease the salinity off List to 0.2443‰ , whereas 10 m^3/sec of Elbe water would decrease it to 0.0275‰. Without the influence of these freshwater sources a mean salinity of 31.92%, would be found off List. Since the Elbe River discharged 52 times more fresh water during the investigation period than the local freshwater input (26 times more in winter, November to April), the Elbe water would decrease the salinity in the Wadden Sea of Sylt sixfold more in absolute terms (threefold more in winter) than the local freshwater surplus. This dominant influence of the Elbe water on the Wadden Sea of Sylt, situated 130 km north of the Elbe estuary, must have considerable ecological significance, since dissolved and finely suspended particulate matter from the Elbe River (at least the "conservative" components) will be carried to the Wadden Sea of Sylt at the same rate as follows from the calculations using salinity. References (10 items).

Hinwood, J. B., and Colman, R. S. "Use of an Echo Sounder to Map Vertical Stratification in an Estuary." (See complete entry in Section VII.)

Hunkins, K. 1981. "Salt Dispersion in the Hudson Estuary," Journal of Physical Oceanography, 11(5):729-738.

The seaward transport of salt by river discharge through an estuary is balanced under steady conditions by landward dispersion effected by various physical mixing processes. Observations of current and salinity in the lower Hudson estuary provide a basis for assessing the relative importance of these different dispersion processes. Wind effects were estimated from two moored current meter records of 1- and 2-month length. There was a significant but weak correlation between wind and currents. Three cross-sectional surveys each lasting 25 hr provide estimates of salt dispersion by other processes. Current and salinity data from the surveys were decomposed into various temporal and spatial means and departures from these means. Covariances between the various quantities are interpreted in terms of physical dispersion processes. The largest contributor to salt dispersion in the Hudson is the steady shear of gravitational circulation. Steady shear dispersion varies by a factor of 5 between spring high-flow and summer low-flow conditions. Dispersion by tidally varying shear was much lower in magnitude. Correlation between sectionally averaged current and salinity yields a paradoxical negative dispersion which can be explained in terms of two documented estuary characteristics, the tendency of bottom tidal currents to lead upper layer currents in phase and the increased longitudinal salinity gradient near the surface. References (16 items).

- Hutchison, I. P. G., and Midgley, D. C. "Mathematical Modelling of Water Level and Salinity Regimes in Some South African Lake and Estuary Systems." (See complete entry in Section VI.)
- Huzzey, L. M. "The Dynamics of a Bathymetrically Arrested Estuarine Front." (See complete entry in Section I.)
- Kawahara, M. "Periodic Finite Elements in Two-Layer Tidal Flow." (See complete entry in Section I.)
- Kawahara, M., and Hasegawa, K. "Finite Element Analysis of Two-Layered Tidal Flow." (See complete entry in Section VI.)
- Kendrick, M. P., and Derbyshire, B. V. "Effects of a Barrier on Existing Estuary Regime." (See complete entry in Section V.)

- Khorram, S. "Remote Sensing of Salinity in the San Francisco Bay Delta." (See complete entry in Section VII.)
- Kjerfve, B., ed. <u>Estuarine Transport Pro-</u> cesses. (See complete entry in Section II.)
- Krause, G. 1980. "Separation of Climatic Fluctuations and Impacts of Engineering Activities in Estuaries," <u>Proceedings</u>, <u>Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia</u>, ASCE, III:2325-2339.

Using salinity as an example of dissolved substances in estuarine waters, it is shown how the long-term trend of concentrations can be split up into a man-made and a climatic contribution. The understanding of long-term mixing processes and adequate sampling techniques is essential for this purpose. The physical state of the estuary can be described in terms of three basic variables: the river discharge, the filtered water level, and the filtered salinity. The river discharge represents the climatic fluctuations in the catchment area, and the filtered water level is a record of the large-scale weather pattern over the adjacent ocean basin. Salinity trends which cannot be attributed to these two variables must originate from man-made actions, such as dredging or other engineering activities which change the geometry of an estuary. Two models are used for the trend analysis: the simplest possible mixing equation, which always holds for a sufficiently long time scale, and a salt flux consideration. References (5 items).

- Kuo, C. Y., and Blair, C. H. "Comparison of Verified Physical and Mathematical Model." (See complete entry in Section VI.)
- Lentsch, J. W., et al. "Stable Manganese and Manganese-54 Distributions in the Physical and Biological Components of the Hudson River Estuary." (See complete entry in Section IV.)
- Lepetit, J. P., and Davesne, M. "Dynamics of Silt in Estuary, Residual Current or Flocculation Which Prevails?" (See complete entry in Section II.)
- Lewis, R. E., and Lewis, J. O. 1983. "The Principal Factors Contributing to the Flux of Salt in a Narrow, Partially Stratified Estuary," <u>Estuarine, Coastal and Shelf</u> <u>Science</u>, 16(6):599-626.

Observations of the velocity and salinity structure of the Tees estuary were made at eight stations along the estuary axis between Victoria Bridge and the sea during the summer of 1975. The measurements were made on ten separate tidal periods covering neap and spring tides. The data were

collected over a period of relatively low freshwater flows and the residual current was found to have a strong dependence on the Stokes drift. At the upstream stations, the residuals were more than an order of magnitude greater than the currents anticipated from the freshwater discharge. Although the mean stratification decreased as the tidal range increased. the vertical circulation was stronger on spring tides than on neaps. Vertical variations in the amplitude and phase of the tidal current result in a current which strengthens the vertical circulation. However, this effect only made a relatively small contribution to the observed vertical circulation. The relative contribution of the individual salt flux terms to the net upstream transport of salt varies along the estuary. As the estuary narrows, the contribution by the oscillatory terms dominates that from the shear in the steady state flow. Of these oscillatory terms, the correlation of velocity and salinity fluctuations plays a key role in the salt transport. The depth mean values make a greater contribution than deviations from the depth mean, and the flux due to phase variations over depth is smaller than either of these. Since the Stokes drift is compensated by a downstream steady state flow, it does not contribute to the tidal mean transport of salt. At the seaward end of the estuary, the salt fluxes due to the steady state vertical shear and the covariance of the tidal fluctuations act in a complementary way to counter the seaward transport of salt by the freshwater flow. With the possible exceptions of the wide or narrow reaches of the Tees, the longitudinal fluxes of salt due to transverse variations in velocity, salinity and depth and turbulent fluctuations are of secondary importance as contributors to the estuary salt budget. On both neap and spring tides, the computed total salt transports at the Newport and Victoria bridges did not match the values required for a salt balance with the corresponding freshwater flows. These fluxes were probably the cause of the observed downstream displacement of the tidal mean salinity distribution between neap and spring tides. References (23 items).

- Lin, P., Dai, Z., and Li, K. "Unsteady Flow Studies in China." (See complete entry in Section I.)
- Liu, S. K., and Leendertse, J. J. "Three-Dimensional SGC Energy Model of Eastern Bering Sea." (See complete entry in Section VI.)
- Lundgren, H. "Struggle of Physics and Mathematics." (See complete entry in Section 1.)

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- McAnally, W. H., Jr., Brogdon, N. J., Jr., and Stewart, J. P. "Columbia River Estuary Hybrid Model Studies; Report 4, Entrance Channel Tests." (See complete entry in Section VI.)
- Mangarella, P. A., and Robilliard, G. A. "Thermal and Biological Impact of LNG Vaporizer Discharge." (See complete entry in Section V.)
- Marche, C. 1978. "Stability Study of an Artificial Salt Intrusion in Estuaries," <u>Proceedings, Sixteenth Coastal Engineering</u> <u>Conference, August 27-September 3, 1978,</u> <u>Hamburg, Germany, ASCE, III:2798-2809.</u>

The stratification and salinity structure of the water mass in the lower portions of tidal estuaries are important factors of the general circulation and local water quality. In natural conditions an equilibrium can be observed in each estuary and depends on the geometry of the estuary, the motion of tides inside the estuary, and the freshwater discharge. Extensive studies of the salinity structure in the estuaries of the La Grande and Grande Baleine rivers have shown that water of high salinity content will be expected along the total length of the estuary, for the discharge expected during the fill-up period. Sandbars being present in several transverse sections in these estuaries, it is of the greatest importance to verify if the salt water introduced upstream of these bars by a provisional modification in the freshwater discharge would not be definitely present. This paper presents the relevant parameters, the theoretical formulation, and the results obtained for the above-mentioned estuaries. References (3 items).

Marche, C., et al. 1978. "A Study of the Influence of River Discharge Regulation on the Salinity Equilibrium in the Estuary," <u>Proceedings, International Conference on</u> <u>Water Resources Engineering</u>, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:219-231.

The salinity structure and the stratification of the water mass of an estuary are analyzed under natural and modified river conditions. The different steps of this analysis are explained. Special attention is given to the data required for the practical application of the different methods used. As an example, results of such an analysis are presented for the La Grande Hiver. This river will be the site of a hydroelectric development which will modify completely the freshwater flow in the lowest part of the river.

Matsuraga, K., et al. 1984. "Behavior of Organically-Bound from in Seawater of Estimates," Estimating, "Gastal and Shelf Sectors, 1999 (15-122). Behaviors of organically-bound iron in an estuary having normal primary production and in a red tide outbreak estuary were investigated. In the former, the iron complex decreases with increasing salinity because of its flocculation. In the latter, the iron complex, as well as nutrients except silicate, is completely assimilated by phytoplankton. Among nutrients, silicate diffuses by only water mixing because the main species of phytoplankton were green colored algae at the river mouth. High nitrite concentration was found at about 15% salinity. This means that the decomposition of phytoplankton as well as photosynthesis is also carried out. The iron complex assimilated would be released to seawater with the decomposition of phytoplankton, and then red tide outbreaks at the estuary would be continued for a long period. References (19 items).

- Milford, S. N., and Church, J. A. "Simplified Circulation and Mixing Models of Moreton Bay, Queensland." (See complete entry in Section VI.)
- Muench, R. D., and Coachman, L. K. "Energy Balance in a Highly Stratified Embayment: Norton Sound, Alaska." (See complete entry in Section I.)
- Muir, L. R. "Internal Tides in a Partially-Mixed Estuary." (See complete entry in Section I.)
- Muralikrishna, I. V., and Devanathan, R. "Circulation and Salinity Distribution in Coastal Inlets." (See complete entry in Section VI.)
- Najarian, T. O., Wang, D-P., and Huang, P-S. "Lagrangian Transport Model for Estuaries." (See complete entry in Section VI.)
- Nece, R. E., and Scheffner, N. W. "Field Data Analysis for Chesapeake Bay Model Verification." (See complete entry in Section VIII.)
- Novak, P., and Čábelka, J. <u>Models in Hy-</u> <u>draulic Engineering; Physical Principles</u> <u>and Design Applications</u>. (See complete entry in Section VI.)
- O'Connor, D. J., and Lung, W. "Suspended Solids Analysis of Estuarine Systems." (See complete entry in Section VI.)
- Odd, N. V. M. "Significance of Long-Period Tidal Oscillations in Estuaries." (See complete entry in Section I.)
- Odd, N. V. M., and Baxter, T. "Port of Brisbane Siltation Study." (See complete entry in Section VI.)

- Odgaard, J. "Salt Exchange by Salt Fingers." (See complete entry in Section VI.)
- Officer, C. B., and Lynch, D. R. 1981. "Dynamics of Mixing in Estuaries," <u>Estu-</u> <u>arine, Coastal and Shelf Science</u>, 12(5):525-533.

The one-dimensional, advective-dispersive equation for a nonconservative substance is reformulated such that salinity replaces longitudinal distance as one of the independent variables. This general formulation is used to discuss the concept of concentrate-salinity mixing curves. The importance of temporal variations and loss terms in distorting these curves is illustrated by solving the transformed equation for simple cases. Procedures for measurement, interpretation, and prediction of mixing curves are discussed. References (6 items).

- Ozturk, Y. F. "Mathematical Modeling of Dispersion in Mixed Estuaries." (See complete entry in Section VI.)
- Pape, E. H., III, and Garvine, R. W. "The Subtidal Circulation in Delaware Bay and Adjacent Shelf Waters." (See complete entry in Section VI.)
- Partch, E. N., and Smith, J. D. 1978. "Time Dependent Mixing in a Salt Wedge Estuary," <u>Estuarine and Coastal Marine</u> <u>Science</u>, 6(1):3-19.

Measurements of the profiles of salinity and velocity at a station in the Duwamish River estuary indicate that the turbulent mixing through the density interface is highly time dependent with the most intense mixing occurring at the maximum current speed during the ebb. Additional measurements of the turbulent kinetic energy and the turbulent flux of salt by the eddy correlation technique verify that interpretation. The vertical turbulent salt flux and the turbulent kinetic energy vary by an order of magnitude over the tidal cycle, and approximately half of the total vertical salt transport takes place during a short time centered about the maximum ebb. Different mechanisms of turbulence generation operate at various times during the tidal cycle, and the intense mixing periods are shown to coincide with conditions favorable for the formation of an internal hydraulic jump. References (15 items).

Partheniades, E., Dermisis, V., and Mehta, A. J. 1980. "Graphs for Saline Wedges in Estuaries," <u>Civil Engineering</u>, 50(1):90-92.

This paper presents an approach for predicting the shape of and change in the longitudinal extent of saltwater intrusion in a stratified estuary for specified geometries for those concerned with the effects of altering the flows of an estuary, such as by dredging. References (4 items).

- Pickrill, R. A., Irwin, J., Shakespeare, B. S. "Circulation and Sedimentation in a Tidal-Influenced Fjord Lake: Lake McKerrow, New Zealand." (See complete entry in Section II.)
- Pitblado, R. M., and Prince, R. G. H. 1977. "The Application of a Two-Layer Time-Dependent Model to Pollution Assessment and Control in a Short Stratified Estuary," <u>Progress in Water Technology, Eighth International Conference on Water Pollution Research</u>, 17-22 October 1976, Sydney, Australia, 9(1):217-231.

The estuary and its tributaries are segmented into 22 sections, each section being composed of two perfectly mixed boxes representing the upper and lower layers. Salinity blochemical oxygen demand (BOD), and dissolved oxygen (DO) are predicted in every box each 20 min following closely the variations due to tidal flow. Comparisons between two experimental runs and predictions are given. An important use of the mode, is to predict transient pollution levels in the estuary after a major storm. A simulation of such a storm is included and the bulk movement of pollution seawards and from the upper and lower layer is clearly demonstrated. Several applications of the model to pollution control and enforcement are outlined, including the identification of polluting sources and loads and the design and interpretation of sampling schemes. Both one-dimensional and twolayer models are discussed. The experimental procedure requires salinity, BOL, and DO to be determined at five represertative locations and at two depths. A.1 significant freshwater inputs in the upper river are measured as well as the seawards boundary conditions. The present model is limited in that it only predicts salirity. BOD, and DO. The two-layer model portains a considered balance between the hydrallic and pollution descriptive composition Ar advantage of this simple hydrain description is that a relatively simple computer model results. The model may reused for several specific applications. including abatement planning especies . for those estuaries subject to make the sient loads, organization of eff. sampling programs and interpretation of resulting data, and identify at the time nature and location of periodicry 1 se

 Bay Hydraulic Model Investigation." (See complete entry in Section VI.)

- Richards, D. R., and Morton, M. R. "Norfolk Harbor and Channels Deepening Study; Report 1, Physical Model Results; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Robinson, I. S. "A Tidal Flushing Model of the Fleet--An English Tidal Lagoon." (See complete entry in Section VI)
- Rodger, 2 0. "Simulation of Stratified Flows in Estuaries." "See complete entry in Section 12.1
- Scheffner, N. W., et al. "Verification of the Chesapeake Bay Model; "Desapeake Bay Hydraulic Model Investigation " . Den complete entry in Section VI.
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Continental Shelf." (See complete entry in Section I.)

- Simpson, J. H., and Nunes, K. A. "The Tida. Intrusion Front: An Estuarine Convergence Zone." (See complete entry in Section 1.)
- Smith, R. 1978. "Effect of Salt Upon Hot-Water Dispersion in Well-Mixed Estuaries," <u>Estuarine and Joasta, Marine Science</u>, 7(5):445-454.

Temperature and salirity variations both give rise to bucyancy-driver corrents. Thus, when not water is discharged into estuaries, the flow is changed both by the heat and by the induced perturbation of the salinity distribution. If crosssectional mixing takes place in much less than the tidal period, then it can be shown that the salinity anomaly and the temperature distribution satisfy coupled nor inear diffusion equations. For wear budyarry efterts, the interactions are such as to despect o heat preferontial a is and the subscription of the processing of the subscription of t tratitre asymmetry between incard and sutto-sea logie - i orffochets can or as must as to per ert - <mark>Refe</mark>rences

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and such phenomena as the transitions of mixing states and the movement of internal vortex due to the tidal amplitude and tidal variation are discussed. Some considerations as the result of field investigation led to the determination of the application range and boundary conditions of the simulation model, supplementing important information and accuracy. References (3 items).

- Sündermann, J., and Holz, K.-P., ed. <u>Mathe-</u> <u>matical Modelling of Estuarine Physics,</u> <u>Lecture Notes on Coastal and Estuarine</u> <u>Studies</u>. (See complete entry in <u>Section I.</u>)
- Thatcher, M. L., and Harleman, D. R. F. "Long-Term Salinity Calculation in Delaware Estuary." (See complete entry in Section VI.)
- Uncles, R. J. "Hydrodynamics of the Bristol Channel." (See complete entry in Section I.)
- Uncles, R. J., and Jordan, M. B. 1979. "Residual Fluxes of Water and Salt at Two Stations in the Severn Estuary," <u>Estuarine</u> and <u>Coastal Marine Science</u>, 9(3):287-302.

Observations of currents and salinity are presented for two stations in the Severn Estuary; the observations extend over 50-hr periods at both stations, and the data are analyzed to provide estimates of the residual fluxes of water and sait. Relative to the depth-averaged values, the axia, residua, currents show a seaward flow in the upper layer, and a landward flow in the pottom layer for both stations, the associated salinity profiles show orly small differences in salinity between the seabed and the sea surface · • ... The tidally averaged velocity and wall rity profiles are used to estimate the effective vertical edgy viscosity and tifus with an or are applicable to beside variaties, estimated maximum values. energy of the content has and the one is a considered and the second complete and second and to per strings that the topes of the start angen et gener i te gener i te te te general i te egneration de la segneration de la segne The manner for why the real sign the state of the state of the state of the state of the state. and the first second as intracting for the same the and a second and the second and the second example and the example of the end of the en التوار فيوافيو فيوق • • • • • • • • • • • •

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position in the Tamar Estuary undergoes large seasonal variations. It is shown that these variations are a consequence of variable freshwater inputs to the estuary, and that axial distributions of surface salinity can be estimated with reasonable accuracy from the freshwater inputs using simple regression formulae. Flushing times and axial dispersion coefficients are computed for low runoff, spring tide conditions, when the estuary approaches the well-mixed state. The observed dispersion coefficients are compared with those predicted from theoretical considerations. Various shear dispersion mechanisms are investigated, as well as those due to tidal "random walk," and tidal "trapping." The estimated cross-estuary mixing due to tidal "random walk" is much greater than that which can be attributed to turbulence alone. Assuming this enhanced cross-estuary mixing, it is shown that the observed dispersion in the upper estuary can be attributed to transverse oscillatory shear. Dispersion in the lower estuary is more complex, and for low runoff, spring tide conditions, the most important individual process appears to be tidal "trapping." References (27 items).

- van de Kreeke, J., and Wang, J. D. "Tida. Hydraulics and Salt Balance of Lake Worth, Florida." (See complete entry in Section VI.)
- Vreugderh..., C. B. "Application of Finite-Difference Methods to Estuary Problems." (See complete entry in Section 1.)
- Walters, R. A., and Cheng, R. T. "A Twolimersional Hydrodynamic Model of a Tidal Estlary." (See complete entry in Section VI.)
- Walton, F., Jhanat, M. A., and Shubunski, F. F. Tha obratoop the chesapeake Bay In Lation Model⁹⁴ See omposite entry of section VC.

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- Ward, L. G. "Hydrodynamics and Sediment Transport in a Salt Marsh Tidal Channel." (See complete entry in Section II.)
- Welch, J. M., and Parker, B. B. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina." (See complete entry in Section I.)
- West, J. R., Knight, D. W., and Shiono, K. "A Note on Flow Structure in the Great Ouse Estuary." (See complete entry in Section I.)
- Winterwerp, J. C. 1983. "Decomposition of the Mass Transport in Narrow Estuaries," <u>Estuarine, Coastal and Shelf Science</u>, 16(6):627-638.

The mass transport as measured in the Rotterdam Waterway Estuary and in the tidal salinity flume of the Delft Hydraulics Laboratory is analyzed to obtain insight into the magnitude of the dispersive mass transport in narrow estuaries. It is found that the magnitude of the dispersive mass transport in the real-time onedimensional advection-diffusion equation varies considerably over the tidal cycle, that the ratio between the magnitude of the dispersive mass transport by the net vertical circulation and by the vertical oscillatory shear in the tidally averaged one-dimensional advection-diffusion equation decreases when the degree of stratification in the flume is decreased, and that the dispersive mass transport in the Rotterdam Waterway and in the tidal salinity flume is affected significantly by the mixing processes at sea near the estuary mosth. References (14 items).

Wiseman, W. J., Jr. 1979. "Hypersaline Bottom Water: Peard Bay, Alaska," <u>Estuaries</u>, 2(3):189-193. Also published as Technical Report No. 292, Coastal Studies Institute Center for Wetland Resources, Louisiana State University, Baton Rouge, La.

Hypersaline bottom conditions have been observed in Peard Bay, Alaska. The water appears to be renewed on an annual basis. Although it does not seem to affect permatrost degradation rates in Peard Bay, simliar pools of water along the Beaufort Sea coast could greatly increase the rates of permatrost degradation. Order of magnitude estimates suggest that the hypersaline waters do not become anoxid. Hefererces oft items.

Wolarsel, E. 1977. "The Fate of Storm Water and Stormwater Pollution in the Parramatta Estuary, Sydney," Augtralian Journal of Marine and Freshwater Research, 28(† 167-75)

2. The semantic draws are accessed the earliest and the second of the erration of a situation of the second sec over Sydney are responsible for strong stratification phenomena in the upper Parramatta River estuary following rainfalls. A simple model is proposed for the fate of storm water and its effects on the water quality of the estuary. References (15 items).

- Wood, T. "Discrete-Time Modelling of Dispersion in Estuaries." (See complete entry in Section VI.)
- Yakuwa, I., Takahashi, S., and Ohtani, M. 1978. "Behaviors of the Salt Wedge and the Salinity Distribution at Estuaries," <u>Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany</u>, ASCE, III:2746-2760.

The salt wedge has been observed by ultrasonic method at estuaries of the Ishikari, Shiribetsu, and Rumoi Rivers in Hokkaido, Japan. According to the records of the longitudinal profile of the salt wedge, behavior of the interface of salt and fresh water is strongly influenced by configurations of the watercourse and the riverbed. Therefore, in this paper, a distance from the front of the salt wedge to the river mouth is divided into two or three sections in accordance with behavior of the interface, and the salinity distribution in the upper layer is estimated in each section. By solving the differential equation of two-dimensional salinity diffusion, the distribution is represented by terms of flow velocity, diffusion coefficients, depth of the upper layer, and salinity at the boundary where diffusion coefficients are determined by comparing evaluated longitudinal distribution of surface salinity with observed ones. By estimating the rate of salinity entrainment into the upper layer, the entrainment coefficient. E at the interface is evaluated as $E = 0.4 + 10^{-5} = 0.8 + 10^{-5}$ at three estuaries. References (softems).

- Yarbro, L. A., et al. "A Sedimert Budget for the Choptark Hiver Estuary in Maryland, U.S.A." (See complete ertry in Section 11.)
- Yoshida, S. 1980. "Muking Mechanisms of Density Current System at a River Mouth," <u>Proceedings, Second International Symposium on Stratified Flows, The Norwegian Institute of Dechnology, Trondreim, 14-27 June 1980, Torklid Tarsters and Thomas Mediumans, ed., 1955-555</u>

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interface due to SVB. Here, SVA and SVB are named for the spiral vortices above and beneath the interface, respectively. SVC is equivalent to the K-H spiral of which the center coincides with the interface, and contributes only to offshore internal mixing. As the tide range becomes large, another spiral vortex (SVR) which generates in the wake of the bed roughness element has an important role for the mixing. The investigation extends also to external mixing mechanism as well as theoretical bases on the growth of the above spirals. References (13 items). STATION REPORT AND NOT AND AND A PROPER AND A PROPER ADDRESS AND A PROPER ADDRESS ADDRESS ADDRESS ADDRESS ADDRES

SECTION IV. CONTAMINATION

Contamination from sources such as industrial wastes or

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sewage, as distinguished from contamination by salt water

Aston, S. R., and Stanners, D. A. 1981. "Americium in Intertidal Sediments from the Coastal Environs of Windscale," <u>Marine</u> <u>Pollution Bulletin</u>, 12(5):149-153.

The distribution of americium in surface intertidal sediments from a coastal environment near the Windscale nuclear fuel reprocessing plant has been investigated. The study includes data on the broad scale distribution of 2+1Am in Northwest England, but focuses on the sediments of the Ravenglass estuary 10 km south of Windscale. The results indicate that americium concentrations in the inner estuary sediments are up to seven times higher than those from the Irish Sea itself. Americium distribution on silt banks is rather constant on a small scale, but varies considerably between adjacent silt bank and salt marsh areas. References (13 items).

Aston, S. R., and Stanners, D. A. 1982. "Gamma Emitting Fission Products in Surface Sediments of the Ravenglass Estuary," <u>Marine Pollution Bulletin</u>, 13(4):135-138.

The occurrence of some fission products from the Sellafield (formerly Windscale) nuclear fuel reprocessing facility has been determined for surface sediments from forty locations in the Ravenglass estuary, Northwest England. The influence of the silt-sized fraction in the sediments on the geographic distribution of ""Cs is clearly important, and to a lesser extert also influences the distributions of CARu, Chard + PhZr Nb and Charles The data are compared with recently published results reported by the Ministry of Agriculture, Fisheries and Food for a monitoring site in this estuary. Heferences '3 tems"

Astor, S. R., and Stannerk, D. A., 1982 "The Transport to and Deposition of Americium in Intertidal Sediments of the Haver glass Estuary and Its Relationship to Plutorium," Epvironmental Policytion Series Bi, 30101-9

The fistrobutions of a Amore four ores. of intertidal and ment from the Rapping, and estuary near the Wirdscale to order for reprocessing facility, contowest England, are reported. Maximum in Am activations up to 200 pC growthere tour the tepte in the sed ments, and this partment. ancomplation is compared with annous discharges to the sea to make the results indicate a sign transit. I energy in an tritte deprisation sed months when the sedumentation rates der used to im two or territor to methody and applied to show an en an temperature a temperature, ar e further constrained, ty access derigt and the (p) 21 (First Dame) - Administration (First Dame) - First Dame) - Administration (First Dame) - First Dame) - F ₩11 1946 ALLES 1 1 The Set 1 mer 1 5 . 1 1. 1. A. 1. A.

This slow movement is consistent with earlier theoretical and field data which indicate that americium is rapidly removed to sediments on release, and subsequently transported with bed loads in the coastal environment. References (10 items).

Aston, S. R., et al. 1981. "Plutonium Occurrence and Phase Distribution in Sediments of the Wyre Estuary, Northwest England," <u>Marine Pollution Bulletin</u>, 12(9):308-314.

The occurrence of plutonium isotopes derived from the Windscale reprocessing facility discharges and weapons test fallout in intertidal sediments of the Wyre estuary, Northwest England, is reported. Windscale plutonium appears to be slowly transported to the estuary in association with sedimentary material, and its distribution in surface and buried sediments is controlled by the variations in organic matter crotent of the sediments and/or their grain size characteristics. Results from chemical leaching experiments suggest that very little plutonium is ion exchangeable or in humic substances, but it is in other organic and Fe Mn hydrous oxide fractions of the sediments. Plutonium shows a similar depositional behavior to mercury, which enters the Wyre directly in local industrial discharges. References 115 items).

Baliga, B. R., and Hudspeth, R. T. 1981. "Evaluation of Sand Waves in an Estuary," Journal, Hydraulics Division, ASCE, 107(HY2):161-178.

The Bella-Williamson rate of sediment turnover-organic content of sediment (RST-OCS) dissection plane method integrates relevant physical, chemical, and biological analyses in order to estimate the chronic impacts of fredging on estimative ecosystems. A spectral analysis by a finite Fourier transform of estuarine sent waves is presented which only requires a spatial samt wave recent that is relatively easy to measure in contrast to stochastic analyses which reduine both spatial and temperal diservations of sard wave protones. The total energy sectors or equivalently, the stall string, vari and the state apparture was a wave proof on an t interlecture of the amount of the wave com there append to an open out to menality oppressional of mergen in an internet of the general gap in the form and the second second

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<u>Journal, Environmental Engineering</u>, ASCE, 109(1):17-35.

Using Kepone as the test compound, the relation of sediment suspension to fate of hydrophobic pollutants through adsorption is examined. Adsorption experiments show rapid attainment of an equilibrium condition that is a linear function of dissolved Kepone concentration and an inverse nonlinear function of adsorbing solids concentration. An apparatus creating a one-dimensional distribution of suspended sediment over a sediment bed is used to experimentally simulate an estuarine tidal cycle during which the transfer of Kepone from the bed to water column is examined. A mathematical model of the adsorption and sediment resuspension process is used to analyze the experimental results. Hesuspension and the variation of adsorption equilibrium with solids concentration are shown to be significant to the transfer. Adsorption kinetics are not significant because of the rapid approach to equilibrium. References (23 items).

- Devine, M. "Some Features of the Dynamic Structure of a Deep Estuary." (See complete entry in Section VI.)
- Elsinger, R. J., and Moore, W. D. 1984. "SefRa and StafRa in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze Hiver and Delaware Bay Estuaries," Estuarine, Coastal and Shelf Science, "8(6):601-613.

Pha and Plana have nonconservative excess concentrations in the mixing zones. of the Pee Dee River-Winyah Bay estuary, the Yangtze River estuary, and the Delaware Bay estuary. Laboratory experiments, ising Pee Dee River sediment, indicate description of 2.6Ra to increase with increasing salinities up to 20 . In Warysh Bay, description from river-borne sediments could contribute almost all of the increases for both isotopes. Desorption adds only a portion of the excess The measured in the Yangtze River and adjacent shelf waters and Delaware Bay. For the cargine River the mixing zone. extends over a considerable portion of the artaronty another whose cother as either to the water is an py dataster from bettem send meeting, which is they over extract least decrements them doubt and other structures of The group of the second to second prove that the second second second second second second second second second Bay promotion of the second sec

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- Fischer, H. B., et al. <u>Mixing in Inland and</u> <u>Coastal Waters</u>. (See complete entry in Section I.)
- Göhren, H., and Christiansen, H. "Ecological Aspects of a Deep Water Port in the Tidal Flats off the German Coast (Scharhörn)." (See complete entry in Section V.)
- Hamilton, P. "Survey of Marine Wetland and Estuarine Water Quality and Ecological Problems in Corps of Engineers Field Offices." (See complete entry in Section V.)
- Hamrick, J. M. "Baroclinic Circulation and Dispersion in Estuaries." (See complete entry in Section III.)
- Harper-Owes. 1981. "Duwamish Waterways Navigation Improvement Study: Analysis of Impacts on Water Quality and Salt Wedge Characteristics," US Army Engineer District, Seattle, Washington.

A review of historical water quality data and studies in the Duwamish Estuar, has revealed that several changes in water quality conditions have occurred since the mid-1960s. Surface water dissolved oxyger (DO) concentrations have dropped near the head of navigation in response to nitrification of increased ammonia discharge1 from the Renton Wastewater Treatment plant (HTP). However, salt wedge DO concentrations, which historically have been depressed to 1 mg t, have increased markedly following sewage diversion from the estiary in the late 1960s. This improvement was found to be principally due to decreased oxygen consumption in the weige Based or a comparison of total sa twater wedge consumption coalculated and set. ment oxygen demand (SCE) measurements taken during August 1973, wedge 19. uptake was found to be almost science perty (bottom/related) - Sther tasts south an s and wedges IR infreshwater angul, tota exitation, and reavation of the second tration base of charge the profile of and the second second

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tidal waters covering the sites. Correlations were observed between coliform counts, Cl⁻ content, and tidal heights. References (15 items).

- Kawahara, M., and Hasegawa, K. "Finite Element Analysis of Two-Layered Tidal Flow." (See complete entry in Section VI.)
- Knap, A. H., and Williams, P. J. LeB. "Experimental Studies to Determine the Fate of Petroleum Hydrocarbons from Refinery Effluent on an Estuarine System." (See complete entry in Section VI.)
- Knox, S., et al. 1984. "Statistical Analysis of Estuarine Profiles: II Application to Arsenic in the Tamar Estuary (S.W. England)," <u>Estuarine, Coastal and Shelf</u> <u>Science</u>, 18(6):623-638.

By combining field observations with a statistical approach and a simple but effective estuarine analogue, the main features of the cycling of arsenic in the Tamar estuary have been elucidated. As(III) and As(V) enrichment in the water column is due to a combination of localized inputs and effective recycling of sediment interstitial waters. The profiles of As(V) are similar to those of NH_+ and are dominated by an estuarine maximum resulting from an input from the sediments. As(III) profiles are correlated with those of dissolved manganese and exhibit both freshwater and estuarine maxima. As(III) appears to be effectively removed at the freshwater brackish water interface by a combination of heterogenous oxidation, catalyzed by hydrous manganese dioxide, and adscrption onto iron oxyhydroxide. The estuarine distribution of As(III) within the water column is consistent with the published rates of oxidation of As(III) to As(V) by both inorganic and microbiological processes. The reduction of As(V = to As(III)) in the sediments is incomplete. On the basis of observations, a tentative estuarine arsenic cycle is presented. References (28 items).

Lee, G. F. 1979. "Persistence of Chlorine in Cooling Water from Electric Generating Station," Journal, Environmental Engineering Livision, ASCE, 105(EE4):757-773.

A study of the persistence of chlorine is the cooling water discharged to the Peliware River estuary by the Philadelphia Electric Company Eddystone Generating Station showed that potentially toxic levels of chlorine were present 1 hr to 2 hr after discharge for organisms (plankton) entrained in the thermal discharge plume Hased or consideration of chlorine persistence-time of exposite relationships that exist in cooling water thermal plumes, little is no tokicty would be applied to the rote of exposite to the lash of constants of the disc fouling control at the Eddystone Electric Generating Station.

Lentsch, J. W., et al. 1971. "Stable Manganese and Manganese-54 Distributions in the Physical and Biological Components of the Hudson River Estuary," <u>Radionuclides</u> <u>in Ecosystems, Proceedings, Third National</u> <u>Symposium on Radioecology, May 10-12,</u> 1971, Oak Ridge, Tennessee, 2:752-768.

The concentrations of stable manganese and 5"Mn in water, suspended sediments, bottom sediments, plankton, rooted aquatic plants, and fish have been measured in samples from a 30-mile sector of the lower Hudson River Estuary during 1969 and 1970. Manganese-54 has been introduced into this section of the Hudson primarily in operational waste from the Indian Point unit 1 reactor. Manganese-54 data are presented both in terms of activity per unit sample mass and as specific activity. The manganese content of several species of rooted aquatic plants has been found to be proportional to the dissolved manganese concentration in water. However, several species of fish have been shown to regulate manganese uptake or loss and maintain relatively constant manganese levels, regardless of variable concentrations of manganese in water. Manganese dissolved in water appears to be more biologically available than sedimentary deposits of manganese, as indicated by the specific activities of 5"Mn in water, bottom sediment, and biota. Manganese has been found to leach from bottom sediments when seawater periodically intrudes into freshwater regions of the estuary, thereby increasing the concentrations of manganese in water. The use of concentration factors and specific activities in assessing the dosimetric consequences of homen releases into estuaries is discussed, and the limitations of these methods are pointed out. Supplementary data or salinity, freshwater discharge, suspended sediment load, water temperature, pH, and dissolved exygen are included to allow generalization of observed phenomera to other similar estuaries. References 122 items

Cobrach, A. S., et al. 198. "He gong Potoman Water Quality: Evolving Approaches," <u>Journal</u>, Environmental organ neering Covision, ASCE, 108-30 (560-577)

While an ambitious point source cleatroit program has yielded measurable improve ments in water guality of the Epper Potomax Blief Estuary, the degree to which additionally struct point source controls are needed is the subject of current smocestigations by Washington, i.e. (), metric point as a collection of current is attracted as the subject of collection and or product on our structure to end or product on our structure to end or product. No. of the second s

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despite public expenditures for advanced wastewater treatment. Contributing to poor water quality conditions are significant uncontrolled loadings of oxygen demanding material and nutrients estimated to come from natural sources, unregulated agricultural activities, urban stormwater and other nonpoint pollution sources generated locally and upstream of the Washington region. Area jurisdictions are beginning to reappraise the region's water quality control program with the intent of developing a more comprehensive program that considers pollutant loadings from all sources. Investigations will involve an assessment of the costs of achieving desired water quality levels, and a study of possible mixes of point source, nonpoint source, and combined sewer overflow controls. Studies will involve use of refined predictive models of the estuary which employ new information on the magnitude and fluctuation of pollution loadings. References (5 items).

Macdonald, G. J., and Weisman, R. N. 1977. "Oxygen-Sag in a Tidal River," <u>Journal,</u> <u>Environmental Engineering Division</u>, ASCE, 103(EE3):473-488.

Freshwater flow in a tidal river is incorporated in a dimensionless soluti n of derived equations for BOD and DO deficit, and profiles obtained with both a constant and a time variable dispersion coefficient are compared. Flow data from the Potomac River, Washington, D.C., are used in computer programs. Increases in river discharge decrease and translate downstream the points of maximum BOD and DO deficit. Time variation of the dispersion coefficient smooths BOD and DO deficit profiles and reduces their peak values. Decisions on the maximum DO deficit associated with a specific effluent outfall appear to be conservative when based on a solution with a constant dispersion coefficient. References (24 items).

Martin, J.-M., and Salvadori, F. 1983. "Fluoride Pollution in French Rivers and Estuaries," Estuarine, Coastal and Shelf Science, 17(3):231-242.

Fluoride concentrations have been determined in major French rivers and estuaries. The unpolluted estuary in the Loire has been compared with the Seine, Gironde, and Charente where important discharges occur. Natural dissolved concentration can be multiplied by a factor of 30. Particulate fluorine concentrations reach almost 2,000 ppm in the Seine estuary. The percentage between free and complexed dissolved fluoride is not affected. by the anthropic discharge. The present French rivers' discharge of fluoride is 700 percent higher than the pristine value. At a global scale, dissolved fluenide has probably increased by 25 percent.

compared with the natural situation. References (23 items).

†Mogolesko, F. J. 1978. "Development of an Analytical Technique for the Design of a Submerged Thermal Discharging System in a Tidal Estuary," Ph. D. Dissertation, New York University, School of Engineering and Science, New York.

The discharge of waste heat from electric power plants into coastal waters has the potential for adversely affecting the aquatic ecology of receiving waters. In this study, a semi-infinite, shallow receiving body of water is identified as the sink for waste heat from a nuclear power plant. From a review of the open literature, a multiport diffuser is identified as the preferred discharge system for the dispersal of heated discharge effluent. The analysis of the near field surface temperature rise induced by the multiport diffuser under variable tidal conditions is the primary objective of this study.

Montgomery, J. R. 1979. "Predicting Level of Dissolved Reactive Phosphate in the Lafayette River, Virginia, from Information on Tide, Wind, Temperature, and Sewagr Discharge," Water Resources Research, 15(5):1207-1212.

The Lafayette River in Norfolk, Virginia, is a shallow, turbid, urban estuary, polluted with primary treated sewage. The river was sampled monthly from October. 1979 to January 1972. Oxygen, temperature, and salinity values are vertically and laterally homogeneous in the Lafayett-River. The mean values of dissolved reactive phosphate (DRP) in the Lafayette River for the winter (1970-1971 and 1972) ranged from 2.2 to 5.8 microgram-atoms per liter (Lg-at t) and for the summer of 1971, 7.6 ug-at £. Multiple linear regression models were prepared to relate the daily changes in phosphate to tide. stage, wind component, and rate of phosphate discharge (kg hr) from the Lamberts Point sewage treatment plant. The equations for the August 1971 sample show that the effect of the tide stage is 3 times as important in the determination of the levels of DRE as the rate of flow of DRE from the sewage effluent on the ebbing tide and is equally as important as the rate of flow of DRP from the sewage etfluent on the flooding tide. The daily variations in off and more noticeable in the summer because of the higher of ertrations of phosphate in the latavette. River during this seasor. The increase of phosphate on the ebb tide and the decrease on the flood tide over a diriv every attrabuted to a doubtion of the water cost the Lafayette Fiver by the water of m Hampton Boyton Dho borostore at co Water temperaturo to the oriento at Here there the series of a strategy to ~ 1 . 1 . . .

to the increased biochemical activities of the microorganisms in the sediment water system. References (33 items).

Morris, F. W., IV, Walton, R., and Christensen, B. A. 1979. "Point and Nonpoint Pollutant Flushing in Tidal Canal Networks," <u>Hydraulic Engineering in Water Resources Development and Management, Proceedings, Eighteenth Congress, International Association for Hydraulic Research, Cagliari, Italia, 10-14 September 1979, 5:91-98.</u>

Extensive, branching networks of tidal canals often exhibit deteriorated water quality due to inadequate flushing, particularly at locations remote from the tidal entrance. Flushing, or the removal of pollutants by convection and dispersion, is effected principally by tidal fluctuations, secondary currents, and wind. Since the hydrodynamics in branching tidal networks is complex, it is necessary to use multidimensional models for the analysis and prediction of canal network flushing effectiveness. A threedimensional numerical model, based on the convective-diffusion equation solved by the method of second moments with a flexible cell structure, has been developed to assist in the analysis of flushing in tidal canal networks. This model predicts the concentration of a substance, as a function of location and time, for constant or time-varying pollutant inflows at any location in the network and for constant or time-varying winds. Results of simulations on various networks, using this model, show the most effective combination of values for canal network design variables for each particular network. References (6 items).

- Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in Marinas." (See complete entry in Section VI.)
- Novak, P., and Čábelka, J. <u>Models in</u> <u>Hydraulic Engineering; Physical Principles</u> <u>and Design Applications</u>. (See complete entry in Section VI.)
- O'Connor, D. J., Mueller, J. A., and Farley, K. J. 1983. "Distribution of Kepone in the James River Estuary." Journal, Environmental Engineering, ASCE, 109(2): 396-413.

An analysis is presented defining the distribution of an organic chemical in the water and bed of an estuarine system. The present structure of the model is a tidally averaged two-dimensional (longitudinal-vertical) main channel interacting with lateral embayments. The water column, segmented into two layers to incorporate the typical est arise circulation, interacts with a bed which is a se segmented into two layers, an active transport layer and a deeper stationary bed. Adsorption-desorption kinetics are included which, in the case of Kepone distribution of the James River, are assumed to be at equilibrium. Both steady-state as well as time-variable conditions are analyzed to calibrate the model to reproduce presently observed concentrations of Kepone. A procedure of analysis to address the problem of organic chemicals in estuaries has been structured. The procedure involves a series of analytic and computational steps, relating to the fluid transport, the solids distribution, and the concentrations of the organic chemical in the water and the bed. The model has been applied to analyze the temporal and spatial distribution of Kepone in the James River under both constant and time-variable freshwater flow conditions. Using actual hydrology and an assumed mass rate of input of Kepone, the concentration was calculated for a 10-year period of production, comparing well to observed values in the water and bed. Projections are presented to estimate the mass contained in the bed and that discharged to Chesapeake Bay. References (15 items).

Officer, C. B. 1981. "Tidal Exchanges and Far Field Effects," Journal Water Pollution Control Federation, 53(10):1551-1552.

The concern, here, is with the far field effects, that is, the wastes returned to the discharge area. Specifically, the discussion is limited to semienclosed bays connected to the ultimate coastal or ocean receiving waters for which the exchanges between the bay and coastal waters are dominated by tidal exchanges. If the dis charge is to an open coastal area with dominant coastal currents, the far field effects are often negligible. If the discharge is at some distance up an estuary, the discussion given here does not apriv and more sophisticated hydrodynam.c considerations must be included. References (4 items).

Olsen, C. R., et al. 1980. "Reactor-Released Radionuclides and Eine-Grained Sediment Transport and Accumulation Patterns in Barnegat Bay, New Jersey, and Adjacent Shelf Waters." Estuarine and Joastal Marine Science, 1910-119-142

A significant portion of ration condex introduced into the Barnegat day environment via global fallout from nuclear weaps sitesting and by low-level discharges from the Dyster Creek Nuclear derenating Station have been absorbed to through sized particles. These provide excellent tracers for fine-sequence to the sized of adoumulation patterns in the tay and adapent she for context. Sized proparticles of environment of the sized A KANGA DUNUN SASSA ANADA SANAA SANAA SANAA BASADA XAKAM DUDUSA BURGE BASAR

shore of Barnegat Bay at rates between 1 and 7 cm/year. Apparently 35-50 percent of the total 137Cs activity in the top 30 cm of the sediments in Oyster Creek is attributable to reactor releases; if transuranic releases have occurred from the Oyster Creek Reactor, the increments of 239, 240Pu and 238Pu are not distinguishable from the fallout Pu burden in the sediments; and radiocobalt is removed from the liquid effluent and stored in the sediments at least 20 times more effectively than radiocesium. A budget of ⁶⁰Co indicates that 40 percent of the 60Co released by the Oyster Creek Reactor resides in the sediments of Barnegat Bay. The accumulation and dispersal patterns of reactive activation products released during routine nuclear reactor operations help determine probable transport pathways of a wide variety of pollutants. References (27 items).

- Onishi, S., and Nishimura, T. "Study on Vortex Current in Strait with Remote-Sensing." (See complete entry in Section VIII.)
- Orlob, G. T. "Simulation of Estuarial Ecosystems." (See complete entry in Section VI.)
- Oriob, G. T. "Water Quality Modeling of Estuaries." (See complete entry in Section V1.)
- Owens, M. 1984. "Severn Estuary--An Appraisal of Water Quality," <u>Marine Pollution Bulletin</u>, 15-21:41-47.

The Severn-Trent, Wessex, South West, and Welsh Water Authorities established the Severn Estuary Joint Committee to manage the estuary. The Joint Committee was serviced by a Technical Working Party . The tasks of the Technical Working Party were too (a) evaluate all existing chemicil. biningical, and physical data available. for the estuary: b) evaluate all the water glality modelling exercises whilet have the undertaker on the estuary article assess treat iseformess for management of the estimate, of identify inadequal estimates those data and models. It organize the ne in the second contraction of the second c tratedracies' eliteration de la destructure -راجع المراجع فالمراجب فلمواص والموطات فالمعامو والمواجع enstrugty of the formation of the source of the source man grammer to source the source of the source of the conversion strugty was source of the source of the source general the state as extend a to the May compress and constraints and constraints of inner under gestelten bestelleren mit men mit Hengen Diesen warms in sachten bestellten. An end and the second of the second of the manned to the east of the second s n na serie (na serie (na serie)) na serie (na serie (na serie (na in the state of th

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discharged daily into the study area. The Severn Estuary Joint Committee (SEJC) has adopted as a policy that there should be no deterioration in overall water quality in the estuary. Since the evidence available indicates that the existing concentrations of contaminants of interest have not had any adverse effect, the standards adopted are based generally upon existing concentrations. To maintain the standards adopted, the constituent Water Authorities of the SEJC have agreed to consult each other before issuing consents to discharge to the estuary. The standards adopted are consistent with those recommended by the EC and Water Research Centre for implementation of the Directive on Dangerous Substances. References (15 items).

Partheniades, E. 1973. "Ecologic and Thermal Problems in Estuaries," <u>NATO Advanced</u> <u>Study Institute on Estuary Dynamics,</u> Lecture No. 13, Laboratório Nacional de Engenharia Civil, Lisbon, Portugal.

This paper presents the basic characteristics of estuarine systems, pollution and its effect on estuarine ecology, thermal pollution, and artificial ecological changes. It is evident that the proper development and protection of estuarine resources depend on the degree of knowledge of both the hydrodynamics and physical characteristics of the system as well as of the response of the individual species and of the entire estuaring ecosystem to man-made changes in the estuar reregime and in the water quality. Needs for future research and estimations management are also presented. References 32 items

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areas, tidal marshes) for fine sediments. These designations can be used for more cost-effective sampling, that is, "focused sampling" of sediments likely to contain pollutants. A sediment budget for the estuary indicates it is a sediment sink, with the largest input coming from landward sources. This analysis can serve as a guide to assessment and management of contaminated environments. References (25 items).

- Fives, S. F., and Pritchard, D. W. "Adaptation of J. R. Hunter's One-Dimensional Model to the Chesapeake and Delaware Canal System." (See complete entry in Section VI.")
- Hobinson, L. S. "A Tidal Flushing Model the Elect An English Tida Labour "Seccomplete entry in Section 41
- Schwarze, H., and Falldert, M. "Influence or Tempetature Increases - Tital Filens Gaused of Maste Heat Growtons with Respect to Tital Groups and Storm Surges S Service molecte entry, to Sector 1.
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lowest in the polluted inner reaches hear large coastal reclamations. The latter values, about 3.0 ug at. Pigto lower than in central Tolo Harbor, might reflect a selective adsorption of phosphate by reclamation sediments. Organic carbon concentrations were high in the inner reactes and decreased towards the outer charnes Correlations between phosphonus and Mrgable carbon were compared with a pub-, shed correlation for the east class of England. In Hong Kong, prosprior is con-Centellions showed a smaller interface as organics parts in choreaged, and reacted in a une-tout d'un the FrauxShirk uns so shake. Lamber approximed . . Ler with the termines 14 (* PRS

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In the sediments were mixed to a depth of 3-4 cm. Although only 12 percent of the total saturated hydrocarbons added to the system were found in the sediments, these hydrocarbons appear to be relatively stable and were still detectable in these

sediments for ≤ 6 months after the last oil addition. References (27 items).

Wood, T. "Discrete-Time Modelling of Dispersion in Estuaries." (See complete entry in Section VI.) SECTION V. REGULATION AND IMPROVEMENT

Examples and histories of prototype improvements, types and locations of improvements, materials and designs of structures, construction practices, dredging, and the practical aspects of regulation and improvement for navigation, sedimentation, and contamination, and other purposes, as contrasted to the theoretical aspects.

- Basu, A. N. "Composite Mathematical Model of Saptamukhi River System Including Outfail Channels for Studying the Effect of Closure." (See complete entry in Section VI.)
- Bohlen, W. F. "Factors Governing the Distribution of Dredge-Resuspended Sediments." (See complete entry in Section VIII.)
- Bohlen, W. F., and Marine Sciences Department, University of Connecticut. "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events." (See complete entry in Section II.)
- Brazier, A., and Strachan, W. V. 1978. "Swansea Channel--A Study of Waterways Management," <u>Managing the Coast, Fourth</u> <u>Australian Conference on Coastal and Ocean</u> <u>Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:113-122.

This paper discusses the findings of a recently released waterway planning study carried out by the N.S.W. Department of Public Works dealing with the tidal inlet to Lake Macquarie-Swansea Channel. References (20 items).

- Breusers, H. N. C., and van Os, A. G. "Physical Modelling of the Rotterdamse Waterweg Estuary." (See complete entry in Section VI.)
- Butler, H. L. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 3, Numerical Model Investigation of Plan Impact on the Tidal Prism of Lake Pontchartrain." (See complete entry in Section VI.)
- Carr, G. R. "Thames Flood Barrier." (See complete entry in Section I.)
- Chatham, C. E. "Los Angeles Harbor and Long Beach Harbor: Design of the Hydraulic Model." (See complete entry in Section VI.)
- <u>Coastal Sediments '77, Fifth Symposium of</u> <u>the Waterway, Port, Coastal and Ocean</u> <u>Division of ASCE</u>. (See complete entry in Section II.)
- Colman, R. S. 1978. "The Modification of a Natural Drainage System and the Subsequent Effects on a Small Estuary and its Surrounding Beaches," <u>Managing the Coast</u>, <u>Fourth Australian Conference on Coastal</u> <u>and Ocean Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:160-164.

The important role that satemment management can have or the environmenta. quality of small, sandy-coast estuaries, and the stability of the surrounding beaches, is illustrated by reference to a case study: Mondialioc Creek estuary The interrelationship between catchment drainage characteristics and freshwater flow variability, and the resultant effect on the estuary and beaches are discussed A typical history of land-coast systems after settlement is summarized. These changes have often necessitated significant morphological change to the estuary to accommodate catchment development, and have greatly altered the freshwater flow characteristics. The subsequent effects are described by analysis of the physical environment, estuary stratification, mixing processes, flushing rates under various flow conditions, and beach sediment movement. In the case study the major problems identified were lack of oxygen supply to the saline wedge of the estuary and the erosion of surrounding beaches. Various options for increasing the supply of oxygen are considered and the effects of current dredging procedures assessed. References (10 items).

Connell, D. W., et al. 1981. "Effects of a Barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland," <u>Australian Journal of Marine and Fresh-</u> water Research, 32(1):57-63.

Tidal exchange was found to flush the Fitzroy River estuary at a comparatively slow rate, leading to residence times of substances in the estuary of approximately 8 months both before and after barrage construction. The principal mechanism of flushing is displacement by freshwater inflow which gives residence times of 0.2-3.5 months. Freshwater inflow has been decreased by barrage construction and residence times consequently increased. Salinity and dissolved oxygen, total phosphorus, filterable reactive phosphorus, oxidized nitrogen and chlorophyll a concentrations were measured at stations located 20 to 110 km upstream from the mouth of the Fitzroy River. This included that section containing the barrage which was constructed 5 km upstream from Rockhampton. Under conditions of high river discharge (22.6 \times 10⁸ m³) little variation in water quality was found, but under low discharge conditions $(0.035 \times 10^8 \text{ m}^3)$ substantial reductions in dissolved oxygen concentration and increases in nutrient and chlorophyll a concentrations were noted in the zone below the barrage. These results are indicative of the impact of barrage construction on water quality, but more detailed chemical and biological investigations would be needed to unequivocally evaluate water quality status. References (5 items).

Davesne, M., and Graff, M. 1978. "Mathematical and Physical Models for Navigation in Approach Channels and Harbour Entrances," <u>Papers, 7th International Har-</u> <u>bour Congress</u>, K.V.I.V. (Royal Society of Flemish Engineers), Antwerp, Belgium, 22-26 May 1978, I:2.09/1-2.09/9.

This paper deals with physical and mathematical models in the Laboratoire National d'Hydraulique for predicting the path of a ship under wind, waves, and tidal current actions. It discusses the capabilities and limitations of these models and presents results obtained for the design of the new outer harbour of Dunkirk and the new harbour of le Verdon near the mouth of the Gironde estuary. References (2 items).

- DeWall, A. E., et al. "Inlet Processes at Eel Pond, Falmouth, Massachusetts." (See complete entry in Section II.)
- Druery, B. M. 1980. "Estuarine Response to Dredging in the Tweed River, Australia," <u>Proceedings, Seventeenth Coastal Engineer-</u> <u>ing Conference, March 23-28, 1980, Sydney,</u> <u>Australia, ASCE, II:1599-1618.</u>

Between mid-1974 and mid-1975, 760,000 m³ of sand was dredged from the bed of the "weed River for the purpose of nourishing cyclone-damaged beaches of the Gold Coast (Queensland). A comprehensive field data program was established in 1976 to record the changes in the hydraulic processes of the Tweed River brought about by the dredging. The field measurements demonstrated that the dredged area was being infilled with sediments of both marine and estuarine origin. The dredging increased tidal ranges throughout the lower estuary, the effect being more pronounced at low water. Sediment bed-load rates were estimated from detailed measurements of bed forms and used to calibrate a sediment transport formula. The formula was used in conjunction with a one-dimensional numerical model of tidal hydraulics to simulate estuarine shoal dynamics by means of a simple sediment routing technique. The results showed that the dredging had altered the tidal hydrodynamics so as to enhance the ebb transport of sediment towards the dredged hole. In the long term it was found that the sediment transport switched to a weak net upstream movement of sediment. The detailed hydraulic mechanisms involved are discussed. The study demonstrates that the impact of dredging can be minimized by location upstream of the entrance plug of marine sand. References (16 items).

Druery, B. M., and Nielsen, A. F. "Mechanisms Operating at a Jettied River Entrance." (See complete entry in Section II.) Escoffier, F. F. "Hydraulics and Stability of Tidal Iniets." (See complete entry in Section 1.)

Everts, C. H. 1980. "Design of Enclosed Harbors to Reduce Sedimentation," <u>Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney,</u> <u>Australia</u>, ASCE, II:1512-1527. PERSON PROVIDE KAASSI KAASSI KAASSA PERSONA PERSONANYA

Sedimentation may be an important problem when quantities of suspended material are carried into an enclosed harbor on a flooding tide. In order to forecast future maintenance costs, two methods for predicting the sedimentation rate prior to harbor construction are proposed: (a) a sedimentation tank to be placed at the proposed harbor site, and (b) a mathematical model which uses sediment and hydraulic data collected at the harbor site. Certain considerations in the design phase of a project may effect a reduction in harbor sedimentation. If feasible, the harbor may be sited in a region where suspended sediment concentrations are low and sediment sizes (settling velocities) are small. Proximity to river sediment sources may be a factor. Conversely, a harbor site in a clear-water river adjacent to a sediment-laden estuary may be desirable if bed load transport during freshets would not be a problem. Settlement of suspended material may occur in the channel which connects an enclosed harbor basin with navigable waters. This material may subsequently be resuspended and carried into the basin, thereby increasing the sedimentation rate. To reduce that rate, the channel should be designed as short as possible. A sill in the channel may also be used to reduce initial excavation costs and the sedimentation rate. Flotation for vessels in the basin will be provided at all times, but movement into and out of the harbor will be reduced to times of higher water. In high-latitude areas where harbor use is limited to periods when ice cover is absent, the sedimentation rate may be reduced using a channel closure structure during nonuse periods. Winter sedimentation rates can be predicted using the mathematical model for summer conditions, and when ice thickness is known. References (5 items).

- Falconer, R. A. "Mathematical Model Study of Mass Transport in Harbours." (See complete entry in Section VI.)
- FitzGerald, D. M., Fico, C., and Hayes, M. O. "Effects of the Charleston Harbor, S.C., Jetty Construction on Local Accretion and Erosion." (See complete entry in Section II.)
- Fleming, J. H., McMillan, P. H., and Williams, B. P. 1980. "The River Hull

Tidal Surge Barrier," <u>Proceedings, The In-</u> stitution of Civil Engineers; Part 1: Design and Construction, 68:417-454.

The River Hull Tidal Surge Barrier is located at the confluence of the rivers Hull and Humber to exclude surge tides from the River Hull. The concept of the unusual turnover lift gate and its control system is set out, together with details of the design of the gate, the superstructure and the foundations. Construction included one of the deepest single-stage cofferdams ever attempted in the UK, and an account is given of the design and practical problems encountered. The project included some unusual architectural features, ancillary flood defenses and a telemetry system. References (7 items).

- Foster, D. N., McGrath, B. L., and Bremner, W. "Rosslyn Bay Breakwater, Queensland, Australia." (See complete entry in Section VI.)
- Funke, E. R., and Crookshank, N. L. "A Hybrid Model of the St. Lawrence River Estuary." (See complete entry in Section VI.)
- Gerrard, R. T., Long, J. J., and Shah, H. R. 1982. "Barking Creek Tidal Barrier," <u>Proceedings, The Institution of</u> <u>Civil Engineers; Part 1: Design and Con-</u> <u>struction</u>, 72:533-562.

Barking Creek tidal barrier is a vital link in the chain of surge-tide defenses which extend on the north bank of the River Thames from the Thames Barrier at Woolwich down to Leigh on Sea. The design and construction of the barrier are described. Of particular interest are the cofferdams and the arrangements for installing the 300-t navigation span gate which is believed to be the largest vertical-lift gate in the UK. Reference (1 item).

Gibson, R. A., and Wilson, E. M. 1979. "Tidal Energy Integration Using Pumped Storage," <u>Journal, Energy Division</u>, ASCE, 105(EY1):71-80.

This paper shows how the value of tidal energy is enhanced when it is integrated into an electrical system using a pumpedstorage scheme. An optimum operations policy for the combined tidal and pumpedstorage schemes has been determined by a dynamic programming method. This objective has been demonstrated for a tidal energy scheme in the Minas Basin, Bay of Fundy, and a pumped-storage scheme on the St. John River, Maine. References (3 items).

Giese, E. H. T. 1978. "Use of an Estuary Mobile Bed Model to Investigate Natural Sedimentation Processes," <u>Proceedings</u>, International Conference on Water <u>Resources Engineering</u>, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:243-253.

The hydraulic institute BAW is operating a tidal model with a movable bed for the improvement of the Elbe-estuary navigation channel (North Sea). Earlier tests, for the interrelationships of unsteady alternating flows and morphological changes, showed a good agreement between model and prototype, so that it is now conventional to investigate future training work. New investigations have been carried out for the deepening of the fairway, now under construction, to find out future annual dredging rates, sections with accretion concentrations, and the main sediment transport directions. In the latter case the locally limited transport processes have been investigated with the help of radioactive tracers, both for model and prototype. References (7 items).

Gohren, H., and Christiansen, H. 1978. "Ecological Aspects of a Deep Water Port in the Tidal Flats off the German Coast (Scharhörn)," <u>Papers, 7th International</u> <u>Harbour Congress, K.V.I.V.</u> (Royal Society of Flemish Engineers), Antwerp, Belgium, 22-26 May 1978, I:6.04/1-6.04/19.

After extensive field investigations (since 1964), Hamburg had, for the first time, in 1970 submitted the plans for the construction of a deep water port in the tidal flats around Neuwerk/Scharhörn. This area lies south of the more than 20-m-deep outer Elbe fairway off the North Sea coast. In these plans it is intended to dredge out a maneuver basin and a 1.5km-long harbor basin connected to the deep natural fairway. With the dredged material from the excavation a 12-km² island will be reclaimed. The bottom height of the whole area will be above the highest storm surge level. A sand dam of some 18 km in length connects the port with the network of railways, roads, and supply ducts on the mainland. In 1974 the Scientific Committee for General Ecological Problems, a team of 11 scientists, each with a different scientific field, were authorized to examine the proposed plans. These experts were given the task of testing the environmental compatibility of the port project comprehensively and of suggesting plans or measures to prevent harmful consequences as well as of proposing how to obtain favorable results. In 1976 the Committee submitted their report. This report contains statements of possible consequences as well as recommendations for plan changes and results of the project. References (17 items).

Gordon, D. C., and Longhurst, A. R. 1979. "The Environmental Aspects of a Tidal Power Project in the Upper Reaches of the 92

Environmental planning is discussed, and the possible effects of the Bay of Fundy tidal power scheme are considered in terms of physical oceanography, hydrology, climatology, and sedimentology. Environmental studies for the Severn Barrage are related to possible effects in the Bay of Fundy. A firm recommendation for preinvestment design studies has been made, backed by provincial and federal governments, and specific impact assessment studies will be commissioned by the proponent if the project is authorized to proceed. References (11 items).

- Granat, M. A., and Gulbrandsen, L. F. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Hales, L. Z. 1985. "Erosion Control of Scour During Construction; Report 8, Summary Report," Technical Report HL-80-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

When major stone structures such as jetties, breakwaters, or groins are erected in the coastal zone, they alter the existing tidal, wave-induced, or wind-driven currents that are in a dynamic equilibrium with the existing bathymetry. These altered currents and waves breaking on such structures under construction may change the existing bathymetry by causing bottom material to be suspended and transported from the region. This removal of material from around structures is often not compensated for by an influx of additional material, and the result is a scour hole that usually develops in the near vicinity of the toe of the partially completed structure. In order to ensure structural stability, any such scour area must be filled with nonerodible material (sufficiently stable to withstand the environmental forces to which it will be subjected) to allow construction to proceed to completion. This may result in significant additional quantities of material being required during construction that can potentially lead to substantial cost overruns. Four fundamentally different materials are presently being used to combat scour from wave-induced erosion around major stone structures: (a) a layer of crushed or quarry-run stone (graded or ungraded) placed as a foundation blanket on sandy or otherwise semiconsolidated foundations to prevent upward migration of loose materials and settlement of larger stone sizes, (b) fabricated gabion units placed underneath stone structures to form a continuous layer in lieu of a crushed stone foundation blanket, (c) a wide assortment of synthetic filter fabrics

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placed underneath rock structures to prevent settlement into otherwise unconsolidated foundations, and (d) to a lesser extent, the use of Gobimats, particularly for toe protection of shore-connected structures such as seawalls or slope revetments. The objectives of this research were to develop techniques and knowledge for estimating resulting wave characteristics and wave-induced current fields in the vicinity of major coastal structures. Both analytical and laboratory experimental studies were conducted during the investigation. The analytical developments regarding wave heights and waveinduced currents were verified by the use of precise experimental studies of shoreconnected breakwaters. Additional underlayer stability experimental studies were conducted for estimating the size of stone comprising the foundation bedding material which would remain stable under various wave conditions. A two-dimensional finite element numerical simulation model (FI-NITE) was developed by Houston and Chou that calculates wave heights under combined refraction and diffraction for both long and short waves approaching structures from any arbitrary direction. The wave equation solved governs the propagation of periodic, small-amplitude, surface gravity waves over a variable-depth seabed. A computation scheme is employed that allows the solution of large problems with relatively small time and memory storage requirements, necessary for practical problem solutions. A generalized wave-induced current numerical model (CURRENT) was developed by Vemulakonda to estimate the magnitude of longshore currents and nearshore circulations in the vicinity of structures. This model retains the unsteady terms of the equations of motion, as well as advection and lateral mixing terms. Comparisons with known analytic solutions and experimental results provided good agreement. The model was successfully applied to a complex actual prototype field situation with reasonable results.

Hamilton, P. 1980. "Survey of Marine Wetland and Estuarine Water Quality and Ecological Problems in Corps of Engineers Field Offices," Miscellaneous Paper EL-80-2, US Army Engineer Waterways Exeriment Station, Vicksburg, Miss.

This report presents the results of a survey of Corps of Engineers (CE) field offices that have coastal zone responsibilities. The purpose of the survey was to investigate existing or anticipated water quality and ecological problems associated with CE activities in marshes and estuaries. Emphasis was placed on identifying those problems amenable to analysis through application of predictive modeling techniques. Three general

problems were emphasized by all offices: (a) the uniqueness of the specific environments in their District; (b) water quality and environmental problems as functions of local concerns of the public; and (c) the need to evaluate effects of a change in physical regime on an estuary. These specific problems are identified: (a) Techniques are needed to predict the effects of CE activities on the hydrodynamics, dissolved and particulate transport, biological and chemical processes, and biota in coastal environments. CE activities include construction, channel deepening and widening, island creation, and upstream projects leading to changes in freshwater flows. (b) Selected marsh/estuarine areas need to be characterized in terms of physical, chemical, and biological structure and chemical and biological processes. Specific areas identified include the east and northeast coasts, infrequently flooded marshes, mangrove swamps, and buffer areas such as the saline flatlands of the western gulf. Included in the characterization would be a uniform methodology of classification and a means to assess the value of the wetland to the total ecosystem. (c) The types and magnitudes of stresses the marsh/estuarine ecosystem may be subjected to in terms of structural stability and deviations in the rates of selected chemical and biological processes need to be determined. Included would be estimation of the assimilative capacity for effluents from diked impoundments, dredged material disposal sites, storm runoff, and agricultural runoff. Indices of structure and processes include fish and invertebrate nursery grounds, fish production, water quality, and import/export relationships of nutrients and detritus. (d) Techniques to evaluate the cumulative impacts of dead-end canals, small boat harbors, and marinas on the adjacent coastal ecosystem need to be developed. Procedures are needed to assess the magnitude of perturbations of water quality due to point and nonpoint sources of contaminants entering the canals and small harbors. Design criteria to minimize adverse water quality degradation within the canals and harbors and in the adjacent ecosystem need to be formulated. (e) An increased understanding is needed of the process of marsh creation through deltaic growth including habitat creation and species succession. (f) Existing hydrodynamic models need to be extended by including selected water quality parameters in advection-dispersion equations. Priority of inclusion is salinity, temperature, dissolved oxygen, nutrients, phytoplankton, and toxicants.

Harper-Owes. "Duwamish Waterways Navigation Improvement Study: Analysis of Impacts on Weather Quality and self-weather tensions tension turns The Developmenter entry on a topological

Harten, H., 1978. "Improvements of 1.1a Estuaries and the Effects of 1.1a, and rent," Proc<u>eedings, Sixteerth</u> coasta. <u>Engineering Conference, August 21-September 3, 1978, Hamburg, Germang, Acco. III:2905-2914.</u>

With the enlargement of industrialization in the 19th century and the growth of world trade, the sea navigation increased considerably. The sea routes had to be improved. This development continued very fast in the last 30 years. The capability of extension in the particular estary (for example, Elbe, Weser, Jade, Ems) is limited. The improvements include not only the deepening of navigational channels, but also groins, training walls, fixation of bars, partial or total damming up from bychannels, new localization of main navigational channel lines, new ports, etc. The tidal low water falls and the tidal high water rises, the tidal lift and the tidal volume increase, and the flood, as well as the ebb current, floats more powerfully through the tidal estuary. This shows the effect of constructions. References (5 items).

- Havnoe, K., Kej, A., and Siefert, W. "Mathematical Modelling of Water Levels and Flows in the Port of Hamburg." (See complete entry in Section VI.)
- Hayes, M. O., Kana, T. W., and Barwis, J. H. "Soft Designs for Coastal Protection at Seabrook Island, S.C." (See complete entry in Section VIII.)
- Hayter, E. J., and Mehta, A. J. "Verification of Changes in Flow Regime Due to Dike Breakthrough Closure." (See complete entry in Section VI.)
- Higgs, K., Treloar, P. D., and Lawson, N. V. 1978. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Prototype Data in Botany Bay," <u>Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering,</u> Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:190-195.

An overall environmental investigation into the effects of port development in Botany Bay is being carried out under the control of the State Pollution Control Commission of New South Wales. Information on water movement is needed as a basis for understanding problems such as water pollution and sedimentation, and for planning and managing the bay. As part of this work a distorted scale physical model has been built by The University of N.S.W, and a development of the Fischer

mathematical model is being operated by the Marctime Services Board of N.1 w Prototype current data have also been obtained using three Aanderaa recording current meters. These three projects have been currency coordinated so that their results could be compared. This paper leavinges this work, compares the marcer in which the models are operated, and discusses their similar ors. Model current care also compared with prototype data. Beferences (5 stems)

H.r.Cons, H., 1978. "Coastal and Tatastrophe Protection in the Area of the Genmar Hay," Masserwintsch, 680,00.46-50 Mlr Genman.

A discussion of the completed and planned hydraulic engineering measures in special consideration of the storm tide of January 1, 1976, and the various contradictory opinions mentioned in connection with this event. References (15 items).

- Hodgson, R. T., Pettibone, B., and Sullivar, S. M. "Siltation Study of Humboldt Bay Marina, California." (See complete entry in Section 11.)
- Hommel, H., and Koehler, G. "Reservoir-Model for Low-Water Regulation in Tidal Influenced Areas." (See complete entry in Section VI.)
- Horie, T., Sato, S., and Murakami, K. "Boundary Treatment on Tidal Current Computation." (See complete entry in Section VI.)
- Horner, R. W. 1981. "The Thames Barrier," Journal of the Institution of Water Engineers and Scientists, 35(5):398-411.

In 1972 the decision was taken jointly by the Government and the Greater London Council (GLC) to protect the low-lying areas of central London from flooding resulting from surge tides in the southern North Sea, by building a flood defence barrier in the western half of Woolwich Reach. This paper gives the background to the design of the structure and details the progress of the construction up to date. Operation techniques are described and possible benefits from operation of the Barrier in other roles than that of a flood defence structure are discussed. References (2 items).

- Hsueh, S. F., and Ahlert, R. C. "Mixing in Shallow Coastal Sea: Case Study." (See complete entry in Section VI.)
- Hutchison, I. P. G., and Midgley, D. C. "Mathematical Modelling of Water Level and Salinity Regimes in Some South African Lake and Estuary Systems." (See complete entry in Section VI.)

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- Terrison, A., Koman, J., Korski, K., Korski, K., S., A., Torperturing and Maconfraction optimation appoint A. Estimation of The International International and American Action.
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- Rawahata, M. ("Exercised: Second s
- Kendrisok, M. F., and Centrysource, no. 4 1978 — "Effects of a Barrier on Existing Estuary Regime," Encounding your terror or Thames Barrier Design, for Jong C. F. October Sy 1977, The Distribution of Escu-Engineers, Eaper 5051-58.
- A summary of the studies indertainer to determine the offect on the existing estuary regime of the construction and operation of a Thame Barrier. Beferences (58 items).
- Kerssens, P. J. M., Prins, A., and Van Rijn, L. C. "Model for Suspended Sediment Transport." (See complete entry in Section VI.)
- Kerssens, P. J. M., Van Rijn, L. C., and Van Wijngaarden, N. J. "Model for Non-Steady Suspended Sediment Transport." (See complete entry in Section VI.)

- Kieslich, J. M. "A Case History of Port Mansfield Channel, Texas." (See complete entry in Section II.)
- Kieslich, J. M. 1981. "Tidal Inlet Response to Jetty Construction," GITI Report 19, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Thirteen tidal inlets located on the Atlantic, Gulf, and Pacific coasts of the continental United States were selected for a study of the response of inlet ocean entrances to man-made improvements. Inlet entrance behavior following jetty construction were evaluated and guidelines for the functional design of inlet entrance improvements are suggested. The inlets considered in the study were those where a single updrift or downdrift jetty was built first. Literature cited (48 items); bibliography (16 items).

- Komar, P. D. <u>Beach Processes and Sedimenta-</u> tion. (See complete entry in Section 1.)
- Krause, G. "Separation of Climatic Fluctuations and Impacts of Engineering Activities in Estuaries." (See complete entry in Section 111.)

- Leenknecht, D. A., Earickson, J. A., and Butler, H. L. "Numerical Simulation of Oregon Inlet Control Structures' Effects on Storm and Tide Elevations in Pamlico Sound." (See complete entry in Section VI.)
- Liu, S. K., Hou, H. S., and Chang, C. C. "Simulation of Wave Wind Forced Harbor Oscillation." (See complete entry in Section VI.)
- McAnally, W. H., Jr., Brogdon, N. J., Jr., and Stewart, J. P. "Columbia River Estuary Hybrid Model Studies; Report 4, Entrance Channel Tests." (See complete entry in Section VI.)
- McAnally, W. H., Jr., et al. "Application of Columbia Hybrid Modeling System." (See complete entry in Section VI.)
- McAnally, W. H., Jr., et al. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth." (See complete entry in Section VI.)
- McKay, G. R., and Tranberg, C. H. 1978.
 "The Development of a Dredged Estuarine Harbour--A Case Study," <u>Managing the</u> <u>Coast, Fourth Australian Conference on</u> <u>Coastal and Ocean Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:196-200.
 - A case study is presented which describes the investigations and implementation of the works associated with the development of the new shipping channels for the Port of Bundaberg, Queensland. This Fort is an estuarine harbour, typical of many on the eastern seacoast of Australia, and has experienced a long history of siltation. In 1976 the Port was upgraded to accommodate larger vessels, and the opportunity was taken to redesign the shipping channel configuration to obtain a more favourable situation with regard to harbour siltation and navigation requirements. References (8 items).
- Magoon, O. T., and Baer, D. C. "Maintenance of Santa Cruz Harbor, California, USA." (See complete entry in Section II.)
- Mangarella, P. A., and Robilliard, G. A. 1978. "Thermal and Biological Impact of LNG Vaporizer Discharge," <u>Proceedings</u>, <u>Sixteenth Coastal Engineering Conference</u>, <u>August 27-September 3, 1978, Hamburg</u>, <u>Germany</u>, ASCE, III:2945-2957.

A simplified steady-state multilayered (horizontally homogeneous) thermal model is described and applied to assess the effects of the cold-water discharge created by a proposed liquid natural gas

(LNG) regasification facility. The model, similar to ones developed for predicting average cooling pond performance, accounts for advection and diffusion between layers, atmospheric and solid boundary heat exchange, and heat exchange due to tidal and density currents. For the configuration in which both the intake and discharge were located in a dredged turning and docking basin, recirculation created thermal deficits from -8° C to -17° C Adverse environmental effects on migrating species (particularly various life stages of shrimp) and the benthic community and costs associated with auxiliary seawater heating suggested that other alternatives (such as a separate intake basin or an offshore diffuser) would be more appropriate. References (6 items).

- Marche, C., et al. "A Study of the Influence of River Discharge Regulation on the Salinity Equilibrium in the Estuary." (See complete entry in Section III.)
- Maza, J. A., Munoz, M. L., and Porraz, M. 1977. "Jetties Studies Contribution," <u>Coastal Sediments '77, Fifth Symposium of</u> <u>the Waterway, Port, Coastal and Ocean</u> <u>Division of ASCE</u>, Charleston, South Carolina, November 2-4, 1977, ASCE, 248-266.

This paper presents a series of studies on a hydraulic model related to the influence on the coastal line and environment that surrounds the convergent jetties that will protect the communicating channel between the ocean and the coastal lagoon or simply a water intake. All the basic research was carried out in the laboratory and based on a classic solution for this type of structure. Several positions were tried. The actual orientation of the jetties was also changed in relation with the coastline; and their effect against two different wave directions was measured. one perpendicular to the shoreline and another with a 30-deg tilt direction. Keeping constant the incoming flow and outflow in the channel, different geometrical configurations were tested with speed measured at several checkpoints for different tide and wave conditions. From the results and analysis of behavior under the mentioned parameters, some design recommendations are included as conclusions.

- Nece, R. E. "Planform Effects on Tidal Flushing of Marinas." (See complete entry in Section VI.)
- Nece, R. E., and Smith, H. N. "Tidal Exchange in Proposed Sitka, Japonski Lagoon, Small Boat Harbor." (See complete entry in Section VI.)
- Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in

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Marinas." (See complete entry in Section VI.)

Nishimura, J. K., and Lau, L. S. 1979. "Structure for Automatic Opening of Closed Stream Mouths," <u>Shore and Beach</u>, 47(4):3-8.

closure of stream mouths by littoral sediment is a natural condition of numerous small streams on islands like Oahu, Hawaii. A new design of a hydraulic structure with nonmoving parts for automatic opening of coastal sediment plugs at small stream mouths has been developed. Investigation of literature on the inlet closure phenomenon and of Oahu streams identified three major factors that contribute to stream blockage. Generally, closed streams have small tidal prisms (inlet surface area times tidal differential between MLLW and MHHW), large amounts of wave power exposure, and little or no (intermittent) streamflow. As a result, it was concluded that closed stream mouths were the natural condition of numerous Oahu streams. Present methods being implemented in Hawaii include the construction of jetties, dredging, and the use of hydraulic outlet structures. Jetties are effective deterrents to inlet closure, but they are not always feasible for small stream mouths and certain offshore conditions. On Oahu, dredging is the most common method used for clearing stream mouths. References (9 items).

- Nishimura, J. K., and Lau, L. S. "Structure for Automatic Opening of Sediment Plugs." (See complete entry in Section II.)
- Novak, P., and Čábelka, J. <u>Models in Hy-</u> <u>draulic Engineering; Physical Principles</u> <u>and Design Applications</u>. (See complete entry in Section VI.)
- Odd, N. V. M., and Baxter, T. "Port of Brisbane Siltation Study." (See complete entry in Section VI.)
- Outlaw, D. G. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 1, Prototype Data Acquisition and Analysis." (See complete entry in Section I.)
- Owen, A. "Effect on the M_2 Tide of Permeable Tidal Barrages in the Bristol Channel." (See complete entry in Section VI.)
- Prandle, D. "Modelling of Tidal Barrier Schemes; An Analysis of the Open-Boundary Problem by Reference to AC Circuit Theory." (See complete entry in Section VI.)
- Price, W. A., Motyka, J. M., and Jaffrey, L. J. 1978. "The Effect of Offshore Dredging on Coastlines," <u>Proceedings, Six-</u> teenth Coastal Engineering Conference,

August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1347-1358.

This paper deals briefly with the licensing procedure and at some length with the involvement of the Hydraulics Research Station (HRS) in assessing how dredging might affect the coastline. In conclusion, the following questions and answers were presented on the subject: (a) Is the dredging far enough offshore that beach drawdown into the hole cannot take place? The approximate limit for onshore/offshore movement off the south coast of England is considered to be about 10 m below low water and this is usually taken as the minimum depth to ensure that beach drawdown will not take place into the hole. There is also a limit in terms of distance offshore of 600 m. This criteria is hardly ever invoked because it is usually overridden by other considerations. (b) Is dredging to be carried out in deep enough water so that the hole will not intercept the onshore movement of shingle? Field tracer studies have shown that for the south coast wave climate and in regions of weak tidal currents shingle will not move in depths greater than 18 m. A method of including the effect of tidal currents has been developed. It is believed to err on the safe side. As an example, the 18-m criterion changes to 22 m for a tidal current of 1.1 m/sec. However it is stressed that the method is at an early stage of its development. (c) Does the dredging area include banks which if removed would increase wave activity at the shoreline? In this case it is usual for the application to be turned down. There are exceptions under special conditions. If, for example, it can be shown that the beach is well protected from wave attack, e.g., by a very wide foreshore, then dredging of a limited quantity of material under controlled conditions may be allowed. For such special cases a desk study is carried out by HRS. (d) Is the area sufficiently distant from the shore and in deep enough water so that changes in wage refraction over the dredged area do not lead to changes of littoral transport at the shoreline and hence changes in beach plan shape? A beach mathematical model developed at HRS has shown that in general the effects of wave refraction are insignificant when dredging takes place in water depths greater than 14 m. References (14 items).

- Ramming, H.-G. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe." (See complete entry in Section I.)
- Raney, D. C. "Los Argeles Harbor and Long Beach Harbor: A Numerical Model for Tidal Circulation." (See complete entry in Section VI.)

- Renger, E., and Partenscky, H. W. "Sedimentation Processes in Tidal Channels and Tidal Basins Caused by Artificial Constructions." (See complete entry in Section I.)
- Richards, D. R., and Morton, M. R. "Norfolk Harbor and Channels Deepening Study; Report 1, Physical Model Results; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Seabergh, W. C. 1977. "Jetty Design for Little River Inlet, South Carolina,"
 <u>Coastal Sediments '77, Fifth Symposium of</u> <u>the Waterway, Port, Coastal and Ocean</u> <u>Division of ASCE</u>, Charleston, South Carolina, November 2-4, 1977, ASCE, 966-985.
 - A dual weir jetty system for Little River Inlet, South Carolina, was designed with the aid of a fixed-bed model. The distorted scale (1:60 vertical and 1:300 horizontal) tidal model was used to develop a plan which would minimize construction cost and provide a stable nonsilting entrance channel. Verification of tidal elevations, tidal currents, and salinities resulted in good model-prototype agreement. The preliminary testing program consisted of examining a variety of structural configurations in the model with surface current photographs from which the best plans were selected for more detailed investigation. Included in the testing of plans for the inlet was the use of a lightweight plastic sediment as a tracer in order to gain a better understanding of the movement of sediment in the vicinity of the jetty system where both tidal currents and wind waves are interacting. Analysis of this type of testing with time-lapse motion pictures proved extremely useful in evaluating jetty design. The paper also includes a review of the inlet's past behavior and factors influencing inlet changes. The model proved to be an integral part of the functional design of the weir jetties, especially with respect to the evaluation of the weir elevations and locations necessary for conditions conducive to the movement of sediment over the weirs and into the bayside deposition basins. Model testing also contributed to economic savings by determining the extent that jetty length could be reduced without detrimental effects. References (12 items).
- Seabergh, W. C. "Model Testing of Structures at a Tidal Inlet." (See complete entry in Section VI.)
- Seabergh, W. C. 1983. "Weir Jetty Performance: Hydraulic and Sedimentary Considerations; Hydraulic Model Investigation," Technical Report HL-83-5, US Army Engineer

Waterways Experiment Station, Vicksburg, Miss.

The investigation was performed to study important design parameters for a weir jetty system including weir length, elevation, orientation with respect to the shoreline and the conventional portion of the jetty structure, tidal currents over the weir section, flow patterns in the vicinity of the weir section, sediment movement over the weir and effects of the weir jetty on accretion, and erosion upcoast of the jetty system. Results indicate the mean tide level weir elevation is the most practical elevation for providing wave protection for a dredge, good sediment transport across the weir, and good floodebb tidal flow relationships, i.e., moderate flood flow currents and little or no ebb flow. Strong ebb flow currents over the weir are not desirable as they might aid in migration of the navigation channel through the deposition basin. Jetty systems with the outer, more oceanward portions parallel to each other and at minimum spacing provide the best flow characteristics when tidal current migration through the deposition basin region is considered. Wave-generated currents upcoast of the weir jetty are not entirely captured by the weir but some current, and thus sediment, move oceanward along the outer portion of the jetty. Also reflected waves off the jetty and weir structure combine with incident waves to form a short-crested wave field which aids in removal of sediment from the upcoast beach to various degrees, depending on the structure's angle with respect to the shoreline and the incident wave angle.

- Seabergh, W. C., and Lane, E. F. "Improvements for Little River Inlet, South Carolina; Hydraulic Model Investigation." (See complete entry in Section VI.)
- Seabergh, W. C., and Outlaw, D. G. "Los Angeles and Long Beach Harbors Model Study; Numerical Analysis of Tidal Circulation for the 2020 Master Plan." (See complete entry in Section VI.)
- Seabergh, W. C., and Sager, R. A. "Supplementary Tests of Masonboro Inlet Fixed-Bed Model; Hydraulic Model Investigation." (See complete entry in Section VI.)
- Sorensen, R. M. "The Corps of Engineers General Investigation of Tidal Inlets." (See complete entry in Section I.)
- Sorensen, R. M., and Schmeltz, E. J. 1982. "Closure of the Breach at Moriches Inlet," <u>Shore and Beach</u>, 50(4):33-40.

Moriches Inlet, on the south shore of Long Island, New York, is the jettied entrance to Moriches Bay from the Atlantic Ocean. A COURT SUCCESSION SEARCH STRATT SUCCESSION SUCCESSION NOT SUCCESSION SUCCESSION SUCCESSION SUCCESSION SUCCESSI

During the last three decades, the pattern of tidal flow through the inlet has caused a narrowing of the barrier beach adjacent to the inlet's east jetty. Then, in January 1980 a storm breached the narrow section and subsequent erosion rapidly expanded the width of the breach. As a result of local concerns regarding increased exposure of backbay areas to storm-induced flooding, as well as the effect of salinity changes in the shellfish industry, the Army Corps of Engineers decided to close the breach. This paper briefly summarizes the recent history of Moriches Inlet, development of the breach, and postbreach changes in the vicinity of the inlet; and presents a description of the construction operations that closed the breach. References (6 items).

Sternberg, R. W., et al. 1977. "Aquatic Disposal Field Investigations, Columbia River Disposal Site, Oregon; Appendix A: Investigations of the Hydraulic Regime and Physical Nature of Bottom Sedimentation," Technical Report D-77-30, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A two-part study was conducted in a region seaward of the Columbia River where disposal of large quantities of dredged material has occurred over the last several decades. The first part included repeated bathymetric surveys and sampling for distribution and seasonal variations of sediment texture and mineralogy throughout the study area, and especially at designated disposal sites. Near-bottom hydraulic conditions (waves, tides, currents, turbidity) were also measured at several sites and during all seasons. The second part was related to an experiment in which 600,000 cu yd of material dredged from the Columbia River estuary was dumped at a specially designated site, which was monitored before, during, and after disposal. The objectives of the sedimentological aspects of the study were to identify and map all deposits of dredged material and to recognize seasonal and long-term changes. The objectives of the hydraulic aspects were to document the ambient nearbottom conditions, and their effect on the deposit at the experimental site. References (9 items).

- Stroband, H. J., and Wijngaarden, N. J. V. "Modelling of the Oosterschelde Estuary by a Hydraulic Model and a Mathematical Model." (See complete entry in Section VI.)
- Sündermann, J., and Elahi, K. Z. "Constructional Effects on the Dynamical Processes in a Tidal Inlet." (See complete entry in Section VI.)

- Sündermann, J., and Holz, K.-P., ed. <u>Mathematical Modelling of Estuarine Physics</u>, <u>Lecture Notes on Coastal and Estuarine</u> <u>Studies</u>. (See complete entry in Section I.)
- Svasek, J. N., and Versteegh, J. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries." (See complete entry in Section VI.)
- Tocker, P. 1979. "Stop Father Thames Flooding," Soil & Water, 15(6):23-26.

In London, a massive scheme to protect the Thames valley from flooding from the sea is under construction by the Greater London Council. The main feature is a barrier across the Thames near Greenwich. which can be raised to prevent a flood reaching London. High water levels at London Bridge have been rising by about 0.76 m per century. This progressively increases the risk of flooding in London. A study of the tidal regime of the River Thames suggests a number of natural causes, the settlement of the land relative to the level of the sea in the southeast of England is probably the most significant. It has been suggested that this tilting (roughly around the axis to the England/Scotland border) may be a readjustment in compensation for the melting of ice sheets from the last Ice Age. Another natural cause is the rise in sea level resulting from the melting of ice masses. The most important artificial cause is probably the dredging and embanking of the Thames estuary. This tends to funnel the tidal flow, "canalization," resulting in an increase in the tidal range of the Thames.

Trafford, B. D. 1981. "Background to the Flood Defences of London and the Thames Estuary," Journal of the Institution of Water Engineers and Scientists, 35(5): 383-397.

The rise of tidal levels and the effect of storm surges in the North Sea make the Thames vulnerable to flooding. Work costing towards £700 million is now in hand to provide increased protection. The main feature is the barrier at Woolwich, but works include other barriers on tributaries and about 112 km of floodwalls or banks. Completion is scheduled for 1982 and will provide protection against a flood which has a probability of occurring once, on average, in any 1,000 years. The warning system which will trigger the closure of the defences is discussed together with potential future developments. References (10 items).

Trawle, N. J. 1981. "Effects of Depth on Dredging Frequency; Report 2, Methods of Estuarine Shoaling Analysis," Technical Report H-78-5, Report 2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Whenever deepening of a dredged channel is under investigation, a prediction must be made as to the effect of the deepening on the existing dredging requirements. If the deepening is related to advance maintenance dredging rather than to an increase in authorized depth, the prediction becomes even more difficult because the project is allowed to shoal over a wide range of depth. Currently a variety of arbitrary, rule-of-thumb procedures are used for predicting the effect of increased depth on dredging requirements. The overall objective of this investigation was to evaluate the effectiveness of advance maintenance dredging in reducing dredging frequency and/or costs in the maintenance of coastal channels and harbors and to establish necessary guidelines for governing the practice. This report, the second of a series, presents an empirical method of shoaling analysis based on historical dredging and shoaling records that results in reliable predictions of future shoaling for deepened channel conditions resulting from either an increase in authorized channel depth or advance maintenance. The method presented was designed to be general enough so that it can be applied to most navigation projects without difficulty. The procedure was described step by step using an example (fictitious) project. To demonstrate how the method would be applied to real navigation projects and to point out problems that occur when evaluating real projects, selected Galveston Bay, Texas, navigation projects were evaluated and the results discussed.

US Army Engineer Division, New England. 1981. "Long Island Sound, Thamesville Tidal-Flood Management Water Resources Study, Norwich, Connecticut," Reconnaissance Report, Waltham, Mass.

The study provides a planning and management tool in the development of alternative solutions to reduce Thamesville's tidal-flood damage. This Stage 1 report only identifies the problems, needs, and opportunities of the study area and then the level of detail required to formulate any intermediate plans.

Vallianos, L. 1980. "Barden Inlet, N.C.: A Case Study of Inlet Migration," <u>Proceed-ings, Seventeenth Coastal Engineering Con-ference, March 23-28, 1980, Sydney, Aus-tralia</u>, ASCE, III:2640-2654.

The migratory pattern of a small coastal inlet was examined in terms of the factors

generally acknowledged to control inlet behavior; that is, the tidal discharge which acts to flush the inlet and, or the other hand, the intrusive littoral mater.als depositing in the inlet environment Specifically, a flow conveyance index was computed and compared to shore.ine movements. The flow conveyance index was defined as the matio of the mean distribution of the overall planform area of the throat of the inlet to the mean distribution of the planform areas of shoals within the throat of the inlet. High and low flow conveyance index values would correspond, respectively, to periods of relatively high and low inlet flushing conditions. A consistent pattern was obtained from this analysis, wherein high and low index values corresponded with high and low shoreline movements. Additionally, the plot of rates of shore movements against rates of change of flow conveyance index was fitted with a simple linear regression line having a positive correlation coefficient of 0.85. Further analyses of the mean distribution of the shoals within the throat of the inlet demonstrated the cause of time-varying rates of movement of points along the spiriferous east shoreline of the inlet. Shoreline movement rates were plotted on a time-space plane and isolines of shore movement rates contoured. The result was a three-dimensional image of shore movement rates over time and distance. The position of the centroid of the inlet shoal distribution at different times was superimposed upon the three-dimensional image. This revealed that variations of shoreline movement rates along the shore at any point in time are dependent on the mean position of the inlet shoal distribution. Also, the direction of movement of the mean position of the inlet shoal distribution appeared to indicate the predominant direction of flushing action, that is, flood or ebb tides.

- van de Kreeke, J., and Haring, J. "Stability of Estuary Mouths in the Rhine-Meuse Delta." (See complete entry in Section II.)
- van de Ree, W. J., Voogt, J., and Leendertse, J. J. "A Tidal Survey for a Model of an Offshore Area." (See complete entry in Section VII.)
- Walther, A. W. "Hydraulic Research in the Oosterschedle Estuary." (See complete entry in Section I.)
- Ward, G. H., Jr. 1982. "Pass Cavallo, Texas; Case Study of Tidal-Prism Capture," Journal, Waterway, Port, Coastal and Ocean Division, ASCE, 108(WW4):513-525.

Pass Cavallo was until 1963 the only permanent inlet for the Matagorda Bay System,

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and has not been stabilized or protected in any way in 1963, a deel-draft stur channel was constructed to provide access from the Guif of Mexion, for which the Entrance Channel was dredged across Matagorda Perinsula 18,000 ft 5.5 km up the coast from the Pass . This land out proved to be scour unstable, enlarging spontanebusly to depths on the order of 50-60 ft. 15-18 ml and widths on the order of 1,000 ft 300 m . Current measurements in Pass lavallo prior to the creation of the land out and approximately 10 years after are analyzed to determine hydraulic characteristics. These indicate that the Entrance Thannel has captured approximately half of the tidal prism of Pass Tavallo. From both critical current and critical stress criteria, the reduction in current speed in Pass Cavailo associated. with this loss of tidal prism is sufficient to render the Pass shoal unstable. hence more susceptible to deposition. References ('3 items).

Warnock, J. G., and Tanner, R. G. 1978.
"Selection of Optimum Sites for Tidal Power Development in the Bay of Fundy," <u>Papers Presented at the International</u> <u>Symposium on Wave and Tidal Energy</u>, University of Kent, Canterbury, England, September 27-29, 1978, BHRA Fluid Engineering, Cranfield, Bedford, England, 1:E1-1-E1-22.

The authors describe studies carried out on behalf of the Bay of Fundy Tidal Power Review Board to develop realistic designs and cost estimates for tidal power plants. Reevaluation of earlier studies, including tidal characteristics, geology, and existing technology, showed that optimal performance would be achieved to include doutlo-regulated Rapian more to the style turbube generators, submerged sem overtur successions, and a machine of site dise The eight sites selected by this precimihary analysis were ther reduced to three by an optimization procedure based in comparative at-site energy costs, the three sites being subjected to more detailed. analysis to provide site-specific flatt design and cost data to support a determination of the competitive status of tidal power at various levels of installed capacity. The authors conclude that it is possible to justify development at two sites of 1,100- and 4,000-MW capacity; the delivered costs of energy should be reduced by future refinements in turbine design and production scheduling - References (5 items).

Weggel, J. P., Roberts, J., and Hagar, J. 1979. "Wave Action on the Savannah Tide Gates," <u>Coastal Structures 79, A Specialty Conference on the Design Construction, Maintenance and Performance of Port and Coastal Structures</u>, March 14-16, 1979, Alexandria, Virginia, ASCE, 1:67-92.

To minimize the need for maintenance dredging in the Front River navigation channel, the Savannah District, US Army Corps of Engineers, constructed a series of 14 tide gates in a tide gate structure across the Back River. The gates open during flood tide and allow upstream flow in the Back River but close during ebb flow and force all of the tidal discharge out through the Front River thereby flushing the navigation channel. References (2 items).

SECTION VI. MODELING AND OTHER LABORATORY EXPERIMENTS

Physical and mathematical model studies and other controlled experiments connected with any phase of tidal hydraulics. Investigations of theoretical aspects, studies for improvement or regulation at specific localities, theory of physical model design and operation, physical model appurtenances, and types of protonosusceptible of model analysis.





Abbott, M. B., Schrøder, H., and Warren, I. R. 1978. "Modelling of the Salinity Intrusion in the Sound Between Denmark and Sweden," <u>Proceedings, International Con-</u> <u>ference on Water Resources Engineering</u>, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:195-207.

A model simulating two-layer flow in two horizontal dimensions has been developed and calibrated. The extensive amount of field data available allowed a close examination of the various methods of representing interfacial shear stress and interfacial mixing (entrainment and/or vertical diffusion) in a two-layer model. The model has been applied to an investigation of the salinity intrusion in the sound between Denmark and Sweden. The effect of a tunnel which may be built across the Sound on the seabed was included in the investigation. The tunnel will reduce the flow in the lower saline laver, which may have had a detrimental effect on the ecological system in the sound. Both subcritical and supercritical flow situations were investigated. References (3 items).

Ali, A. 1982. "A Comparison Between Vertically Integrated and Multilevel Models of Tidal Dynamics in Channels," <u>Estuarine,</u> <u>Coastal and Shelf Science</u>, 14(4):405-419.

A comparative study of vertically integrated and multilevel river models has been made numerically. The multilevel model is a simplified version of the earlier model developed by Johns (1978). The study indicates the extent to which vertically integrated models are a reasonable substitute for the multilevel models. The effect of fresh water on tidal elevation and current in a river is also considered. References (11 items).

Ambrose, R. B., Jr., and Roesch, S. E. 1982. "Dynamic Estuary Model Performance," Journal, Environmental Engineering <u>Division</u>, ASCE, 108(EE1):51-71.

Applications of the Dynamic Estuary Model (DEM) to both the Delaware and Potomac estuaries by the Environmental Protection Agency during the 1970s are summarized and evaluated. Methods for calibrating, refining, and validating this model, and statistics for evaluating its performance are discussed. Following a brief description of DEM, observed and predicted hydrodynamic, mass transport, and water quality variables are statistically analyzed for the Delaware and Potomac applications. Weaknesses in the model and in these applications are identified. Model performance is evaluated for its usefulness to investigations of wastewater management alternatives in tidal rivers and the upper reaches of estuaries. Results indicate that the DEM can describe real-time

longitudinal tidal hydraulics with good accuracy for relatively steady flow periods and can predict longitudinal mass circulation with sufficient accuracy for well-mixed, far-field conditions. The DEM can adequately predict relative differences in water quality to be expected from incremental wastewater management alternatives, but more realistic kinetic structures are needed to predict water quality response to large changes in waste load characteristics. References (17 items).

- Anwar, H. O., and Weller, J. A. "An Experimental Study of the Structure of a Freshwater-Saltwater Interfacial Mixing." (See complete entry in Section III.)
- Awaji, T. "Water Mixing in a Tidal Current and the Effect of Turbulence on Tidal Exchange through a Strait." (See complete entry in Section I.)
- Bartholdy, J. 1984. "Transport of Suspended Matter in a Bar-Built Danish Estuary," <u>Estuarine, Coastal and Shelf Science</u>, 18(5):527-541.

The river Varde A discharges into the bay of Ho Bugt on the western coast of Jutland forming a small, bar-built estuary. This paper deals with tidal fluxes of water and sediment in the Varde A estuary. The inflowing water at flood tide is part of a turbidity maximum in the northern part of the bay. At high tide slack water the suspended material deposits inside the estuary. During ebbtide it is resuspended, and the estuary bottom is washed clean coinciding with the influx of relatively pure fresh water from the drainage area. From one station in the estuary mouth, current velocities and concentrations of suspended material have been measured during 10 tidal periods covering all four seasons. It is shown how these data can be used in a quantitative calculation of the transport of water and suspended material through the cross section of study. A model has been formulated which--based on half-tidal periods--quantified the transport of water and suspended material through the estuary mouth. The model is calibrated on the basis of measurements made during the above-mentioned 10 tidal periods. The rather small number of measurements is to some extent compensated for by a carefully prearranged selection of tidal periods. The model is discussed in relation to the prediction of net suspended transport through the estuary mouth in different weather and tidal situations. References (17 items).

Basu, A. N. 1978. "Composite Mathematical Model of Saptamukhi River System Including Outfall Channels for Studying the Effect of Closure," <u>Proceedings, International</u> <u>Conference on Water Resources Engineering</u>, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:297-313.

The effects of a contemplated closure of river Saptamukhi upstream of Namkhana Creek junction have been investigated by tidal computation in a composite mathematical model of the Saptamukhi system comprising unidimensional flow in the estuary portion and two-dimensional flow in the outfall channels. Solution of the basic tidal equations by harmonic method has been obtained on a computer. After achieving simulation of the prototype tidal phenomena, both immediate and longterm effects of the closure have been investigated. The study reveals that the total combined maximum discharge of the east and west outfall channels at the downstream end, which reduces by about 7 percent immediately after closure, undergoes a further reduction by about 24 percent of the existing maximum discharge due to siltation. The maximum velocities in the reaches immediately downstream of the closure would be low. Therefore, dredging would be necessary to maintain navigability of these reaches. References (5 items).

- Battisti, D. S., and Clarke, A. J. "A Simple Method for Estimating Barotropic Tidal Currents on Continental Margins with Specific Application to the M₂ Tide off the Atlantic and Pacific Coasts of the United States." (See complete entry in Section I.)
- Berndt, D., et al. 1980. "Artificial Roughness in Physical Models of Estuaries for Storm Surge Investigations," <u>Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2495-2503.</u>

One of the characteristics of the North Sea between the British Isles, The Netherlands, Germany, and Denmark is the occurrence of heave storm surges especially in autumn and winter with heights of about 4 m above spring high water. Coastal areas and especially the estuaries of the tidal rivers are hit by these storm surge events. The mean tidal range at the German coast comes to about 3 m with relatively low daily and semimonthly inequalities of less than 0.5 m. Within the framework of long-term developments of the navigation channels of the estuaries as well as of the storm surge protection works, physical model tests had to be carried out in order to predict the influences of such measures on the storm surge heights to be expected. It was possible to find out the reason for the difficulties in reproducing storm surge events in physical models of estuaries with wide flat areas. The importance of the necessity of not underestimating the influence of flat areas on the simulation of storm

tides was pointed out. On this basis a new method for such investigations including the consideration of the influence of local winds was developed and successfully applied. By means of momentum jets and pendulum strips it was possible to achieve a good agreement with natural courses of storm surges. Finally it should be pointed out that up to now the idea for this new method and its application exists for one physical tide model after some basic tests in a plume. However, further research is needed, in particular to modify the facilities of this new development. Reference (1 item). Bottin, R. R., Jr., and Earickson, J. A. 1984. "Buhne Point, Humboldt Bay, California, Design for the Prevention of Shoreline Erosion; Hydraulic and Numerical Model Investigations," Technical Report CERC-84-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Two numerical models and two physical models were used to investigate the effects of proposed improvement plans with respect to shoreline erosion at Buhne Point, Humboldt Bay, California. Initially, a numerical tidal circulation model was used to determine the tidal current field adjacent to Buhne Point. Maximum flood and ebb tidal currents were identified and used as test conditions for the physical models. A 1:100-scale physical model of central Humboldt Bay included the jettied entrance to the bay, approximately 18,000 lin ft of shoreline inside the bay (including Buhne Point), and underwater contours throughout the central portion of the bay and the area between the jetties. This model was used to determine the wave climate (angle of wave fronts and wave heights along these fronts) in the vicinity of Buhne Point for a series of incident wave conditions and directions (waves propagated through the Humboldt Bay entrance) and for various water levels and tidal flow conditions. 30-ft-long wave generator, an Automated Data Acquisition and Control System (ADACS), and a model circulation system were utilized in model operation. The output conditions obtained from the 1:100scale physical model were input into a 1:50-scale physical model of Buhne Point where the effectiveness of various structures proposed for shore protection was evaluated. This model reproduced approximately 9,200 lin ft of shoreline in the Buhne Point area and the immediate underwater contours in Humboldt Bay and utilized an 85-ft-long curved wave generator, a model circulation system, and crushed coal tracer material in model operation. Through the use of a numerical sediment transport model of Humboldt Bay, the effects of the optimum improvement plan developed from the 1:50-scale physical

model on conditions (sediment movement, tidal flushing, etc.) in other areas in the bay (areas not included in the physical models) were determined. The numerical tidal circulation model provided the tidal current field adjacent to Buhne Point for existing (1983) conditions and for the optimum improvement plan (Plan 3D). Based on the results of this model investigation, it was concluded that changes in tidal current velocities and flow patterns will be minimal due to the proposed improvements. The 1:100-scale physical model of central Humboldt Bay provided the wave front and wave heights along the front in the vicinity of Buhne Point for test waves for five water levels and from three directions. Based on the results of this model investigation, it was concluded that: (a) regardless of the direction of incident wave approach from the Pacific Ocean, the angle of the wave front in the vicinity of Buhne Point remains essentially the same; (b) test waves from northwest (approaching through the Humboldt Bay jettied entrance almost directly up the axis of the channel) result in significantly larger wave heights in the vicinity of Buhne Point, as opposed to test waves from north and/or west. The 1:50-scale physical model of Buhne Point was used to determine the causes of erosion at the point and the effectiveness of various structures proposed for shore protection. Based on the results of this model investigation it was concluded that: (a) Wave energy approaching Buhne Point from the jettied entrance to Humboldt Bay resulted in erosion of the original spit. Sediment eroded from the eastern portion of the shoal and migrated westerly where it entered the navigation channel. (b) For the originally proposed improvement plan (Plan 1), erosion occurred at the eastern portion of the fill with accretion against the proposed groin. Eventually, material migrated around the groin head and toward the navigation channel. (c) For the proposed groin plan (Plan 2), the shoreline did not remain stable. Sediment eroded at the eastern portion of the fill and accreted against the originally proposed westernmost groin. Material eventually migrated around the groin head and toward the navigation channel. (d) Sediment eroded in the lee of the shore-connected breakwater with the +7-ft elevation (Plan 3) for normal high-tide conditions (water el +6.7 ft). (e) Sediment remained stable in the lee of the shore-connected breakwater with the +10-ft elevation (Plan 3A) for normal tide conditions (water el +6.7 ft), but erosion occurred for extreme high-tide conditions (water el +9.5 ft). (f) Sediment remained stable in the lee of the shore-connected breakwater with the +13-ft elevation (Plans 3C and 3D) for all tide conditions (including the extreme +9.5-ft

conditions). (g) A reverse curve in the shore-connected breakwater where it originates from the existing Buhne Drive revetment (Plan 3D) minimized wave convergence and runup in this area. (h) A 25-ft-wide fill (el +12 ft) in the lee of the shoreconnected breakwater and adjacent to the existing Buhne Drive revetment (Plan 3D) prevented transmitted wave energy from running up on Buhne Drive for all test conditions. (i) Erosion occurred in the lee of the offshore breakwater plans with the +13-ft elevation (Plans 4 and 4A) for extreme high-water conditions (water el +9.5 ft). When the fill was depleted, wave energy transmitted through the revetment adjacent to Buhne Drive and onto the roadway. (j) A 1,000-ft-long offshore breakwater with the eastern 425-ft portion installed at a crest elevation of +16 ft (Plan 4B) was required to stabilize the fill in the lee of the structure. Slight erosion of the fill at its eastern limit occurred prior to stabilization, but wave runup onto Buhne Drive did not occur. (k) A 1,200-ft-long offshore breakwater with the eastern 625-ft portion installed at a crest elevation of +16 ft (Plan 4F) resulted in a stable shoreline in the lee of the structure with no erosion. (1) Sediment stabilized and remained in the area between the structures with the 425-ft-long extension of the original groin for all test waves, tidal currents, and water levels. (m) Small amounts of sediment penetrated through the voids of the rubble groin head at the downcoast (western) end of the fill for extreme high-tide conditions (water level +9.5 ft). (n) Of the improvement plans tested, Plan 3D was regarded as the optimum, considering shore protection and construction costs. The shoreline remained stable for all test waves, tidal flow conditions, and water levels. The numerical sediment transport model (CELC3D) provided estimates of sediment movements due to residual tidal currents and wave interactions, for both the existing (1983) conditions and for improvement Plan 3D. From this investigation, it was concluded that no new sediment transport patterns are induced by the optimum improvement plan (Plan 3D). References (26 items).

Bowman, M. J., et al. 1983. "Shelf Fronts and Tidal Stirring in Greater Cook Strait, New Zealand," <u>Oceanologica Acta</u>, 6(2):119-129.

Numerical tidal simulations and hydrographic data from two austral summer (January 1980 and 1981) cruises were used to study tidal mixing variations, upwelling and circulation in the shelf seas of central New Zealand. Four classes of fronts were identified: the Cape Farewell upwelling front, two tidal mixing fronts spanning Cook Strait, a plume front bounding an intrusion of subtropical water driven into Cook Strait from the northwestern approaches, and a shelf break front east of Cook Strait. Bulk stratification correlated well with the h/u^3 stratification index (r ~ 0.6); potential energy deficit and surface to bottom temperature differences less well (r ~ 0.53 and 0.38, respectively); potential energy deficit showed some tendency to follow the bathymetry. A critical value of the stratification index s ~ 1.5 (c.g.s. units) appeared to separate mixed from stratified water at the tidal mixing fronts, in good agreement with results obtained in other semi-enclosed shelf seas in temperate latitudes. The data suggest that prevailing patterns of stratification can be considerably modified by the variable and often strong winds that frequent the region. References (35 items).

Breusers, H. N. C., and van Os, A. G. 1981. "Physical Modelling of the Rotterdamse Waterweg Estuary," Publication No. 249, Delft Hydraulics Laboratory, Delft, The Netherlands.

The model of "Europoort" and the "Rotterdamse Waterweg" estuary has a long history. Improvement in knowledge of the hydrodynamic phenomena and technical possibilities has resulted in major changes in the model and its operation. This paper describes both the evolution and the final state of the model, together with the related aspects of calibration, verification, operation, and data processing. References (13 items).

Brocard, D. N., and Hsu, S.-K. 1981. "Combined Near- and Far-Field Water Quality Predictions in an Estuary," <u>Proceedings,</u> <u>Specialty Conference, Water Forum '81</u>, San Francisco, Calif., August 10-14, 1981, ASCE, I:375-382.

This paper describes a mathematical modeling technique for predicting water quality parameters associated with effluent discharges in a tidal estuary with flow reversals. Because of these reversals, the ambient river water used to dilute the effluent contains previously discharged substances or heat, thereby producing a background concentration or temperature rise over the near-field plume. Due to the large distances traveled by the returning effluent and as a result of the lateral mixing associated with secondary currents during flow reversals, the background rise, while variable in time, can be assumed to be uniform over the river section. A one-dimensional transient model can, therefore, be used for the determination of the background rise. The near field is dominated by the discharge jet which can be simulated using an integral buoyant jet model including the effects of ambient currents. Results from the two models are then appropriately superimposed to obtain complete temperature rise predictions. The characteristics of the mathematical models as well as the method used for their superposition are briefly described and the application to an actual site is discussed with emphasis on the results of the intermediate steps and on the utilization of existing measured data to set boundary conditions, estimate parameters, and verify results. References (4 items).

Brown, W. D., and Arellano, E. 1980. "The Application of a Segmented Tidal Mixing Model to the Great Bay Estuary, N.H.," Estuaries, 3(4):248-257.

Measurements show that in general salt is vertically well mixed everywhere in the Great Bay Estuary, New Hampshire, except near the river entrances at the head of the estuary. Dyer and Taylor's (1973) modified version of Ketchum's segmented tidal prism model has been applied to the Great Bay Estuarine System in order to predict high- and low-water salinity distribution for a specified river flow. The theory has been modified here to account for the mixing which occurs at the junction of two branches of an estuary. The mixing parameter, which in this model is related to the tidal excursion of water in the estuary, has been determined for different segments in the estuary on the basis of a comparison between predictions and a comprehensive data set obtained for a low river flow period. Using a mixing parameter distribution based on the low river flow calibration procedure, the salinity distribution has been predicted for high river flow. The resulting salinity distribution compares favorably with observations for most of the estuary. The corresponding flushing times for water parcels entering at the head of the estuary during periods of low and high river flow is 54.5 and 45.9 tidal cycles, respectively. References (13 items).

Buchak, E. M., and Edinger, J. E. 1982. "User Guide for CE-QUAL-ELV2: A Longitudinal-Vertical, Time-Varying Estuarine Water Quality Model," Instruction Report EL-82-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report is the user guide for a FORTRAN program that permits time-varying hydrodynamic and transport simulations of estuaries. It also includes a summary of the development of this program, with emphasis on the characteristics of estuaries, estuarine boundary conditions, turbulence, and validation tests. CE-QUAL-ELV2, an acronym for the Estuarine Longitudinal-Vertical 2-Dimensional model, consists of the original Laterally Averaged Estuary Model (LAEM) plus the

Water Quality Transport Module (WQTM). The LAEM program was developed for a test application to the Potomac Estuary from the then-current version of the Laterally Averaged Reservoir Model (LARM). The References section of this report lists all the available documents describing the related development of the LARM and LAEM programs. This report contains an overview of the capabilities of CE-QUAL-ELV2; a summary of its theoretical foundation and discussion of the validation tests; a synopsis of estuarine characteristics, including turbulence, with reference to the Patuxent Estuary; and a detailed discussion of the application procedure, again with reference to the Patuxent example. The appendices contain an input data description with examples and user notes for two auxiliary codes. References (53 items).

Butler, H. L. 1978. "Coastal Flood Simulation in Stretched Coordinates," <u>Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, I:1030-1048.</u>

Coastal flooding in developed areas can be catastrophic. As an essential element in coastal water level prediction, a twodimensional numerical model of long period wave behavior is presented. The time dependency is treated implicitly for costeffective simulation of coastal flooding from hurricane surges or other hydrodynamic phenomena such as extratropical storm surges, tides, tsunamis, etc. An important feature of the model is use of a coordinate transformation in the form of a piecewise exponential stretch. Such a technique permits simulation of a complex landscape by locally increasing grid resolution and/or aligning coordinates along physical boundaries. The model is applied to Galveston Bay, Texas, for storm surge and coastal flooding from Hurricane Carla, 1961. Verification for the Galveston area was accomplished by using physical model data from simulations of free gravity waves (tide and design surge). Subsequent hindcasting of Carla produced good agreement between observed and computed surges with a mean absolute error of 0.18 m for peak elevations. References (19 items).

Butler, H. L. 1983. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 3, Numerical Model Investigation of Plan Impact on the Tidal Prism of Lake Pontchartrain," Technical Report HL-82-2, Report 3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents results pertinent to a detailed investigation of effects of proposed structures in the two major arteries (the Rigolets and Chef Menteur Pass) connecting Lake Pontchartrain with the Gulf of Mexico and the lock/structure system between the lake and the Inner Harbor Navigation Canal (IHNC). The basic approach to simulating the impact of structural alterations on the Lake Pontchartrain tidal prism can be outlined as follows: (a) develop a numerical model of the three-basin system (Lakes Pontchartrain, Borgne, and Maurepas); (b) obtain and analyze field data to aid in calibrating and verifying the lake system model; (c) perform sectional model studies of each pass to provide descriptions of structure hydraulic characteristics to the numerical tidal prism model; and (d) calibrate and verify the tidal prism model and test plan impact under mean, spring, and neap tide conditions. Preliminary calculations with these tide conditions indicated difficulty in assessing the true impact of the hurricane protection plan on the tidal prism of Lake Pontchartrain. References (14 items).

- Butman, B., et al. "An Upper Bound for the Tidally Rectified Current at One Location on the Southern Flank of Georges Bank." (See complete entry in Section I.)
- Carton, J. A. "The Variation with Frequency of the Long-Period Tides." (See complete entry in Section I.)
- Chatham, C. E. 1977. "Los Angeles Harbor and Long Beach Harbor: Design of the Hydraulic Model," <u>Ports '77, 4th Annual</u> <u>Symposium of the Waterway, Port, Coastal</u> <u>and Ocean Division of ASCE</u>, Long Beach, Calif., March 9-11, 1977, I:47-64.

This paper describes the design of a hydraulic model and related equipment constructed to experimentally investigate the effects of proposed expansions of Los Angeles and Long Beach Harbors. In order to ensure proper reproduction of waves in the model, it was necessary to conduct an extensive study of (a) wave refraction for wave periods of 15 sec to 6 min; (b) energy transmission through the breakwaters; (c) diffraction through the harbor entrances; (d) reflection from the offshore topography and from harbor boundaries: (e) wave filters and absorbers; (f) model wave-height attenuation; (g) wave generators; and (h) model data acquisition and analyses. After consideration of the various items described above, it was concluded that valid data could be obtained from the model for a vertical scale of 1:100 and a horizontal scale of 1:400 (distortion of 4.0). The model, completed in July 1973, reproduces the entire harbor area, the shoreline from Point Fermin to Huntington Beach, and underwater contours out to -300 ft. The total model area is 44,000 sq ft representing the largest wave model ever constructed in the United States. Tides are mechanically reproduced by exchanging water between the model

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headbay and a water storage sump by means of a system of pumps, valves, and pipes. Waves are generated by a 210-ft-long electrohydraulic wave generator composed of 14 individual sections (each 15 ft long) which can be positioned to reproduce curved wave fronts and controlled by automation techniques to generate waves of variable heights and periods. Due to the extreme complexity and large size of the Los Angeles and Long Beach Harbors model, as well as the volume of model data to be collected, an automated data acquisition and control system (ADACS) with supporting software for data analyses has been designed and assembled. References (18 items).

Chelton, D. B., Jr. 1980. "Low Frequency Sea Level Variability Along the West Coast of North America," Ph. D. Dissertation, University of California, San Diego.

The use of linear statistical estimators to examine dynamical models is discussed, and the importance of using multiple input statistical models rather than a series of single input models is emphasized. A methodology is described for determining the effects of statistical uncertainty in both time and frequency domain multiple input statistical models. These methods are then used to examine 30 years of nonseasonal tide gage and steric sea level data along the west coast of North America. The objective is to explore the nature and causes of nearshore oceanic variability over short-term climatic time scales of months to years. After the tide gage records are corrected for the inverse barometric effects of atmospheric pressure, it is found that there is close agreement between the two measures of sea level at frequencies less than 1 cycle/ year. At higher frequencies the steric sea level variations measured relative to 500 db are, on average, only about one half as large as high-frequency tide gage sea level variations. Analyzing tide gage records from Alaska to Mexico, it is found that low-frequency sea level fluctuations are closely related to El Niño occurrences in the eastern tropical Pacific and that these El Niño events appear to propagate poleward with phase speeds of around 50 cm/sec. Higher frequency variations are primarily the result of forcing by the local atmospheric pressure but the response is generally found to be greater than inverse barometric (1 cm/mb). Much of the remaining high-frequency sea level variability is the result of forcing by the wind field. The longshore component of wind stress generally forces a larger sea level response than the onshore component, but the important dynamical aspects of the wind field generally appear to be basinwide rather than local. The

dominant signal in residual sea level after removing the atmospheric and oceanographic effects as determined from the statistical models represents long-term trends over the 30-year record length. The trends at the lower latitude stations are attributed to the eustatic rise in sea level from melting glaciers. The drop in measured sea level at the higher latitudes has generally been attributed in the past to an apparent drop due to isostatic rebound of the earth's crust from the most recent glaciation. However, it is shown that part of this drop may reflect a true change in sea level due to cooling of the surface waters in the North Pacific over the last 30 years. Analyzing steric sea level records off California, it is found that the hydrographic data are quite noisy but that empirical orthogonal function analysis is an effective method for extracting the large-scale "signal" from the mesoscale "noise." Most of the nonseasonal upper ocean variability is restricted to the upper 200 m but located subsurface at about the depth of the permanent thermocline. The dominant signal in nonseasonal nearshore oceanic variability is a very large-scale lowfrequency variation in the flow with biological effects off the coast of California similar to those of Southern Hemisphere El Niño events off the coast of Peru and southern Ecuador. Over shorter time scales the wind stress curl appears to be an important aspect of large-scale dynamics of the California Current. In addition, another mode of high-frequency variability with very short longshore coherence is isolated that resembles the response expected for coastal upwelling driven by the longshore wind stress. References (73 items).

- Chiang, W.-L., and Lee, J.-J. "Tide-Induced Currents in Harbors of Arbitrary Shape." (See complete entry in Section I.)
- Chu, W.-S., and Willis, R. 1981. "Mathematical Modeling of Humboldt Bay," <u>Proceedings, Specialty Conference, Water</u> <u>Forum '81</u>, San Francisco, Calif., August 10-14, 1981, ASCE, I:375-382.

The objective of this paper is to present the results of hydrodynamics and water quality investigation of Humboldt Bay, California. Humboldt Bay is a unique estuarine system with a variety of fishery and marine resources. The bay is also a major commercial shipping and fishing port. The motivation for the study is to develop a clearer understanding of the hydrodynamic and water quality variations occurring within the bay, and, in contrast to previous studies, to provide a practical, rational methodology for environmental planning. References (7 items).

- Chu, W.-S., and Yeh, W. W-G. 1980. "Parameter Identification in Estuarine Modeling," <u>Proceedings, Seventeenth Coastal</u> <u>Engineering Conference, March 23-28, 1980,</u> <u>Sydney, Australia</u>, ASCE, III:2433-2449.
 - Parameter Identification (PI) algorithm is an optimization procedure that systematically searches the parameters embedded in a mathematical model. These parameters are not measureable from a physical point of view. The optimization is based on the minimization of a selected norm of the differences between the solution of the mathematical model and scattered observations collected from the system. This study deals with PI in a two-dimensional vertically averaged estuarine salinity model. The salinity transport equation is coupled with the hydrodynamics equations. The coupled relationship introduces extra density terms in the hydrodynamics equations, which must be solved simultaneously with the transport equation. References (18 items).
- Chu, W.-S., Yeh, W. W-G., and Kristof, R. C. 1981. "Mathematical Modeling and Parameter Identification in a Two-Dimensional Estuary: Case Study of the Hydraulic Model of the San Francisco Bay and Delta," Contribution No. 183, California Water Resources Center, University of California, Davis, Calif.

This report presents a study of conjunctive use of mathematical and physical models for estuarine hydrodynamics and salinity transport simulation. Two sets of mathematical models are developed which are capable of simulating both the intertidal and intratidal conditions as represented by an existing, well-calibrated hydraulic model. Suisun Bay, a significant portion of San Francisco Bay, is selected as a study area for this project. Data collected from the physical model which contain relatively less noise are used to calibrate the mathematical models by an automatic optimization routine. The calibrated parameters are used for verification using a different set of data collected from the hydraulic model. Both calibration and verification compare favorably with observations. This report identifies a number of discrepancies in the general use of both mathematical and physical models based on the findings of this study. The problem of optimization in parameter identification with noisy data is also discussed. The prospect of parameter identification with prototype data is summarized, along with the recommendations for future use of similar algorithms. References (47 items).

<u>Coastal Sediments '77, Fifth Symposium of</u> <u>the Waterway, Port, Coastal and Ocean</u> <u>Division of ASCE</u>. (See complete entry in Section II.) Committee on Tidal Hydraulics, Corps of Engineers, US Army. 1980. "Evaluation of Numerical Storm Surge Models," Technical Bulletin No. 21, Office, Chief of Engineers, Washington, DC.

Federal services that minimize loss of life and property due to tropical hurricanes include forecasts and flood warnings by the National Weather Service, design of protective works by the US Army Corps of Engineers, and the establishment of flood insurance rates by the Federal Insurance Administration. Each agency employs mathematical models of hurricane events for simulating impacts. Because of the different concerns of these agencies, their models have evolved in different ways and are applied with different input data, and apparent disparities have appeared. The Office of the Chief of Engineers (OCE) expressed concern for this situation and requested that the Committee on Tidal Hydraulics conduct an evaluation of the existing models. OCE specifically requested that the Committee determine the needs for further development of mathematical models by the Corps, the models most suitable for Corps applications, and if the models perform comparably, the most cost-effective models. Evaluation was accomplished by having each modeling group separately exercise its models for selected past events and by comparing the model outputs with each other and with observed water elevations. The modeling groups were those at the National Weather Service, the Coastal Engineering Research Center, the Waterways Experiment Station, and Tetra-Tech, Inc. Open-coast storm surge models were evaluated; then inland flooding models were evaluated using as input one of the open-coast model results. Each model tested included features that offered important advantages. Further, the models were continually evolving to include improved descriptions of the land and waters and of storms. No one model's predictions consistently gave better comparisons with observed data, however; and it is unlikely that one will be clearly better than the others for Corps purposes. It was found that large uncertainties exist in the quality of water-surface elevation observations, large gaps occur in water elevation and meteorological data during the course of storm events, and the few existing observations are not taken at the most desirable locations. This situation is the most serious impediment found during the study to the development of accurate predictive models. Different procedures for specifying or selecting model input parameters and for calculating storm frequencies can lead to the calculation of widely different return periods for computed surges even when the same hydrodynamic model is used. These procedures are not uniform among the several

agencies. Further improvements of the simulated wind fields are needed, and sensitivity analyses of the models are required in order to extend the usefulness of all of the models to new situations. Specific recommendations are presented for optimizing the value of mathematical models of storm surge and inland flooding for use by the Corps of Engineers. References (27 items).

- Connolly, J. P., Armstrong, N. E., and Miksad, R. W. "Adsorption of Hydrophobic Pollutants in Estuaries." (See complete entry in Section IV.)
- Cooper, C. K., and Pearce, B. R. 1977. "Development of a Simple Numerical Model to Calculate the 3-D Structure of Currents in Coastal Areas Using a Depth Varying Eddy Viscosity," <u>Proceedings, Seventeenth</u> <u>Congress of the International Association</u> <u>for Hydraulic Research; Hydraulic Engi-</u> <u>neering for Improved Water Management,</u> <u>15-19 August 1977</u>, Baden-Baden, Federal <u>Republic of Germany, 2:141-148</u>.

Most previous three-dimensional circulation models have assumed the vertical eddy viscosity to be a constant through the water depth. Fundamental arguments are briefly presented demonstrating the lack of theoretical and physical justification for such an assumption. The formulation of a three-dimensional numerical model using a depth-varying vertical eddy viscosity is presented. A functional form for the velocities in terms of a cosine series of unknown amplitude is assumed. The Galerkin weighted residual approach is used to transform the nonlinear Navier Stokes equations into a set of linear PDE's in terms of the unknown amplitudes. These equations are solved using a simple finite-difference scheme. The model is applicable to coastal areas and lakes where winds and tides are the dominant driving forces. Model results include a continuous functional form for the vertical variation of the horizontal velocities. Computer time and space requirements are of the same order as for existing two-dimensional vertically averaged numerical models. References (6 items).

- Daifuku, P. R., and Beardsley, R. C. "The K₁ Tide on the Continental Shelf from Nova Scotia to Cape Hatteras." (See complete entry in Section VIII.)
- Davesne, M., and Graff, M. "Mathematical and Physical Models for Navigation in Approach Channels and Harbour Entrances." (See complete entry in Section V.)
- Davies, A. M. 1978. "Role of 2D and 3D Models in JONSDAP '76," <u>Proceedings, Six-</u> teenth Coastal Engineering Conference,

<u>August 27-September 3, 1978, Hamburg, Ger-</u> many, ASCE, I:1085-1103.

This paper describes how a two-dimensional numerical model of the North Sea was used to determine optimum positions for the deployment of offshore tide gages during the JONSDAP '76 oceanographic exercise. A three-dimensional model of the Northwest European Shelf is also described. Using this model, the three-dimensional distribution of the M_2 tidal current over the sheif has been computed. This model has also been used to compute the wind-induced circulation of the North Sea for the INOUT period of JONSDAP '76.

Dennis, W. A., Lanan, G. A., and Dalrymple, R. A. 1978. "Case Studies of Delaware's Tidal Inlets: Roosevelt and Indian River Inlets," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, II:1282-1301.</u> Studies were undertaken to document the past and present characteristics and trends of Delaware's two major tidal inlets, Roosevelt and Indian River Inlets. It was found that both inlet complexes are effective sediment traps causing considerable downdrift erosion. The major mechanism by which sand enters Indian River Inlet is by overtopping the impounded south jetty. At Roosevelt Inlet sediments are readily transported past the severed steel sheet pile jetties. The results of a onedimensional hydraulic model, as well as field measurements, predict the presence of a mean southerly flow through the canal and bay system which connects these two inlets. This flow is shown to have a substantial effect on the behavior and stability of these entranceways, causing major asymmetries on the depositional patterns at each location. Roosevelt Inlet was found to have a strong tendency to trap sediment within its throat, whereas Indian River Inlet, on the opposite end of the system, was found to retain large quantities of sand on its developing ebb tidal shoal. References (15 items).

Devine, M. 1983. "Some Features of the Dynamic Structure of a Deep Estuary," <u>Estu-</u> <u>arine, Coastal and Shelf Science</u>. 16(3):271-289.

A boundary layer formulation for the dynamic structure of a deep estuary is developed. Cross-stream averages are used, but the boundary layer structure is shown to depend on the cross-stream geostrophic constraint. A similarity transformation and a weighted residual method are used to derive an approximate solution for the velocity and salinity structure of the upper layer. This solution indicates that, in the central regime of the estuary, outflow extends through the entire halocline.
Inflow takes place in a much less stratified lower layer, and mass exchange between the layers is by upwelling. This structure is modified in the outer regime of the estuary, where mixing between the layers develops, and in the inner regime, where a sharp halocline develops and where the dynamics are dominated by river runoff. The implications of the dynamics for the flushing process and for pollutant movement and dispersion are discussed. References (28 items).

- DeWall, A. E., et al. "Inlet Processes at Eel Pond, Falmouth, Massachusetts." (See complete entry in Section II.)
- Diamante, J. M., et al. "Tidal and Geodetic Observations for the SEASAT Altimeter Calibration Experiment." (See complete entry in Section VII.)
- Dronkers, J. "Longitudinal Dispersion in Shallow Well-Mixed Estuaries." (See complete entry in Section I.)
- Druery, B. M. "Estuarine Response to Dredging in the Tweed River, Australia." (See complete entry in Section V.)
- Druery, B. M., and Nielsen, A. F. "Mechanisms Operating at a Jettied River Entrance." (See complete entry in Section II.)
- Duwe, K. C., and Hewer, R. C. 1982. "A Semi-implicit Tidal Model for Wadden Sea Areas" ("Ein semi-implizites Gezeitenmodell für Wattgebiete"), <u>Deutsche Hydrographische Zeitschrift</u>, 35(6):223-238 (In German).

A new numerical method for the simulation of water movements in Wadden Sea areas is presented. It is based on a semi-implicit algorithm that has been generalized to cope with shallow water problems and falling-dry processes. The method is not bound by the Courant-Friedrichs-Lewy stability criterion. A comparison of model calculations of the tidal movements in the Heverstrom with results derived by a traditional explicit model shows that besides considerable computer time savings, marked qualitative improvements of the simulation are achieved. References (8 items).

Edinger, J. E., and Buchak, E. M. 1981. "Estuarine Laterally Averaged Numerical Dynamics: The Development and Testing of Estuarine Boundary Conditions in the LARM Code," Miscellaneous Paper EL-81-9, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The longitudinal and vertical hydrodynamics and transport in stratified water bodies as formulated for the Corps of Engineers Laterally Averaged Reservoir Model (LARM) have been transformed to estuaries by development of appropriate boundary conditions. The resulting computational code Laterally Averaged Estuary Model (LAEM) is tested on the Potomac River estuary for a short period of time with intensive field data. The estuary problem was formulated in terms of spatially varying geometry, a time-varying tide height and salinity distribution at the mouth, and freshwater inflow. The LAEM code was found to reproduce overall estuarine dynamics including tide heights, tide phase shifts, and salinity distributions. In addition, detailed time-varying vertical velocity profiles were produced to a high degree of resolution. Detailed results of the model including the distribution of vertical velocities and turbulent dispersion coefficients were compared to those expected for a coastal plain estuary with favorable agreement. References (9 items).

- Elahi, K. Z., and Sündermann, J." "The Wind-Driven Circulation in the Northern Arabiar Sea." (See complete entry in Section I.)
- Elsinger, R. J., and Moore, W. D. "226Ra and 228Ra in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze River and Delaware Bay Estuaries." (See complete entry in Section IV.)
- Everts, C. H. "Lesign of Enclosed Harbors to Reduce Sedimentation." (See complete entry in Section V.)
- Falconer, R. A. 1983. "Mathematical Model Study of Mass Transport in Harbours," <u>Dock</u> <u>and Harbour Authority</u>, 63(748):343-347.

This paper describes the details and application of a mathematical model to determine the mass transport and time average momentum flux into a harbour or coastal basin as a result of a tidal inflow. In a study for the British Transport Docks Board the model has been applied to Royal Dock Basin, Grimsby, to give an indication of the likely changes in the mass inflow resulting from changing the characteristics of the boundary geometry and the bed topography. Based on the assumption that a reduced mass inflow across the entrance would lead to a reduction in the sediment volume transported into the basin on the flood tide, the two main engineering conclusions arising from this study were as follows: (a) making the East Pier a solid wall would reduce the mass inflow and the time average momentum flux across the entrance, and hence probably the sediment influx and uniformity of deposition deross the basin; and (b) the effect of dredging the proposed area would only manginally affect the mass inflow and momentum flux across the entrance. References (5 (tems).

Falconer, F. A. (1986). "Modelling of Flanform Influence on Strealation of Harbours," <u>Epscendings, Seventeer to Coasta</u>. Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, III:2726-2744.

A two-dimensional numerical model has been developed which is capable of predicting the tidal water elevations, depth-averaged velocity components, and horizontal concentration distributions in narrow entranced harbours and marinas. Particular attention has been paid to the numerical treatment of the convective accelerations where, as a result of narrow harbour entrances and the general nature of planform geometries, the resulting highly nonuniform flow fields can readily lead to nonlinear instabilities and unstable numerical solutions. In order to check the validity of the numerical results, a comprehensive study was carried out to compare, with scaled laboratory model studies, the predicted tidal velocity fields and flushing characteristics for a number of rectangular harbours of constant planform area but different length to breadth ratios. The experimentally measured average per cycle exchange coefficients and the observed mean water level pathlines agreed reasonably well with the corresponding numerically predicted exchange coefficients and depth-averaged velocity fields. The results of both the numerical and laboratory model studies confirmed conclusively that the maximum gross flushing characteristics occurred within a rectangular harbour when the length to breadth ratio was close to unity. Also, further tests showed that the insertion of impermeable barriers as a possible means of increasing the flushing efficiency proved to be unsatisfactory. References (9 items).

Fandry, C. B. 1981. "Development of a Numerical Model of Tidal and Wind-Driven Circulation in Bass Strait," <u>Australian</u> <u>Journal of Marine and Freshwater Research</u>, 32(1):9-29.

The initial stages of the development of a numerical model to investigate the effects of wind and tidal forcing on the seasurface height distribution and currents within Bass Strait are described. The hydrodynamical model is based on depthaveraged equations and incorporates the effects of the earth's rotation and variations in bottom topography. Numerical experiments have been performed with the model to determine the response of Bass Strait to two separate forcing mechanisms: stationary fields of uniform wind stress suddenly imposed over the sea surface, and tidal heights specified along the open-sea boundaries of the model. The results of these experiments are presented and discussed, the principal conclusions being that the maximum tidal currents generated are generally larger than those generated

by the wind, and that variable bathymetry is a major influence on the flow. Furthermore the tidal motion may be characterized by two Kelvin waves travelling in opposite directions through the strait. References (27 items).

Fandry, C. B. 1983. "Model for the Three-Dimensional Structure of Wind-Driven and Tidal Circulation in Bass Strait," <u>Australian Journal of Marine and Freshwater</u> <u>Research</u>, 34(1):121-141.

Earlier models of the circulation in Bass Strait have been extended to include vertical structure. Time-dependent circulation fields in Bass Strait, induced by wind driving at the surface and tidal oscillations along open-sea boundaries, are computed at a number of selected depths. The original two-dimensional model is combined with an analytical solution of the Ekman equations, which at each grid point provides an expression for the timedependent flow at any depth in terms of a convolution integral over the sea-surface slope and wind stress. This model should be applicable to winter conditions when the strait is well mixed vertically and hence the dynamical effects of density stratification negligible. The predicted wind-induced circulation fields are highly depth dependent, with equilibrium surface currents in the central Bass Strait basin flowing in a direction approximately 45 deg to the left of the wind. At lower levels, currents are controlled by pressure gradient forces due to the seasurface slope and friction. Significant upwelling and downwelling motions along the Victorian and Tasmanian coastlines can be inferred from these circulation fields. In the deep water off the continental shelf, currents in the upper 100 m are dominated by the (Ekman) drift current which rotates in an anticlockwise direction with increasing depth, such that the wind drift at the surface is accompanied by a measure of return flow at depth. Tidal currents are predicted in the absence of wind stress, but include the effects of bottom topography. Considerable variation with depth is found and the distinctive features are explained in terms of the relative importance of Coriolis force, bottom friction, and water depth. Comparison with the few existing observations reveals that the present model is producing realistic results. References (14 items).

- Fischer, H. B. "The Effect of Estuarine Circulation on Pollution Dispersal." (Secomplete ertry in Section 1.)
- Fischer, H. B., et al. <u>Mixing in United in</u> <u>Coastal Waters</u>. Cler complete entry in Section 1.)

Fischer, K. 1978. "Numerical Salinity Intrusion Models," <u>Proceedings, Interna-</u> <u>tional Conference on Water Resources</u> <u>Engineering</u>, Asian Institute of Technology, Bangkok, Thailand, January 10-13, 1978, I:209-218.

Three types of numerical models to simulate salinity intrusion into estuaries are investigated. The simplest is the vertically averaged model with barotropic forces, where the salinity intrusion must be simulated by pseudodiffusive mechanisms. The vertically averaged model with baroclinic forces is only slightly more complex, gives a better physical picture of the intrusion process, but breaks down under certain boundary conditions and bottom topography. The vertically discretized model is much more complicated, but gives sufficient results under general conditions and can be applied to stratified and mixed estuaries equally well. provided that the numerical schemes do not produce a high amount of numerical diffusivity. References (8 items).

Fischer, K. 1978. "Numerical Tidal-Salinity Models of the Ems Estuary," <u>Pro-</u> ceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978, <u>Hamburg, Germany</u>, ASCE, III:2840-2854.

A satisfactory salinity intrusion simulation of a mixed estuary has been obtained by application of a spatially threedimensional finite difference model with three adjustable parameters. The results of the mathematical model were of a quality comparable to the results of a hydraulic model. The salinity intrusion was found to be mainly influenced by the combined action of vertical eddy viscosity and bottom friction. The vertical eddy diffusivity parameter could be adjusted separately and had only influence on the vertical stratification. The accuracy of the simulation was limited by the grid coarseness and artificial diffusion effects of the numerical method. An analogous simulation by means of a vertically averaged model with constant horizontal diffusion parameter gave no acceptable results. Given a certain range of desired accuracy in the results (mainly defined by the accuracy of the available measurement data), the following model restrictions were possible to obtain satisfactory results: (a) constant vertical eddy viscosity, (b) constant bottom friction. (c) constant vertical eddy diffusivity, (d) constant salinity at the open boundary, (e) a coarse grid in the horizontal plane, and (f) only six vertical grid points. These restrictions made a simulation of the vertical and lateral dispersive fluxes possible in the framework of a model consuming computer time to a still moderate extent. References (8 items).

Fornerino, M., and Chabert d'Hieres, G. 1982. "Study of M₂ Tidal-Currents in the English Channel Using the Physical Model at Grenoble" ("Étude Des Courants De La Marée M₂ Dans La Manche A L'Aide Du Modèle Réduit De Grenoble"), <u>Annales Hydro-</u> graphiques, 10(757):13-31 (In French).

This paper presents a set of maps which point out M2 tidal currents main characteristics in the English Channel. These results were obtained by performing systematic measurements of tidal currents in the English Channel physical rotating model of Grenoble, using a laser Doppler anemometer. The model was calibrated to represent the M_2 tide level variations when the measurements were carried out. On the other hand, comparisons between the physical model and the prototype were conducted as far as possible in order to estimate the precision of tidal current representation in a physical model. References (10 items).

Foster, D. N., McGrath, B. L., and Bremner, W. 1978. "Rosslyn Bay Breakwater, Queensland, Australia," <u>Proceedings, Sixteenth Coastal Engineering Conference, August 27-September 3, 1978,</u> Famburg, Germany, ASCE, III:2086-2103.

The Queensland Harbours and Marine Department conducted a study on possible boat harbour sites between Yeppoon and Port Alma on the Central Queensland Coast based on the following criteria: (a) degree of protection afforded; (b) tidal access; (c) degree of maintenance dredging anticipated; (d) capital cost necessary to establish the harbour and the ability to construct the harbour in stages; (e) availability of foreshore area for development; (f) accessibility by road transport and to establish amenities; and (g) availability of suitable quarry material. Rosslyn Bay was selected as the most suitable site and a 105-m rubble mound rock breakwater was constructed in 1968. The breakwater was extended to 210 m in 1970 and was further extended to 300 m in 1972. In 1976 tropical cyclone David extensively damaged the breakwater and harbour facilities. The breakwater was redesigned following model studies and reconstruction was completed in May 1978. This paper discusses damage to the breakwater from wave and surge action, model studies, and repair of the breakwater.

Funke, E. R., and Crookshank, N. L. 1978. "A Hybrid Model of the St. Lawrence River Estuary," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, 111:2855-2869.</u>

A hydraulic model of the St. Lawrence River Estuary had to be partially dismantled. In order to reestablish an upstream boundary for the simulation outside the zone of influence of proposed navigational improvements to the lower estuary, a numerical model of the disbanded upstream river section was dynamically coupled to the remaining hydraulic model. This combination of a numerical and physical model running simultaneously and interactively is referred to as a hybrid model. The implementation of this hybrid configuration was undertaken in part to reactivate the St. Lawrence model as well as to study the feasibility of this approach in preparation for further model studies. References (5 items).

- Gardner, G. B., and Smith, J. D. "Observations of Time-Dependent, Stratified Shear flow in a Small Salt-Wedge Estuary." (See complete entry in Section I.)
- Giese, E. H. T. "Use of an Estuary Mobile Bed Model to Investigate Natural Sedimentation Processes." (See complete entry in Section V.)
- Godin, G. "The Tide in Rivers." (See complete entry in Section I.)
- Gopalakrishnan, T. C., and Machemehl, J. L. 1978. "Verification of a Numerical Flow Model for Carolina Beach Inlet, North Carolina," <u>Verification of Mathematical</u> and Physical Models in Hydraulic Engineering, Proceedings, 26th Annual Hydraulics Division Specialty Conference, University of Maryland, College Park, Maryland, August 9-11, 1978, ASCE, 509-517.

The numerical flow model developed by Machemehl and Gopalakrishnan for computation of flow in tidal inlets with junctions has been applied to Carolina Beach Inlet, North Carolina. The model couples the Galerkin Technique with a finite element analysis. The vertically integrated equations of momentum and mass conservation were used with appropriate boundary and initial conditions. The junction conditions were introduced by the time rates of change of energy and mass flux at the junction. A "double sweep" approach was used in solving for the dynamics of flow. An attempt was made to analyze the inlet using the linear and quadratic shape functions normally used in the finite element method. References (5 items).

- Graff, J., and Karunaratne, A. "Accurate Reduction of Sea Level Records." (See complete entry in Section VII.)
- Graham, D. S., Hill, J. M., and Christensen,
 B. A. 1978. "Verification of Estuarine Model for Apalachicola Bay, Florida."
 <u>Verification of Mathematical and Physical</u> Models in Hydraulic Engineering, Proceedings, 26th Annual Hydraulics Division.

Specialty Conference, University of Maryland, College Park, Maryland, August 9-11, 1978, ASCE, 237-245.

A current research project at the Hydraulic Laboratory of the University of Florida involves linking appropriate currently available basin runoff and estuarine models to quantitatively predict the transient effects of runoff emanating from upland basin activities, particularly forestry practices, upon the biology and water quality of Apalachicola Bay, Florida. References (7 items). SALAN SALA SALANA ANA SALANA SALANA SALANA

Granat, M. A., and Gulbrandsen, L. F. 1982. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-82-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Tests on the Chesapeake Bay hydraulic model were conducted to specifically investigate possible changes in the hydrodynamic characteristics of velocity, salinity, and tidal elevations associated with the proposed channel enlargements. Changes in these parameters can result in changes to estuarine circulation and dynamics and sedimentation rates and patterns; can affect biological communities and distributions; and can affect dispersion of pollutants and nutrients. The present investigation included a series of base tests using the verified model with the existing Baltimore Harbor and approach navigation channels at 42 ft plus a 2-ft dredging tolerance. After these tests were completed, the channels were remolded to the new authorized 50-ft depth plus a 2-ft dredging tolerance, and a series of compatible plan tests were similarly performed for comparison purposes. Velocity and salinity were tested individually under different modes or techniques of model operation. Velocity measurements were taken at 13 selected stations while maintaining constant freshwater discharges and repetitive cosine tides. Salinity and tide height measurements were collected at 68 and 10 locations, respectively, during dynamic testing associated with timevarying boundary conditions.

- Hales, L. Z. "Erosion Control of Scour During Construction; Report 8, Summary Report." (See complete entry in Section V.)
- Hall, R. W., Jr. 1982. "Evaluation of Marsh Estuarine Water Quality and Ecological Models: An Interim Guide," Miscellaneous Paper EL-82-1, US Army Engineer Waterways Experiment Station, Viewanurg, Miss.

This report presents water quality ed ecological problems in eclectal medies and estuaries, seriests applicable medicing

approaches to problem solution, and provides the basis for the modeling recommendations through a brief summary of water quality and ecological modeling in the marsh/estuarine environment. References (102 items).

- Hamilton, P. "Survey of Marine Wetland and Estuarine Water Quality and Ecological Problems in Corps of Engineers Field Offices." (See complete entry in Section V.)
- Hamrick, J. M. "Baroclinic Circulation and Dispersion in Estuaries." (See complete entry in Section III.)
- Harleman, D. R. F. 1973. "Diffusion and Dispersion Processes," <u>NATO Advanced Study</u> <u>Institute on Estuary Dynamics</u>, Lisbon, Lecture No. 9.

Diffusion and dispersion processes as they relate to mathematical modeling for water quality control and management in estuaries, and the interrelationship between mathematical models and the collection of field data necessary for verification are discussed. References (38 items).

Häuser, J., Eppel, D., and Tanzer, F. 1980. "Analysis of Thermal Impact in Tidal Rivers and Estuaries," <u>Water Research</u>, 14(10):1409-1419 (In English, German).

A far field mathematical model is presented for numerical simulation of transient one- or two-dimensional (2-D) thermal distributions in regions with severe reversing flow conditions. The Eulerian formulation employs the integral form of the conservation principles for mass and thermal energy. The 2-D solution area is spanned by discrete elements of variable size and shape. The three-dimensional geometry of the flow region is accounted for by spatially integrating over the enclosure surfaces of the discrete element. The derivation of the 2-D depthaveraged temperature equations includes the contributions of the vertical variations of velocity and temperature. Surface heat transfer and turbulent effects are considered. Important mathematical and computational features of the model are summarized. There is a discussion of the four main algorithms necessary to treat flow regions with complex shoreline geometries: specification of the boundary, determination of all discrete element midpoints lying within the solution area, construction of discrete elements of irregular geometry exactly matching the boundary, and treatment of boundary conditions and numerical solution of the resulting mathematical system of weakly coupled, ordinary differential equations derived from the conservation principles. Preliminary results of a

computer simulation are compared with the available data for the Lower Elbe River. References (7 items).

Havnoe, K., Kej, A., and Siefert, W. 1983. "Mathematical Modelling of Water Levels and Flows in the Port of Hamburg," <u>Dock</u> <u>and Harbour Authority</u>, 63(749):369-372.

Though located 100 km from the North Sea, the Port of Hamburg is significantly influenced by tides and storm surges in the deepened Elbe River. A numericalhydrodynamic model has been established to provide fast and reliable predictions of the effects of man-made changes such as further dredgings, introduction of new channels, and changes in sluice operating policies. The model is based on System 11, a modelling system for rivers, channels, and similar one-dimensional water bodies, developed by the Danish Hydraulic Institute. References (3 items).

Hayter, E. J., and Mehta, A. J. 1979.
"Verification of Changes in Flow Regime Due to Dike Breakthrough Closure," <u>Coastal</u> <u>Structures 79: A Specialty Conference on</u> <u>the Design Construction, Maintenance and</u> <u>Performance of Port and Coastal Struc-</u> <u>tures, March 14-16, 1979, Alexandria, Vir-</u> <u>ginia, ASCE, II:729-746.</u>

Methodology for the verification of changes in the hydrodynamic regime of a tidal waterway network due to modifications made to the network is discussed. The methodology includes the use of two numerical models: a discharge model which calculates the discharge through a flow section from a single velocity measurement at the section, and a one-dimensional hydrodynamic model for a waterway network which calculates the stage and discharge at selected flow sections. The methodology is applied to the shallow waterway network near Matanzas Inlet, Florida, to investigate changes in the flow regime resulting from a dike breakthrough closure. Comparison of the results obtained from the two models is made for both cases. Reasonable agreement is observed, thus attesting to the validity of the methodology. References (3 items).

Heaps, N. S. 1978. "Three-Dimensional Modelling of the Irish Sea," <u>Proceedings</u>, <u>Sixteenth Coastal Engineering Conference</u>, <u>August 27-September 3, 1978, Hamburg, Germany</u>, ASCE, III:2671-2686.

Three-dimensional modelling of the Irish Sea has led to the determination of regimes of residual elevation and current due to wind, density, and sea-surface gradient. These regimes are superimposed, along with tidal residuals from twodimensional modelling, to yield first estimates of mean sea level distribution Sources and a structure structure subjects and the structure

and long-term residual circulation. References (8 items).

Heaps, N. S., and Jones, J. E. 1978.
"Recent Storm Surges in the Irish Sea,"
Marine Forecasting: Predictability and
Modelling in Ocean Hydrodynamics; Proceedings, 10th International Liege Colloquium on Ocean Hydrodynamics, J. C. J. Nihoul, ed., Elsevier Oceanography Series 25, Elsevier, Amsterdam.

The tidal and meteorological conditions associated with some recent very large storm surges in the Irish Sea are described. Surges generated during a period of 10 days in November 1977 are investigated dynamically using a vertically integrated finite-difference model of the Irish Sea. Deductions are made concerning the possibilities of surge prediction for this area using a numerical model. References (8 items).

Heath, R. A. 1982. "Generation of the M_w Tide in Cook Strait, New Zealand," <u>Deutsche Hydrographische Zeitschrift</u>, 35(6):261-270.

Analytical models are used to examine the generation of the M_u tide in Cook Strait, New Zealand. The largest contribution to the M_u tidal elevation comes from the acceleration of the constricted M₂ flow--the M_u elevation reaches about 7 percent of the small M₂ elevation and is therefore of importance in determining the nature of the sympathetic tide in the adjacent Marlborough Sounds. The M_u tidal flow is generally small compared to the large M₂ flow. References (10 items).

Henry, R. F. 1971. "Simulation of Tidal Motion in Complex River Systems and Inlets by a Method of Overlapping Segments," Manuscript Report Series No. 17, Marine Sciences Branch, Department of Energy, Mines, and Resources, Ottawa, Canada.

A method is presented to facilitate digital and hybrid computation of tidal motions for a coastal inlet or river system with many branches and confluences. A simple numerical experiment was implemented for testing the validity of the proposed method in a known physical situation. References (4 items).

- Hickel, W. "The Influence of Elbe River Water on the Wadden Sea of Sylt (German Bight, North Sea)." (See complete entry in Section III.)
- Higgs, K., Treloar, P. D., and Lawson, N. V. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Prototype Data in Botany Bay." (See complete entry in Section V.)

Higuchi, H., Yasuda, H., and Hayakawa, N. 1978. "Experimental Study on Scale Effect of Tidal Model," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2646-2655.</u>

This paper presents a comparative study of two hydraulic models of the Seto Inland Sea in order to better understand the effect of the scale effect of the hydraulic model. The larger model is built with scale ratio of 1 to 2,000 and 1 to 159 in horizontal and vertical directions, respectively. The smaller model has scale ratios of 1 to 50,000 and 1 to 500 in horizontal and vertical directions, respectively. The experimental data of this comparative study are concerned with tides, tidal current, and diffusions. References (4 items). CONTRACT BASSASSING SCORE APARter P

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- Holloway, P. E. "Tides on the Australian North-West Shelf." (See complete entry in Section VIII.)
- Holz, K.-P., and Januszewski, U. 1980. "Automatic Calibration of Numerical Tidal Models," <u>Proceedings, Seventeenth Coastal</u> <u>Engineering Conference, March 23-28, 1980,</u> <u>Sydney, Australia</u>, ASCE, III:2450-2460.

A method from the field of mathematical optimization was applied for the calibration of a one-dimensional river model. The model starts from the St. Venant equations which are solved numerically. The optimization leads to a closed system, so that the calibration can be performed automatically within one computer run. This leads to considerable savings in manpower and computer time. The physical transparency for the hydraulic engineer is maintained. The engineer still defines the criteria according to which the calibration is performed. The parameter set finally obtained is the best and only combination of parameters which is obtainable within a given error bound. References (4 items).

Hommel, H., and Koehler, G. 1978. "Reservoir-Model for Low-Water Regulation in Tidal Influenced Areas," <u>Wasserwirtsch</u>. 68(1):1-5 (In German).

A mathematical model is presented for the simulation of low-flow regulation in coastal regions by a single-purpose reservoir. Operating rules are developed regarding the special case of tide gate influence on natural runoff. Concept and application of the model are illustrated using as example a project near Wilhelmshaven. References (2 items).

Horie, T., Sato, S., and Murakami, K. 1977. "Boundary Treatment on Tidal Current Computation," <u>Proceedings, Seven-</u> teenth Congress of the International

Association for Hydraulic Research; Hydraulic Engineering for Improved Water Management, 15-19 August 1977, Baden-Baden, Federal Republic of Germany, 2:359-366.

This paper concerns the simulation techniques related with line boundary such as breakwaters, contracted cross section such as the open mouth of breakwaters, and elevation and/or velocity control on open boundary, in tidal current computation based on the scheme of alternating direction implicit method developed by J. J. Leendertse. Line boundary requires special operation different from the case of rigid or open boundary. Contracted cross section is treated by the partial modification of continuous and momentum equations. The choice between elevation control and velocity on open boundary depends on the hydraulic properties of the area of interest. Reference (1 item).

Hsueh, S. F., and Ahlert, R. C. 1978. "Mixing in Shallow Coastal Sea: Case Study," Journal, Environmental Engineering Division, ASCE, 104(EE6):1293-1304.

Two tracer studies were used to characterize mixing and tidal exchange in a New Jersey coastal sea. Several dredged channels and complex flow patterns due to islands and embayments cause the system to exchange slowly and to be mixed relatively well internally. Tracer output at the mouth displayed multiple peaks, a long delay, and detectable concentrations for several days. A transient lumpedparameter, reactor network model was calibrated with the second data set. Agreement between the model and field data was good. The simulation did not perform well with the first data set. Further, the output was relatively insensitive to input. This model is not well suited to water quality planning and management for the estuary studied. References (6 items).

Hutchison, I. P. G., and Midgley, D. C. 1977. "Mathematical Modelling of Water Level and Salinity Regimes in Some South African Lake and Estuary Systems," <u>Proceedings, Seventeenth Congress of the</u> <u>International Association for Hydraulic Research; Hydraulic Engineering for Improved Water Management, 15-19 August 1977, Baden-Baden, Federal Republic of Germany, 2:133-140.
</u>

Expanding agricultural and industrial development in South Africa is disrupting the natural water and salt balance in several major coastal lake-bay-estuary systems. The consequent environmental impact has in some cases been severe. The paper is concerned with two such systems on the Zululand coastline, viz., Lake St. Lucia and Richards Bay. Mathematical models simulate the behavior of the systems over long periods of historical hydrology. Results of calibrations against field data are illustrated. Simulated before and after sequences of water level and salinity permit the efficacy of various engineering options for improving the system to be judged. References (4 items).

Huthnance, J. M. 1982. "On the Formation of Sand Banks of Finite Extent," <u>Estuarine, Coastal and Shelf Science</u>, 15(3):277-299.

A model is considered where the fluid depth depends on both horizontal coordinates; quasi-steady depth-uniform nondivergent fluid flow is governed by inertial, pressure, and bottom-frictional forces; sand transport is proportional to the cube of the instantaneous current but augmented by a down-slope component and by wind-wave action; and sand is conserved. It is found that low parallel banks grow fastest, so that in an extensive spatially uniform sea, previous calculations for linear banks are appropriate. The inclination of banks to the tidal currents can be interpreted in terms of similarly inclined deposition bands resulting from vorticity generation and advection in flow over a small isolated hump. A small bump can evolve to an equilibrium bank (typically after an initial rapid extension across the tidal currents) provided that sand is sufficiently restricted and particularly if some wind-wave action prevents growth up to the sea surface. Sand banks are likely to be in a late stage of evolution, when the main change is a slow lengthening as the net current and transport along the bank side slow and turn around the bank end with net deposition. The equilibrium is apparently stable except when there is an overall bed slope in the direction of the tidal currents, or when sand is abundant. References (18 items).

- Huzzey, L. M. "The Dynamics of a Bathymetrically Arrested Estuarine Front." (See complete entry in Section I.)
- Imasato, N. 1983. "What is Tide-Induced Residual Current?" Journal of Physical Oceanography, 13(7):1307-1317.

A numerical experiment was conducted to study the velocity field of a twodimensional tidal current in a simple model basin with a narrow strait. It was found that the tide-induced transient eddy (TITE) originated from the low pressure area that is generated downstream behind a headland by the nonlinearity or the centrifugal force of the tidal current flowing with a large curvature through a

narrow channel. The transient eddy is maintained during certain phases of the tide, and therefore the Eulerian tideinduced residual current is the result of the averaging process of transient phenomena; the Eulerian residual current is only a mathematical representation of the tideinduced transient eddy and has no physical reality. The concept of residual velocity should be abandoned. The lifetime of TITE depends on the magnitude of vorticity and its dissipation. In an inner basin with large bottom friction, the eddy diminishes within a short time (1 or 2 hours) after the generation, and the pressure gradient of the eddy is smaller than the pressure gradient of tidal flow in the strait at the time of high-tide slack water. In this case, TITE is swept away by the ebbing tidal current which flows outward through the strait and soon disappears. On the other hand, in a basin with small bottom friction, because the eddy grows so strong at the time of the start of the ebb tide that the pressure gradient becomes larger than that of the ebbing tide, it is maintained by the ebbing tidal current which runs around the eddy toward the strait. In the latter case, vorticity dissipation caused by horizontal eddy viscosity is larger than that due to bottom friction because of a larger horizontal velocity shear near the eddy. References (8 items).

Indlekofer, H. 1981. "On Numerical Stability of One-Dimensional Sediment Transport Models for Unsteady and Tidal Flows," <u>Proceedings, Specialty Conference, Water</u> <u>Forum '81, San Francisco, Calif., August 10-14, 1981, ASCE, I:403-410.</u>

The mathematical sediment transport model used is based on the one-dimensional St. Venant equations for water flow, the sediment continuity equation, and a Colby type formula for bed material transport. The four-point implicit scheme is applied to discretize the partial differential equations. With the aid of the von Neumann method the influence of different physical and numerical parameters on the numerical stability is studied. The major results of the study are summarized in two dimensionless graphs demonstrating the applicability of the sediment transport model regarding numerical stability. References (2 items).

Isaji, T., and Spaulding, M. L. 1984. "A Model of the Tidally Induced Residual Circulation in the Gulf of Maine and Georges Bank," Journal of Physical Oceanography, 14(6):1119-1126.

A three-dimensional nonlinear numerical hydrodynamic model using Legendre polynomials to represent the vertical structure of the horizontal currents has been used to study the tidally induced residual flows in the Gulf of Maine-Georges Bank study region using a 6.25-km square grid. Tidal elevations in terms of the M₂ phase and amplitude along the open boundaries are specified using Schwiderski's deep ocean tidal model. The model predicts strong clockwise circulation gyres around Georges Bank and Nantucket Shoals with a weak gyre around Browns Bank. Strong inflow to the Gulf of Maine is predicted near the southwestern tip of Nova Scotia. These results are in good agreement with recent model predictions of Greenberg. References (29 items). BALLOW ROSSISSING RECOORDER REAL

Jain, S. C. 1982. "Movable-Bed Tidal Inlet Model," Journal, Waterway, Port, Coastal and Ocean Division, ASCE, 108(WW3):326-342.

The effectiveness of movable-bed tidal inlet hydraulic models in predicting prototype behavior is evaluated by comparing the model predictions with the observations made in the prototype. The calibration of the model, as measured by bed topography changes, is evaluated by means of quantitative indicators, including correlation coefficients and root-mean-square error. Evaluation of data from the Galveston Harbor entrance model revealed that the shoaling rates and distribution along the navigation channel predicted by the model are not in good agreement with the prototype data. Disagreement between model and prototype is believed to have been due to scale effects introduced by nonsimilarity of the physical processes, insufficient prototype data for model calibration, oversimplification of the available prototype data for use in the model study, and experimental errors. References (6 items).

Jenkins, S. A., Inman, D. L., and Bailard, J. A. 1980. "Opening and Maintaining Tidal Lagoons & Estuaries," <u>Proceedings,</u> <u>Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia</u>, ASCE, II:1528-1547.

This paper reports on five separate prototype scale field experiments that test alternative measures to dredging. Two of these experiments evaluate techniques of resuspension and exclusion for reducing fine sediment accumulations in quiet water, cul-de-sac berths, where the observed shoaling rates are greatest and dredging most difficult. These berths are essentially sediment settling basins where currents are insufficient to resuspend new deposits. The fine sediment control studies were performed in and around berths at Mare Island Naval Shipyard. Another two experiments involved bypassing sand around the inlet of Agua Hedionda Lagoon, California, using fluidized trenches funneling into a crater sink. The final experiment used open trench fluidization to reopen

Penasquitos Lagoon, California. References (16 items).

Jiang, J. X., and Falconer, R. A. 1983. "On the Tidal Exchange Characteristics of Model Rectangular Harbours," <u>Proceedings</u>, <u>The Institution of Civil Engineers;</u> <u>Part 2: Research and Theory</u>, 75:475-489.

This paper describes a laboratory model study to determine the influence of the planform geometry, the entrance width, and the tidal range on the exchange characteristics of a simple shaped harbor, having a constant depth and planform area. The model tidal ranges, mean water depth, and planform area had scaled dimensions typical of many existing small harbors in Puget Sound, Washington, U.S.A., where in recent years concern has been expressed as to the water quality characteristics of many of these harbors. Each of the rectangular harbor configurations studied had a single asymmetric entrance and vertical sides. In the laboratory investigations the effects of wind, short period waves, and the earth's rotation have all been neglected. The laboratory results confirm that the optimum gross tidal flushing occurs for a rectangular harbor when the length to breadth ratio is between 1/2 and 2, and for lower tidal ranges ideally the harbor should be square, i.e., with a length to breadth ratio of unity. Analysis of the flow fields for the various geometries also showed that, for length to breadth ratios of less than 1/2 and greater than 2, more than one circulation cell (or gyre) was observed within the basin. Varying the entrance width confirmed that there was an optimum entrance size and the use of guide vanes positioned appropriately can lead to a marked improvement in the exchange characteristics of a poorly flushed basin. References (8 items).

Joshi, P. B., and Taylor, R. B. 1983. "Circulation Induced by Tidal Jets," Journal, Water, Port, Coastal and Ocean Engineering, ASCE, 109(4):445-464.

Steady potential motion induced by a tidal jet in an ebbing ocean is analyzed by representing the jet as a distribution of sink singularities and relating the sink strength to jet solutions for steady bottom-frictional turbulent jets over constant bathymetry. Circulation patterns are determined for various inlet configurations of practical interest and for different values of the bottom friction parameter. Particular attention is given to the jet-induced alongshore current which is shown to be sensitive to the presence of jetties and also to the bottom friction experienced by the jet. The present theory is applied to Fort Pierce Inlet, Florida, where severe erosion is known to exist on both sides of the inlet. It is

suggested that the alongshore current, albeit small in magnitude, is a potential contributor to the movement of suspended beach material toward the inlet due to its continual occurrence during every ebb tide. References (24 items).

- *Kabbaj, A., and LeProvost, C. "Nonlinear Tidal Waves in Channels: A Perturbation Method Adapted to the Importance of Quadratic Bottom Friction." (See complete entry in Section I.)
- Kawahara, M., and Hasegawa, K. 1977. "Finite Element Analysis of Two-Layered Tidal Flow," <u>Proceedings, Symposium on Applications of Computer Methods in Engineering, August 23-26, 1977, Los Angeles, California, L. C. Wellford, Jr., ed., University of Southern California, II:1357-1366.</u>

In estuaries, salt water intrudes into the river so that the flow patterns of the estuaries are considerably altered. In a stratified estuary, the flow may be assumed as two-layered density flow. In this paper, two-layered tidal flow analysis has been carried out by the finite element method using the shallow water equation. The conventional finite element Galerkin method leads to a simultaneous ordinary differential equation system. To solve the differential equation, the finite element perturbation method has been applied employing a trigonometric solution. Pollutant dispersal analysis of Niigata Harbour has been analyzed by the present method. References (4 items).

Kawahara, M., and Hasegawa, K. 1978. "Periodic Galerkin Finite Element Method of Tidal Flow," <u>Numerical Methods in Engi-</u> neering, 12(1):115-127.

This paper presents the finite element method of the analysis of tidal flow. Assuming that tidal flow is periodic, the Galerkin approach is employed as the numerical integration procedure in time using a trigonometric function as the interpolation function. The present method has shown to be suitable for computation especially from the point of computing time and numerical stability. References (10 items).

Kawahara, M., Hasegawa, K., and Kawanago, Y. 1977. "Periodic Tidal Flow Analysis by Finite Element Perturbation Method," <u>Computers and Fluids</u>, 5(4):175-189.

The numerical analysis of periodic tidal flow is presented. The paper investigates a numerical procedure based on the mixed approach of the finite element method and the perturbation method by postulating periodic motion. Several numerical studies are presented to examine the validity of the formulation. References (18 items). Kerssens, P. J. M., Prins, A., and Van Rijn, L. C. 1979. "Model for Suspended Sediment Transport," <u>Journal, Hydraulics</u> <u>Division</u>, ASCE, 105(HY5):461-476.

A mathematical model for suspended sediment transport is described, which enables the investigation of certain effects of river works or geometrical changes, or both, in a river or estuary by morphological computations. The model is based on the two-dimensional diffusion-convection equation. This equation describes the distribution of the sediment concentrations in a two-dimensional flow field by diffusion and convection. For the local velocities in the vertical the logarithmic distribution is used, while for the sediment diffusion coefficient a new expression is applied. The diffusion-convection equation is solved by an implicit numerical method using a coordinate transformation, while the influence of the diffusion coefficient on the adaptation of the transport in the case of an overcapacity of sediment is presented. A dimensionless graph of the adaptation length of a uniform concentration vertical is given, the application of the model for tidal flow is described, and for such conditions a prototype verification and a sensitivity analysis are given. The model is limited to situations with relatively small changes in lateral direction and nongraded bed. References (14 items).

Kerssens, P. J. M., Van Rijn, L. C., and Van Wijngaarden, N. J. 1977. "Model for Non-Steady Suspended Sediment Transport," <u>Proceedings, Seventeenth Congress of the</u> <u>International Association for Hydraulic</u> <u>Research; Hydraulic Engineering for Improved Water Management, 15-19 August, 1977, Baden-Baden, Federal Republic of Germany, 1:113-120.</u>

The paper describes a mathematical model for suspended sediment transport which enables morphological computations to investigate the effects of human interference and/or geometrical changes in a river or estuary. The model is partly based on former research on bed-load transport models, and on the two-dimensional sediment diffusion-convection equation. This equation describes the movement of the sediment, in fact the distribution of the concentrations in the two-dimensional flow field, under the influence of diffusion, convection, and gravity. The local velocities in the vertical are given by the logarithmic distribution, while for the sediment diffusion coefficient a newly derived parabolic/constant expression is applied. The diffusion equation is solved by an implicit numerical method, making use of a favorable transformation. The method is restricted to noncohesive and nearly uniform sediment material. A test computation concerning the sedimentation

in a trench has been executed to verify the applicability of the mathematical model. References (7 items).

Knap, A. H., and Williams, P. J. LeB. 1982. "Experimental Studies to Determine the Fate of Petroleum Hydrocarbons from Refinery Effluent on an Estuarine System," <u>Environmental Science & Technology</u>, 16(1):1-4. This report illustrates that the important questions relating to the processes afecting the fate of organic industrially derived pollutants in the estuarine environment can partly be resolved by relatively simple experiments. These experiments also give an important insight into what processes warrant further investigation in the ecosystem. Biodegradation appears to be important with regard to long-term modification of aliphatic hydrocarbons of refinery origin. Evaporative processes play an important role in the short-term removal of all fractions of the refinery effluent. However, experiments show that the most important process which would affect the long-term health of the estuary is the adsorption of petroleum hydrocarbons to estuarine sediments. This rapid near-source sedimentation would create a deposit of petroleum hydrocarbons that can be released to the aqueous environment. Subsequent analyses of surface sediments and sediment cores from the outfall area indicate that approximately 25 percent of the total nonvolatile hydrocarbon material estimated to have been discharged from the refinery may still reside in these sediments. References (24 items).

Knight, D. W. "Some Field Measurements Concerned with the Behaviour of Resistance Coefficients in a Tidal Channel." (See complete entry in Section VIII.)

Koutitas, C., and O'Connor, B. 1980. "Modeling Three-Dimensional Wind-Induced Flows," Journal, Hydraulics Division, ASCE, 106(HY11):1843-1865.

A three-dimensional numerical model has been developed to study hydrodynamic circulations produced in coastal zones due to tide and wind action. The model consists of a mixed finite difference/finite element solution of the simplified fluid momentum and continuity equations. A numerical splitting technique is used to reduce the size of model solution matrices while the finite element approach is used over the flow depth to enable irregular seabeds to be tackled easily. Model errors arising from the numerical method are minimized by the use of a Galerkin weighted-residual procedure. The problems associated with modeling the turbulence closure of the basic momentum equations

are also investigated with a simplified form of the model, and the need for high levels of closure is demonstrated. The potential use of the three-dimensional model is illustrated by prediction of wind-induced flows in Thessaloniki Bay in the Aegean Sea. References (21 items).

- Kowalik, Z., and Matthews, J. B. "The M₂ Tide in the Beaufort and Chukchi Seas." (See complete entry in Section VIII.)
- Krause, G. "Separation of Climatic Fluctuations and Impacts of Engineering Activities in Estuaries." (See complete entry in Section III.)
- Kuo, C. Y., and Blair, C. H. 1978. "Comparison of Verified Physical and Mathematical Model," <u>Verification of Mathematical and Physical Models in Hydraulic</u> <u>Engineering, Proceedings, 26th Annual</u> <u>Hydraulics Division Specialty Conference,</u> <u>University of Maryland, College Park,</u> <u>Maryland, August 9-11, 1978</u>, ASCE, 222-229.

A physical model and a mathematical model have been used to study the Lafayette River, a small well-mixed estuary in Norfolk, Virginia. The studies include the tide heights, currents, salinity distributions and mass transport. Both types of models were verified. Results from physical and mathematical models were compared. The longitudinal salinity gradient is very small in the lower reach and the vertical profile nearly isohaline except during the period of tropical storms.

Lai, C. 1969. "A Computer Simulation Study of Traveltimes of Injected Particles and Tide-Waves in Well-Mixed Estuaries," <u>Pro-</u> ceedings, Thirteenth Congress of the <u>In-</u> ternational Association for Hydraulic <u>Research, 31 August-5 September 1969</u>, Science Council of Japan, 3:123-130.

A mathematical model using the method of characteristics and appropriate numerical procedures for computer has been constructed to simulate the unsteady motion of the water-surface profile and the movements of index particles in well-mixed estuaries. Techniques in computer graphics have been applied to the model so that the numerical data of computer output representing the complex motions of watersurface movement, wave propagation, particle injection and its travel along the channel, etc., can be graphically displayed for visual observation. Two examples, one for a hypothetical tidal reach and the other for a tidal reach in the Connecticut River, have been used to illustrate computer animation and x-y plotting by an S-C 4020 computer recorder as means of graphical outputs. Examination of the results reveals that a large

amount of qualitative and quantitative information concerning traveltimes of index particles and tide-waves can be obtained by this approach. References (8 items).

Lai, C. 1977. "Computer Simulation of Two-Dimensional Unsteady Flows in Estuaries and Embayments by the Method of Characteristics: Basic Theory and the Formulation of the Numerical Method," Water-Resources Investigations No. 77-85, US Geological Survey, Water Resources Division, Reston, Va.

Two-dimensional unsteady flows of homogeneous density in estuaries and embayments can be described by hyperbolic, quasilinear partial differential equations involving three dependent and three independent variables. A linear combination of these equations leads to a parametric equation of characteristic form, which consists of two parts: total differentiation along the bicharacteristics and partial differentiation in space. For its numerical solution, the specified-timeinterval scheme has been used. The unknown, partial space-derivative terms can be eliminated first by suitable combinations of difference equations, converted from the corresponding differential forms and written along four selected bicharacteristics and a streamline. Other unknowns are thus made solvable from the known variables on the current time plane. The computation is carried to the secondorder accuracy by using trapezoidal rule of integration. Means to handle complex boundary conditions are developed for practical application. Computer programs have been written and a mathematical model has been constructed for flow simulation. The favorable computer outputs suggest further exploration and development of model worthwhile. References (16 items).

Lai, C. 1968. "The Boundary Conditions in the Implicit Solution of River Transients," <u>Geological Survey Research 1968;</u> <u>Chapter C</u>, Geological Survey Professional Paper 600-C, Geological Survey, Washington, D. C., C204-C210.

Problems in obtaining boundary conditions for the implicit method of solving tidal equations are discussed. Separate solution schemes must be established for different combinations of boundary variables. A common set is known water stages at boundaries; however, others may be easier or cheaper to obtain. An example is the condition of zero flow at a closed end or at sites where flow discharge is known or easily obtained. Several boundary-condition schemes are derived for implicit solution of the appropriate equations. Results of two examples are given. References (7 items).

Leenknecht, D. A., Earickson, J. A., and Butler, H. L. 1984. "Numerical Simulation of Oregon Inlet Control Structures' Effects on Storm and Tide Elevations in Pamlico Sound," Technical Report CERC-84-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Three numerical hydrodynamic models with progressively finer grid resolutions, utilizing the finite difference code WIFM, were developed for the purpose of evaluating the influence of proposed structures under storm conditions and providing elevation and velocity data for concurrent numerical sediment transport studies at Oregon Inlet, North Carolina. The offshore model encompassed the entire Carolina coast over the continental shelf and was used to propagate storm effects from deep water to the finer resolution models. The nearshore model extended from Cape Henry to Cape Lookout, and provided finer detail along the Outer Banks, within Pamlico and Albemarle Sounds, and at Oregon Inlet. This model was used for both tide and surge simulations and was the primary tool for establishing structural effects under storm conditions in the Oregon Inlet vicinity. It also was used to provide boundary conditions for the most detailed model of the study known as the shore process model. The shore process model encompassed less than 85 square miles centered about Oregon Inlet and provided high resolution at the inlet and in the surf zone. It provided more realistic circulation patterns of the inlet, the effects of jetties on inlet flow, and hydrodynamic data for concurrent numerical sediment transport studies. Simulations at very fine grid resolution were made using the shore process model to provide hydrodynamic data for numerical sediment transport studies covering the normal range of tides with no jetties, four structural alternatives with a mean tide, and the historical March 1962 northeaster with no jetties. References (18 items).

Leitass, R. 1979. "Wave Damages to Stone Slope Under Marginal Wharves," <u>Coastal</u> <u>Structures 79, A Specialty Conference on</u> <u>the Design Construction, Maintenance and</u> <u>Performance of Port and Coastal Struc-</u> <u>tures, March 14-16, 1979, Alexandria,</u> <u>Virginia, ASCE, II:1106-1123.</u>

In Quebec region, site inspections showed that a few years later after the completion of the construction of marginal wharves on piles, the slopes under the wharves and the pavements behind were damaged. At the upper part of the slope, the armor stones were displaced, and damages to the pavement appeared in the form of potholes and as general settlements. Considering the fact that there was no information available on what basis

the remedial works could be designed, it was decided to run laboratory model tests for Matane and Rivière au Renard marginal wharves, in order to better understand the behavior of rubble-mound slopes under the air pressure caused by wave and tide action. The testing in both cases was carried out at Laval University's hydraulic laboratory for different air pressure relief hole arrangements and for variable parameters, like water level, wave period, and wave height. For each series of tests, air pressures were recorded and the air relief hole area in relation to the total area was determined, which led to practical suggestions for remedial work to be done. References (3 items).

- Lepetit, J. P., and Davesne, M. "Dynamics of Silt in Estuary, Residual Current or Flocculation Which Prevails?" (See complete entry in Section II.)
- Lepetit, J. P., and Hauguel, A. "A Numerical Model for Sediment Transport." (See complete entry in Section II.)
- Le Provost, C. 1981. "A Model for Prediction of Tidal Elevations Over the English Channel," Oceanologica Acta, 4(3):279-288.

A model for prediction of tidal elevations in the English Channel is presented. It is based on the classical harmonic description of tides deduced from the harmonic development of the tide-generating potential. The spatial distribution of the amplitudes and the phases of the 29 harmonic constituents included in the procedure of prediction are deduced from a previous study: spline functions determined on the basis of these data allow to compute these harmonic parameters at every point of the English Channel. Two examples of application of the model are presented: first, a tidal prediction is realized in the harbor of Le Havre over a period of half a year and compared with in situ observation; second, the model is used to analyze altimetric measurements of the sea level along subsatellite flights across the English Channel, supplied by the oceanographic satellite Seasat. The predicted tides, computed by the proposed procedure, are removed from the altimetric measurements; this allows the demonstration that the precision of the altitude of the satellite over the Channel, processed during these flights, is not better than several metres; nevertheless, these results give an estimate of the slope of the geoid between England and France, along the subsatellite track. References (18 items).

Le Provost, C., and Poncet, A. "Finite Element Method for Spectral Modelling of Tides." (See complete entry in Section I.)

- Librach, A. S., et al. "Managing Potomac Water Quality: Evolving Approaches." (See complete entry in Section IV.)
- Lie, H.-J., and El-Sabh, M. I. 1983. "Formation of Eddies and Transverse Currents in a Two-Layer Channel of Variable Bottom with Application to the Lower St. Lawrence Estuary," Journal of Physical Oceanography, 13(6):1063-1075.

Baroclinic shelf waves and Kelvin waves in a two-laver channel of variable bottom are discussed using a simple numerical model. Two different propagation directions are shown to be possible, analogous to the existence of shelf waves and trench waves in an ocean bounded by a coast with a trench, described by Mysak et al. The eigenfunctions of baroclinic shelf wave modes are quite different from the barotropic eigenfunctions; that is, each of the baroclinic modes shows a pattern similar to the first mode with the exception of small-scale structures near the coast. The model also shows the formation of a series of eddies with alternating rotation senses accompanied by transverse currents between two successive eddies. Eddies and transverse currents were observed in the upper layer of the lower St. Lawrence Estuary based on 4 months of direct measurements taken in 1979. The observed wavelike motion with a period of about 80 days and a wavelength of 75 km corresponded to the fourth baroclinic shelf wave modes. The observed near-surface circulation patterns with important variability in space and time are thus explained by the superposition of two baroclinic shelf waves propagating in opposite directions. References (27 items).

- Liou, Y.-C., and Herbich, J. B. "Velocity Distribution and Sediment Motion Induced by Ship's Propeller in Ship Channels." (See complete entry in Section II.)
- Liu, S. K., Hou, H. S., and Chang, C. C. 1978. "Simulation of Wave/Wind Forced Harbor Oscillation," <u>Proceedings, Six-</u> teenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2551-2562.

This paper describes the methods used in an investigation of the response characteristics of a large man-made harbor under construction. In the investigation a three-dimensional finite difference model is applied in conjunction with physical models and field observations to assist in determining criteria for design and operation. In the modeling investigation, the dynamic response of the harbor system induced by tide, incoming short/long waves, wind stress and bottom dissipation are considered simultaneously. Particular emphasis of the study has been on the waveand strong monsoon-induced oscillations that match the range of the resonant

period of ships and mooring systems expected to operate in the harbor. The resolution required to handle short-period oscillation and wind stress precludes the possibility of using methods involving the inversion of extremely large matrices. The results of the numerical simulation at important localities within the harbor system are later analyzed by spectral and cross-spectral methods. The same methods can then be used to study ships' responses at these localities with the predicted water level and three-dimensional current components. References (2 items).

Liu, S. K., and Leendertse, J. J. 1978. "Three-Dimensional SGC Energy Model of Eastern Bering Sea," <u>Proceedings, Six-</u> <u>teenth Coastal Engineering Conference, Au-</u> <u>gust 27-September 3, 1978, Hamburg, Ger-</u> <u>many</u>, ASCE, III:2687-2707.

This paper describes the development, adjustments, and verification of a threedimensional, nonhomogeneous model of Bristol Bay and the St. George Basin. The modeled area is situated on the continental shelf area at the southeastern corner of the Bering Sea, which has one of the largest shelf areas of the world's oceans. Because of this, the water mass movement in the modeled area is driven predominantly by wind and tide, whereas waters in the deeper basin to the west are part of the cyclonic Bering Sea slope current system flowing parallel to the continental shelf break. Annual cycles of surface heating and cooling and the duration, strength, and phasing of these periods give a distinctive hydrodynamic behavior to the system. During autumn and winter, local negative buoyancy (vertically unstable) exists due to surface cooling and brine rejection during ice formation. In spring, positive buoyancy is added by freshwater runoff, ice melting, and insulation. The hydrographic structure in the modeled area is further modified by the seasonal wind, with higher mean speed in autumn and winter. References (5 items).

- Lundgren, H. "Struggle of Physics and Mathematics." (See complete entry in Section I.)
- McAnally, W. H., Jr. 1977. "Los Angeles Harbor and Long Beach Harbor: Physical Model of San Pedro Bay Tidal Circulation," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, March 9-11, 1977, Long Beach, Calif., I:65-84.

A physical hydraulic model is used to assess the effects of Los Angeles Harbor and Long Beach Harbor port improvements on tidal circulation in San Pedro Bay, California. The model is of fixed-bed construction with length scales of 1:100 vertically and 1:400 horizontally. A

comparison of model results with field data obtained for model verification plus data from other sources shows that the model satisfactorily reproduces tidal circulation in the harbors. Tidal circulation in the existing harbors is dominated by a few large circulation cells that result in a net westward flow in Cerrittos Channel and a net eastward flow in the Outer Harbor. Wind effects appear to alter the gyre patterns in the Outer Harbor but are not believed to change general net flow characteristics of the harbors. It is concluded that the physical model accurately predicts important tidal circulation characteristics. References (10 items).

McAnally, W. H., Jr., Brogdon, N. J., Jr., and Stewart, J. P. 1983. "Columbia River Estuary Hybrid Model Studies; Report 4, Entrance Channel Tests," Technical Report HL-83-16, Report 4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A hybrid modeling approach using a fixedbed physical model, numerical models, and analytical techniques was used to study navigation channel shoaling at the mouth of the Columbia River. Sixteen plans for reducing channel maintenance dredging at the existing 48-ft depth and at 55- and 60-ft depths were tested. Effects of the plans on tides and currents were found to be subtle. Nondeepening plans had minor effects on salinity intrusion while channel deepening increased salinities by 1 to 6 ppt up to about mile 18. Only one structural plan reduced shoaling below base conditions for the 48-ft channel. Channel deepening increased shoaling considerably. References (9 items).

McAnally, W. H., Jr., and Raney, D. C. 1977. "Los Angeles Harbor and Long Beach Harbor: Physical and Numerical Tidal Models: A Comparison," <u>Ports '77, 4th</u> <u>Annual Symposium of the Waterway, Port,</u> <u>Coastal and Ocean Division of ASCE</u>, March 9-11, 1977, Long Beach, Calif., I:101-118.

Physical and numerical hydrodynamic models are frequently used to determine the effects of port development on tidal circulation. A comparison of field data with results from a physical model and a numerical model of San Pedro Bay, California, indicates that both are suitable for studying tidal circulation under certain conditions. The physical model has length scales of 1:100 vertically and 1:400 horizontally and models about 264 square miles. The numerical model is a twodimensional, depth-averaged formulation solved by an implicit-explicit finite difference scheme with a rectangular grid size of 300 ft by 300 ft and a 45-sec time-step. The numerical model has 20,000 grid points and models an area of

approximately 64 square miles. Both models have been used for detailed examination of tidal circulation within the harbors of Los Angeles and Long Beach, California. The results show substantial agreement between the two models for two harbor configurations and with available field data. Net tidal flows are reproduced in direction and approximate magnitude, and large gyres occur in similar locations in both models (with some differences in strength and lateral extent). It is concluded that both models are reliable tools for studying circulation in similar well-mixed bays. References (2 items).

McAnally, W. H., Jr., et al. 1984. "Application of Columbia Hybrid Modeling System," <u>Journal, Hydraulic Engineering</u>, ASCE, 110(5):627-642.

The Columbia Hybrid Modeling System was applied to navigation channel shoaling problems at the mouth of the Columbia River Estuary. The models were verified to satisfactorily reproduce observed prototype behavior. The adjustment process created a typical year from a statistical analysis of river runoff and waves combined with a typical tide. References (6 items).

McAnally, W. H., Jr., et al. 1983. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth," Technical Report HL-83-16, Report 1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The Columbia Hybrid Modeling System was applied to the mouth of the Columbia River Estuary to evaluate alternatives for reducing navigation channel maintenance dredging. The hybrid modeling method uses a physical hydraulic model, analytical techniques, and various numerical models in an integrated solution method that takes advantage of the strengths of each technique while avoiding its weaknesses. The methods accounted for the effect of tides, freshwater runoff, wind waves, and littoral currents on sediment transport, deposition, and erosion. The models were verified to satisfactorily reproduce observed prototype behavior. References (50 items).

MacArthur, R. C. "Turbulent Mixing Processes in a Partially Mixed Estuary." (See complete entry in Section I.)

MacAyeal, D. R. 1984. "Numerical Simulations of the Ross Sea Tides," <u>Journal of</u> Geophysical Research, 89(C1):607-6¹⁵.

Tidal currents below the floating Ross lice Shelf are reconstructed by using a numerical tidal model. They are predominantly

diurnal, achieve maximum strength in regions near where the ice shelf runs aground, and are significantly enhanced by topographic Rossby wave propagation along the ice front. A comparison with observations of the vertical motion of the ice shelf surface indicates that the model reproduces the diurnal tidal characteristics within 20 percent. Similar agreement for the relatively weak semidiurnal tides was not obtained, and this calls attention to possible errors of the open boundary forcing obtained from global-ocean tidal simulations and to possible errors in mapping zones of ice shelf grounding. Airsea contact below the ice shelf is eliminated by the thick ice cover. The dominant sub-ice-shelf circulation may thus be tidally induced. A preliminary assessment of sub-ice-shelf conditions based on the numerical tidal simulations suggests that (a) strong barotropic circulation is driven along the ice front and (b) tidal fronts may form in the sub-ice-shelf cavity where the water column is thin and where the buoyancy input is weak. References (49 items).

McClimans, T. A., and Gjerp, S. A. 1978. "Numerical Study of Distortion in a Froude Model," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, <u>III:2887-2904.</u>

A numerical model utilizing a fully timecentered implicit (ADI) computational algorithm is used to investigate the effects of distortion of the laboratory model of the Tromsø Sound where advective accelerations are important. The numerical model is used to study the individual effects of bottom and side resistance in order to obtain a better understanding of the dynamics and energetics of the tidal flow. Bottom friction is modeled by Chezy's formula. Correspondingly, a lateral viscosity proportional to the local velocity is used to obtain a realistic representation of turbulent lateral momentum exchange. Deviations between the results of the models and field observations are found to be within the natural variability from one tidal cycle to the next, indicating that the laboratory simulation is not seriously affected by distortion. References (20 items).

McKay, G. R., and Tranberg, C. H. "The Development of a Dredged Estuarine Harbour--A Case Study." (See complete entry in Section V.)

Machemehl, J. L., and Gopalakrishnan, T. C. 1977. "Comparison of Numerical Simulation Flow Models for Coastal Inlets." <u>Hydraulics in the Coastal Zone,</u> <u>Proceedings, 25th Annual Hydraulics Specialty Conference, Texas A&M University.</u>

College Station, Texas, August 10-12, 1977, ASCE, 1-10.

A numerical simulation model for the computation of flow in inlets with junctions has been developed by Gopalakrishnan and Machemehl. This model uses the Galerkin technique with a finite element analysis. The vertically integrated equations of momentum and mass conservation are used with the appropriate boundary and initial conditions. The finite element model is used to investigate the flow in Masonboro Inlet, North Carolina. The junction conditions are introduced by the time rates of change of energy and mass flux at the junctions. The effectiveness of the "double sweep" approach in solving the flow dynamics is described along with a discussion of appropriate shape functions. The computer results from the finite element scheme are compared with the field data and with the results from the finite difference schemes. References (3 items).

- Madsen, O. S., and Grant, W. D. "Sediment Transport in the Coastal Environment." (See complete entry in Section II.)
- Maiar-Reimer, E. 1977. "Residual Circulation in the North Sea Due to the M₂-Tide and Mean Annual Wind Stress," <u>Deutsche</u> Hydrographische Zeitschrift, 30(3):69-80.

In a high resolving (mean grid size 11 km. barotropic numerical model of the North Sea tides, the M_2 tide is computed. Nonlinearities of the Navier-Stokes-equation yield, in connection with an annual mean wind stress, a residual circulation fitting well to observational data. Some effects of this circulation are discussed in connection with pollution problems. References (11 items).

- Mangarella, P. A., and Robilliard, G. A. "Thermal and Biological Impact of LNG Vaporizer Discharge." (See complete entry in Section V.)
- Markofsky, M. 1979. "Design of a Tunnel Discharge in an Estuary-Physical Model and Field Studies," <u>Hydraulic Engineering in</u> <u>Water Resources Development and Manage-</u> <u>ment, Proceedings, Eighteenth Congress,</u> <u>International Association for Hydraulic</u> <u>Research, Cagliari, Italia, 10-14 Septem-</u> ber 1979, 4:339-346.

A comparison between the results of physical model studies used in the design phase of a diffuser discharge in tidal waters and field measurements under operating conditions is given. The comparison helps to illustrate both the important role of laboratory model studies as a design and for thermal discharges and some limitations of field monitoring programs for the determination of compliance with low temperature rise thermal criteria in tidal waters. Beferences (6 items). 1997 N. 1997

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Maxworthy, T. 1979. "A Note on the Internal Solitary Waves Produced by Tidal Flow over a Three-Dimensional Ridge," <u>Journal of Geophysical Research</u>, 84(C1):338-346.

Using a simple laboratory model, the author believes to have clarified the mechanisms whereby a train of solitary waves can be generated by the barotropic tidal flow of a stratified fluid over a three-dimensional obstacle. As the tidal flow reaches critical value of the internal Froude number, a downstream depression is formed in the mixed layer. When the tide slackens and turns, this depression moves upstream and evolves into a sequence of solitary waves. Under some circumstances the depression becomes turbulent, and intense mixing takes place. In this case it is also the collapse of the mixed region that generates solitary waves which mainly propagate upstream. Available field data are consistent with this explanation, and the number of waves formed can be estimated using existing theory. References (12 items).

- Maza, J. A., Munoz, M. L., and Porraz, M. "Jetties Studies Contribution." (See complete entry in Section V.)
- Milford, S. N., and Church, J. A. 1977. "Simplified Circulation and Mixing Models of Moreton Bay, Queensland," <u>Australian</u> <u>Journal of Marine and Freshwater Research</u>, 28(1):23-24.

An investigation of water motions in Moreton Bay has employed existing data on tide heights and salinity to establish and check a quasi-two-dimensional mathematical model of the bay. Agreement between model and prototype tide levels is good, and the predicted circulation patterns are generally similar to the clockwise circulation inferred by earlier workers. Because of the uncontrolled numerical dispersion in the model, the predicted salinity distributions show only fair agreement with the measured values. Overall, the study identifies the following needs for further modelling: adequate treatment of multiple ocean entrances, detailed sensitivity tests, more extensive field data, and more sophisticated models. References (13 items).

- Montgomery, J. R. "Predicting Level of Dissolved Reactive Phosphate in the Lafayette River, Virginia, from Information on Tide, Wind, Temperature, and Sewage Discharge." (See complete entry in Section IV.)
- Morris, F. W., IV, Walton, R., and Christensen, B. A. "Point and Nonpoint Pollutant Flushing in Tidal Canal Networks." (See complete entry in Section IV.)

Muralikrishna, I. V., and Devanathan, R. 1978. "Circulation and Salinity Distribution in Coastal Inlets," <u>Coastal Engineering</u>, 2(2):119-131. The mathematical model developed by Hansen and Rattray based on Pritchard's equation for a coastal-plain estuary has been analysed to study the circulation and salinity distributions in coastal inlets with constant width and depth. Numerical solutions of the basic equations have been obtained without placing any restriction on Rayleigh numbers. A noteworthy contribution of the present analysis is that solutions of equations have been obtained for higher Rayleigh numbers, which was not possible in the earlier model. It is found that the effect of higher Rayleigh numbers is to increase the vertical advection, making the salinities in the upper and lower layers more uniform, with a distinct halocline near the mid-depths. Solutions are discussed for some special cases of practical interest. References (5 items).

- Murty, T. S., and Henry, R. F. "Tides in the Bay of Bengal." (See complete entry in Section VIII.)
- Najarian, T. O., Wang, D-P., and Huang, P-S. 1984. "Lagrangian Transport Model for Estuaries," <u>Journal, Waterway, Port,</u> <u>Coastal and Ocean Engineering</u>, ASCE, 110(3):321-333.

A two-dimensional (in a vertical plane), nonlinear model is used to analyze tideinduced mean currents in shallow estuaries forced with tides of significant amplitude. The model is first verified by comparing its results with known analytical solutions of Lagrangian currents in a uniform and homogeneous estuary. The Lagrangian velocity fields are derived from the computed mean Eulerian and Stokes velocities in the estuary. A set of model experiments is performed to investigate the influences of tidal forcing, density gradients, and topographic variations on the mean circulation in tidal channels. It is shown that the tide-induced transport opposes density-induced transport in tidal rivers. Model sensitivity analysis indicates that for mean estuarine circulation studies, it is essential to include the coupled effects of density and tides active in the domain of interest. References (15 items).

Najarian, T. O., et al. 1984. "Application of Nitrogen-Cycle Model to Manasquan Estuary," Journal, Environmental Engineering, ASCE, 110(1):190-207.

A refined version of an ecologic and water quality mathematical model is applied to a small Atlantic coast estuarine network. The temporal and spatial variations in the water quality of the system are examined through the analysis of the nitrogen cycle developed for estuarine environments. The model is based on the mass conservation of elemental nitrogen in its various biotic and abiotic states. The ecologic model structure contains two trophic levels: primary producers and herbivorous copepods. A concerted effort is made to derive realistic model-governing transformations and rate parameters. The hydrodynamic and water quality model simulations are calibrated and verified using shortterm transient data gathered in the Manasquan Estuary and Point Pleasant Canal. Model verification for abiotic constituents of the nitrogen cycle is achieved. with biotic constituent verification needing more detailed field data. Model results show the influence of transport processes on the temporal and spatial distribution of nitrogen-cycle constituents in the network examined. References (16 items).

- Nakagawa, H., Tsujimoto, T., and Nakano, S. "Characteristics of Sediment Motion for Respective Grain Sizes of Sand Mixtures." (See complete entry in Section II.)
- Nakagawa, T., and Hinwood, J. B. 1978. "A Proposed Model of Large Scale Cellular Motion in Strong Tidal Flows," <u>Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78 11:185-189.

Large-scale cell-like eddies have been observed in strong tidal currents. A possible mechanism for the formation of these cells is presented, and their relation to other turbulent flows is discussed. In Western Fort and Port Phillip, the cells have been observed either at or just downstream from an area in which the seaped is formed of sand dires. Downstream from the creat of each dure there will be a region. of separated flow. The proposed mechanism views the pressure differences and flow field in this zone of separation as the origin of the cells. The flow over the curved rear side of the dute gives rise to Görtler vortices. It is proposed that the interaction of these vortices with each other and with the fidel surrents gives. rise to the observed relive. References (14 items).

Nece, F. E. 1984. "Flation Effects on Tidal Flushing of Marinas." (<u>Gyrgal</u> <u>Waterway, Port, (Gastal at a char Pres</u> <u>perfirg</u>, ASCE, 110-201151-204.

Effects of various geometry parameters on tidal flushing and internal circulation in small-buat basing (maninas) of rectargular planform were determined in physical bydraulic models by means of a protostabulo technique incorporating the use of a photodensitometer. The schematic model marinas tested were scaled to have surface areas, water depths, and tide ranges comparable to "prototype" marinas in the Pacific Northwest. Results are presented in terms of spatial average tidal flushin. (exchange) coefficients for each configuration tested, and by contour drawings of equal local per-cycle exchange coefficients for a number of configurations, all at the same tide range. Emphasis is placed on planform geometry and aspect ratio, those variables over which designers may have most latitude in designing a marina for a specific site. Effects of basin length to width ratio are delineated for basins with typical single asymmetric entrances. References (15 items).

- Nece, R. E., and Forsyth, G. W. "Annotated Bibliography on Tidal Flushing and Circulation in Marinas." (See complete entry in Section I.)
- Nece, R. E., and Smith, H. N. 1981. "Tidal Exchange in Proposed Sitka, Japonski Lagoon, Small Boat Harbor," Technical Report No. 71, Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle.

The purpose of the study presented in this report was to analyze tidal circulation and flushing in the proposed Sitka, Japonski Lagoon, small-boat harbor. Three situations were investigated and d.scribed: (a) Existing condition. The existing shallow saltwater lagoon connects to ambient water via a natural opening between Alice Island and Harbor Island. (b) Constructed boat harbor. The 580-boat harbor, with a surface area of '2 acres at mean tide level, is to be constructed in the saltwater lagoon. The lagoon will be deepened by dredging, the water area will be decreased by dredged matricial service as landfill for service areas, and the entrance chargel is to be dredged. The basin is to be dredged to -10 feet (MLLW datum). (e) Incorporation of brackish lagoon. The constructed boat basin described in (b) is to be connected via a channel and ollverts to the trackish lagoon formed when the Sitka Alrient nurway was constructed. Theoryporation of the brackish lapoon into the near marcar eineulation system la considered as a miturative alternative replacing wetlaris lost · . .. in the dredging of the blat farter. specific objectives of the till were t determine, by physical hydraulic medel studies, the tidal flashing fates and aspopulated tudal openulation pattern of r each op the three spluation purchast lan, fer se it was bound to beremine guartic at 200 provide the statute structure the reat cashs and the bracks to act of 4 . * . * And the second second

Nece, R. E., et al. 1979. "Effects of Planform Geometry on Tidal Flushing and Mixing in Marinas," Technical Report No. 62, Charles W. Harris Hydraulics Laboratory, University of Washington, Seattle.

Physical hydraulic models of small-boat basins (marinas) possessing a rectangular planform were tested to determine the effects of various geometry parameters on tidal flushing and internal circulation in small harbors. The schematic model marinas were scaled to have surface areas, water depths, and tide ranges comparable to prototype marinas in the Pacific Northwest. The geometry parameters investigated, to varying degrees, were (a) planform geometry aspect ratio; (b) ratio of entrance cross-sectional area to basin planform area; (c) effect of rounding of corners in the basin interior; (d) orientation and location of single entrances; and, (e) effect of two entrances versus a single entrance. Results are presented in terms of average tidal flushing (exchange) coefficients for each configuration tested, and by contour drawings of equal local per-cycle exchange coefficients for a number of configurations, all at the same tide range, in order to compare the spatial variabilities in local exchange obtained for different planform geometries. Emphasis is placed on those variables--planform geometry and aspect ratio--over which designers may have most latitude in designing a marina for a specific site. It is concluded that for rectangular planform basins, optimum exchange, both overall and in terms of spatial uniformity, is achieved when the aspect ratio (basin length to width ratio) lies between 1/2 and 2.0, the interior corners are rounded, and the single entrance is centrally located in the breakwater, or enclosure, on the seaward side of the harbor. Rounding of interior corners has little effect on average flushing but does increase the uniformity of local exchange throughout the basin. Effects of basin length:width ratio are delineated for basins with typical single asymmetric entrances. References (22 items).

- Nelson, R. C., and Keats, A. J. "A Coastal Inlet with Fixed Bed and Mobile Sides." (See complete entry in Section I.)
- Nihoul, J. C. J., ed. <u>Marine Forecasting;</u> <u>Predictability and Modelling in Ocean</u> <u>Hydrodynamics; Proceedings, 10th International Liege Colloquium on Ocean Hydrodynamics. (See complete entry in Section 1.)</u>
- Nishimura, J. K., and Lau, L. S. "Structure for Automatic Opening of Closed Stream Mouths." (See complete entry in Section V.)

Nof, D. 1978. "On Geostrophic Adjustment in Sea Straits and Wide Estuaries; Theory and Laboratory Experiments, Part I: One-Layer System," Journal of Physical Oceanography, 8(4):690-702. SURVEY. EUNING DEERCE FEEDERE

The dynamics of outflows from sea straits and wide estuaries are examined through a simplified frictionless model whose primary motions are not constrained to be quasi-geostrophic. The potential vorticity equation is solved by means of approximate analytical methods. Some of the model predictions are tested in the laboratory. The mathematical model predicts that an outflow from a channel with uniform velocity distribution deflects to the right or left depending on the depth of the basin into which it debouches. There is a "critical" Rossby number below which the flow separates from one of the basin banks. When a nonuniform velocity is introduced upstream, the direction of deflection may differ substantially from the upstream uniform flow case. The model shows that rotation is important whenever the ratio between the relative depth variation to the Rossby number is not negligible; rotational effects can be important even if the ratio between the channel width and the Rossby deformation radius is entirely negligible. An experimental system consisting of a rotating channel with an abrupt cross-sectional variation was used in the laboratory to test the theory described above. Deflections resulting from "supercritical" conditions were tested qualitatively with favorable results. References (17 items).

Novak, P., and Čábelka, J. 1981. <u>Models in</u> <u>Hydraulic Engineering; Physical Principles</u> <u>and Design Applications</u>, Pitman Publishing Inc., Boston.

Contents: 1. "Introduction," References (2 items). 2. "Theory of Similarity," References (26 items). 3. "Procedure of Investigation," References (4 items). 4. "Laboratory Installations and Instrumentation," References (17 items). 5. "Models of Pressure Systems," References (50 items). 6. "Models of Rivers and Open Channels," References (109 items). 7. "Models of Weirs, Dams and Hydroelectric Power Stations," References (115 items). 8. "Models of Navigation Structures and Inland Waterways," References (28 items). 9. "Models of Outfalls and Public Health Engineering Plants," References (5' items). 10. "Models of Estuaries, Coastal and Maritime Engineering Works," References (62 items). 11. "Aerodynamic and Analogue Models and Models of Groundwater Flow," References (34 items). 12. "Field Investigations of Hydraulic Parameters," heferences (27 items).

- Nummedal, D., and Fischer, I. A. "Process-Response Models for Depositional Shorelines: The German and the Georgia Bights." (See complete entry in Section II.)
- O'Connor, D. J., and Lung, W. 1981. "Suspended Solids Analysis of Estuarine Systems," Journal, Environmental Engineering Division, ASCE, 107(EE1):101-120.

A steady-state analysis of the distribution of suspended solids in estuaries has been developed and applied to the Sacramento-San Joaquin Delta and the James and the Rappahannock rivers. The method is based on a simplified analysis of the density-driven circulation in estuaries, resulting in a two-layered flow pattern, with the surface layer flowing seaward, the bottom layer landward, and a vertical flow between the layers for continuity. These transport coefficients, with the vertical dispersion coefficient, permit calculation of the longitudinal distribution of salinity in the two layers. The settling velocity, assigned on the basis of size and density measurements of the particles, is included in the transport equation to determine the distribution of suspended solids. Comparisons of the calculated profiles with the observed values of solids concentrations indicate good agreement and demonstrate the general validity of the approach as a practical engineering analysis. References (32 items).

- O'Connor, D. J., Mueller, J. A., and Farley, K. J. "Distribution of Kepone in the James River Estuary." (See complete entry in Section IV.)
- Odd, N. V. M. "Vertical Mixing in Stratified Tidal Flows." (See complete entry in Section I.)
- Odd, N. V. M., and Baxter, T. 1980. "Port of Brisbane Siltation Study," <u>Proceedings</u>, <u>Seventeenth Coastal Engineering Confer-</u> <u>ence, March 23-28, 1980, Sydney, Aus-</u> <u>tralia</u>, ASCE, III:2377-2396.

The paper describes the constituent parts of a combined field and mathematical model investigation into the processes causing siltation in the Port of Brisbane. It describes the methods of collecting and using field data and laboratory results in conjunction with a variety of mathematical models which were employed to simulate and predict the interaction of tidal and fluvial flows, saline intrusion, and sediment transport in the Brisbane tidal river. A newly developed X-Z-T model was used to simulate the unsteady patterns of mud transport and siltation resulting from the interaction of tidal flows with short flashy fluvial floods, which are the main cause of shoaling in the port. The paper

discusses the structuring of the investigation which involved a carefully phased schedule of desk, field, laboratory, and mathematical model investigations with the aim of solving the problem with minimum effort and cost. The paper does not discuss predictions. References (2 items).

Odgaard, J. 1979. "Salt Exchange by Salt Fingers," <u>Hydraulic Engineering in Water</u> <u>Resources Development and Management, Proceedings, Eighteenth Congress, International Association for Hydraulic Research, Cagliari, Italia, 10-14 September 1979, 3:319-324.</u>

Laboratory experiments are described showing that salt fingers will form in a twolayer stratified flow under temperature and salinity conditions similar to those existing at heated discharge from power and desalination plants. The fluxes of heat and salt across the interface are measured. Some tentative calculations show that salt fingers may give rise to a significant dilution of the heated discharge. References (5 items).

O'Kane, J. P. 1978. "On the Choice of Boundary Conditions for One-Dimensional Models of Estuarine Water Quality," <u>Modelling the Water Quality of the Hydro-</u> logical Cycle Symposium, Proceedings of the Baden Symposium, September 1978, IAHS-AISH Publication No. 125:77-85.

The one-dimensional convective-diffusion equation is assumed to describe the dispersion of a contaminant in an estuary. Very general solutions are presented for Dirichlet (prescribed concentration) and zero Neumann (specified concentration gradient) boundary conditions. These correspond respectively to infinite and zero values of dispersion in the adjoining sea. The intermediate conditions are studied by matching at the mouth, realistic dispersion models for both the sea and the estuary. This provides a basis for judging the validity of the Dirichlet condition which is almost always used. References (12 items).

"Old Laboratory Tests Large Coastal Models," 1982. <u>Engineers Australia</u>, 54(24):16.

A model of Gladstone harbor covering 1,000 m² almost fills the testing hall at the recently opened Queensland Government Hydraulics Laboratory. The laboratory, on 8 ha in the Brisbane suburb of Deagon, is equipped to carry out studies of a range of coastal and estuary models. Wave basins in the testing hall have water sumps, constant head tanks, and wave and tide generators. The river model area has its own water supply and pumping facilities. The laboratory is set up specifically to prepare large-area hydraulic models of rivers and floodplains,

harbor models to study wave penetration and siltation, coastal and estuary morphology modelling, and coastal protection models.

- Onishi, S., and Nishimura, T. "Study on Vortex Current in Strait with Remote-Sensing." (See complete entry in Section VIII.)
- Onishi, Y. 1981. "Sediment-Contaminant Transport Model," <u>Journal, Hydraulics</u> <u>Division</u>, ASCE, 107(HY9):1089-1107.

The unsteady, two-dimensional model. FETRA, was developed to simulate both sediment and contaminant transport in rivers and estuaries. The model consists of three submodels which, when used jointly, accurately depict the interaction and migration of sediment, dissolved contaminants, and particulate contaminants. FETRA solves the migration (transport, deposition, and resuspension) of cohesive and noncohesive sediments and particulate contaminants of three sediment-size fractions. FETRA was applied to the James River estuary to simulate the migration of river sediments and the pesticide Kepone. Computed results produced by the model are very similar to field-measured data, meaning that FETRA is reasonably accurate. References (20 items).

- Onishi, Y., et al. "Critical Review: Radionuclide Transport, Sediment Transport, and Water Quality Mathematical Modeling; and Radionuclide Adsorption/ Desorption Mechanisms." (See complete entry in Section II.)
- †Oonisni, Y. 1977. "A Numerical Study on the Tidal Residual Flow," Journal of the Oceanographical Society of Japan, 33:207-218.

A fundamental mechanism of generation of the tidal residual flow, the steady or quasi-steady flow induced in the tidal current system, is studied by numerical methods. The model basin has the same topography as that studied by Yanagi by means of the hydraulic model experiments. The steady circular, horizontal current is found to be induced through the following processes. Horizontal friction at the coast makes the vorticity of vertical component in the oscillating flow. Selfinteraction of this flow causes the vorticity transfer to the steady flow in frequency domain. This vorticity transfer is confined in the narrow coastal boundary layer. References (5 items).

Orlob, G. T. 1973. "Simulation of Estuarial Ecosystems," <u>NATO Advanced Study In-</u> <u>stitute on Estuary Dynamics</u>, Lecture No. 12, Laboratorio Nacional de Engenharia Civil, Lisbon, Portugal. Simulation of estuarial ecosystems is discussed. Basic ecologic concepts such as the estuary as an ecosystem, primary production of the ecosystem, algae-bacteria symbiosis, factors limiting growth rates, growth rates at higher tropic levels, and other environmental factors are presented as a background. Constituents affecting the formulation of the model are then given. The concepts given in Lecture 11 are applied to a practical working model. References (4 items). 122222221 122222222

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Orlob, G. T. 1973. "Water Quality Modeling of Estuaries," <u>NATO Advanced Study Insti-</u> <u>tute on Estuary Dynamics</u>, Lecture No. 11, Laboratório Nacional de Engenharia Civil, Lisbon, Portugal.

Basic theoretical conditions upon which most of the current estuarial quality models are founded are reviewed. A brief history of estuarial model development in the United States from 1963 to 1973 is included. The close relationship between quantity and quality is considered in demonstrating the need for a good hydrodynamical model for quality control modeling. References (15 items).

- Outlaw, D. G. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 1, Prototype Data Acquisition and Analysis." (See complete entry in Section I.)
- Owen, A. 1979. "Effect on the M_2 Tide of Permeable Tidal Barrages in the Bristol Channel," <u>The Institute of Civil Engineers</u> <u>Proceedings, Part 2</u>, 67:907-928.

Using two-dimensional numerical models, Owen and Heaps investigated the effects on the tides of impermeable barrages across the Bristol Channel at three locations in the upper part of the estuary. It was shown that the introduction of an impermeable barrage at any of the sites considered would cause a decrease in the amplitude of the ${\rm M_2}$ tidal constituent immediately seaward of the barrage. However, for each barrage this decrease was found to diminish on going further downstream. The changes were greatest for barrages located furthest seaward. In this paper permeable barrages, each simulating a tidal power station, are considered. Thus, water is allowed to pass through a barrage by means of turbines and sluices. The flow of water and the power thereby generated are related empirically to the head of water across the barrage. Twodimensional models are used to estimate barrage effects on the existing tides. All the results presented concern the M. tide only (i.e., the principal semidiurnal lunar tide which is responsible for the observed '2.4-hr variation in sea level); consequently, the spring-neap cycle is not represented. Two possible locations are

considered for the construction of tidal power barrages. At each, the operation of a barrage with different combinations of turbines and sluices is examined. References (7 items).

Ozturk, Y. F. 1981. "Mathematical Modeling of Dispersion in Mixed Estuaries," <u>Jour-</u> <u>nal, Environmental Engineering Division</u>, ASCE, 107(EE1):211-228.

The use of the conventional dispersion coefficient equations has met with a limited success, and they do not seem to be appropriate in tidal estuaries. An original dispersion coefficient equation has been developed for mixed estuaries. The developed equation, as a function of real-time flow depth and four-thirds power of real-time tidal velocity, represents isotropic flow conditions. In mixed estuaries the concept of isotropic dispersion may be acceptable. The dispersion model established by this equation represents adequately the rates of dispersion in the Brisbane River estuary in Australia. References (28 items).

Pape, E. H., III, and Garvine, R. W. 1982. "The Subtidal Circulation in Delaware Bay and Adjacent Shelf Waters," <u>Journal of</u> <u>Geophysical Research</u>, 87(C10):7955-7970.

Surface and seabed drifters were used to study the subtidal circulation in Delaware Bay and over the adjacent continental shelf of the Middle Atlantic Bight. Over 7,000 drifters were released in eight experiments during the yearlong study period. Velocity vector maps representing the study period mean fields for the surface and bottom confirmed the pattern of classical, two-layer, estuarine flow, with surface water moving seaward from the bay onto the shelf and bottom water landward over the shelf from at least as far as 40 km seaward of the bay mouth. Within the bay, bottom water moved laterally toward the nearest shore, diverging horizontally along a line roughly marking the deep channels. The surface speeds were about an order of magnitude larger than the bottom. Significant variations from this mean pattern were seen between the eight experiments. Return percentages for surface and bottom drifters correlated inversely over the eight experiments. Correlations with wind stress were above the level of significance, and winds explained about two-thirds of the total variance. The strong coupling found between the subtidal circulation in the estuary and over the shelf is consistent with recent observational and modelling studies. References (23 items).

Pearce, B. R., Fidler, B. R., and Humphreys, A. C. 1980. "A 3-D Model for Penobscot Bay, Maine," <u>Proceedings, Seventeenth</u> <u>Coastal Engineering Conference</u>,

March 23-28, 1980, Sydney, Australia, ASCE, III:2397-2412.

Penobscot Bay is a deep, geometrically complex, partially stratified estuarv lying on Maine's Atlantic Coast. Like other Maine estuaries, the Penobscot supports economically important fisheries and tourist industries, and is a significant transportation artery. It is frequently proposed as a region suitable for new industrial and port development. Once heavily polluted by upstream paper mills, the estuary has today been substantially restored by enforcement of discharge regulations under the National Pollution Discharge Elimination System. The goal of this study was to improve knowledge of the Penobscot estuary's circulation patterns, as an important factor in maintaining the estuary's water quality and economic resource capacity. A previous effort to model Penobscot Bay (Fidler, 1978) laid the foundation for this study, but concentrated on instantaneous tidal velocities, and was hampered by a shortage of data suitable for model tuning and for comparison of modeled output. The present study concentrated on modeling residual currents, which are somewhat more interesting than instantaneous currents from the point of view of pollution control. In addition, an extensive data set, hitherto largely unanalyzed, became available for tuning and comparison. The numerical model GAL was applied to a 36by 51-km rectangular grid covering the entire lower estuary from Fort Point to the southern end of Vinalhaven Island. Developed by Pearce, et al. (1978), it is a three-dimensional model which has a finite difference formulation in the horizontal but is continuous in the vertical. Model inputs are bathymetry. vertical eddy viscosity, wind velocity, tidal excitation at the seaward boundary, and a river inflow. Model outputs are current velocities at each grid element for specified depths, velocity profiles, and net drift information. References (5 items).

Pethick, J. S. 1980. "Velocity Surges and Asymmetry in Tidal Channels," <u>Estuarine</u> and Coastal Marine Science, 11(3):331-345.

Previous work on tidal dynamics in salt marsh creeks has shown that velocity and discharge exhibit well-marked surges throughout the cycle as well as a floodebb asymmetry. Two general models of tidal dynamics are discussed: one assuming modification of tidal stage by the marsh channel, the second assuming that channels have a purely passive role. Using the second model, a series of theoretical velocity curves are calculated using progressively more complex tidal approximations. The theory is tested using velocity data obtained from the Stiffkey marsh, North Norfolk, England, by Bayliss-Smith et al. The velocity curve can be predicted using channel morphometric and tidal stage data. The interaction between channel morphology and the velocity curve is considered: it is suggested that channel velocity curves may provide an indication of marsh morphological development. References (11 items).

- Pickett, E. B., and Greer, H. C. "Los Angeles Harbor and Long Beach Harbor: Prototype Data Acquisition and Observations." (See complete entry in Section VIII.)
- Pingree, R. D., and Griffith, D. K. 1980. "A Numerical Model of the M₂ Tide in the Gulf of St. Lawrence," <u>Oceanologica Acta</u>, 3(2):221-225.

A two-dimensional numerical model of the M_2 tide in the Gulf of St. Lawrence and the St. Lawrence Estuary is developed in spherical polar coordinates. The model is used to predict frontal regions separating areas of tidally mixed waters from areas showing pronounced summer stratification. Marked increases in biological productivity may be associated with upwelling and mixing in these regions. References (13 items).

- Pitblado, R. M., and Prince, R. G. H. "The Application of a Two-Layer Time-Dependent Model to Pollution Assessment and Control in a Short Stratified Estuary." (See complete entry in Section III.)
- Praagman, N. 1982. "Comparison of Numerical Models for the Computation of Residual Currents in Coastal Seas," <u>Deutsche Hydrographische Zeitschrift</u>, 35(3):93-113.

In their article "The Influence of Tidal Stress," Nihoul and Ronday demonstrated the importance of tidal effects on the residual currents. Since then the method has also been recommended as an alternative to compute residual currents and has been used for practical purposes. The present study shows results which make clear that the method is less accurate than the "classical method" to obtain residual currents and also gives an explanation of these results. Moreover, the influence of the wind on the residual terms is shown to be quite large. Hence these results show that a simple superposition of residual currents as proposed by Alfrink and Vreugdenhil and van de Kreeke and Chiu is not recommendable for the model used. References (22 items).

Prandle, D. 1978. "Hydrodynamic Modelling of the Southern North Sea," <u>Proceedings,</u> <u>Sixteenth Coastal Engineering Conference,</u> <u>August 27-September 3, 1978, Hamburg, Germany</u>, ASCE, I:1122-1141. Numerical modelling of rivers, estuaries, and shallow seas has attracted increasing interest over the last two decades. The models have developed from one-dimensional (1D) applications to tidal propagation and flood routing through two- and, finally, three-dimensional applications to motions ranging from "pseudo-turbulence" to annual-mean residual flows. The present account describes the development, over the last 5 years, of the modelling studies carried out by the author concerning the hydrodynamics of the southern North Sea and River Thames. The objective is to identify those major points which have emerged that may have a wider significance. References (12 items).

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Prandle, D. 1980. "Modelling of Tidal Barrier Schemes; An Analysis of the Open-Boundary Problem by Reference to AC Circuit Theory," <u>Estuarine and Coastal Marine</u> <u>Science</u>, 11(1):53-71.

In modelling a tidal barrier scheme, it is generally difficult to determine whether the downstream boundary is sufficiently seaward to ensure that the prescribed boundary conditions, pertaining to the existing system, remain valid after the barrier has been installed. This problem is examined using the hydrodynamic analogy with AC circuit theory; the essential elements of this theory are summarized. The first application of this theory concerns the effect of tidal barriers in the River Thames; it is shown that barriers in the region between North Woolwich and Chelsea Bridge will lead to a small increase in the M_2 tidal range. Using a number of models with the downstream boundary successively further downstream, the different results are analyzed in a manner which provides an indication of the validity of the tidal prognostication for any particular boundary location. The second application concerns the Bristol Channel where it is shown that barriers downstream of Newport will produce a small reduction in the M_2 tidal range. In view of the present interest in this region this is an important result confirming the earlier findings of Heaps. References (15 items).

Prandle, D., and Wolf, J. 1978. "The Interaction of Surge and Tide in the North Sea and River Thames," Report No. 64, Bidston Observatory, Institute of Oceanographic Sciences, Birkenhead, Merseyside, England.

An examination of surges recorded by any of the tide gages in the River Thames shows that surge peaks tend to occur 3 to 4 hr before high tide and that large peaks seldom, if ever, occur actually on high tide. These characteristics have been repeatedly confirmed by statistical analyses and are of direct relevance to such problems as flood prediction and the

determination of the probability of maximum flood levels. The effects may be attributed to the interaction between tidal propagation and surge propagation in the area, accountable in terms of the presence of nonlinear terms in the relevant hydrodynamic equations. The phenomenon of surge-tide interaction in this context has attracted the attention of a number of researchers, but their work has not yielded a coherent and satisfying explanation of the mechanisms involved. The present study seeks to clarify some of the processes at work and includes both a statistical analysis of recorded surge data and an examination of surge-tide propagation with the aid of numerical models. An analysis is given of surges recorded at various British east coast ports from Lerwick in the northern North Sea southwards to Tower Pier near the head of the Thames. Results show that surge levels are amplified progressively as the surges propagate southwards and that the magnitude of this amplification is sensibly independent of the height of the initial disturbance. Similarly the level of interaction increases progressively from an almost insignificant level at Wick to a maximum at Tower Pier; an interruption in the progression is, however, seen at Lowestoft and reasons for this are suggested. A study of discrete surge events shows that the generation of a surge peak on the rising tide in the Thames can occur irrespective of the phase relationship between tide and surge in the northern North Sea. The present work employs a one-dimensional numerical model of the Thames with a seaward boundary running approximately from Walton to Margate. This model was used to determine the response and sensitivity of the river to surges of different types. The results show that the amplification of surge levels along the river is sensibly independent of the surge level at the mouth whereas the amplification is strongly dependent on the shape (i.e. the time profile) of the surge. A method of identifying the mechanics of interaction in the Thames has been developed here involving two versions of the numerical model mentioned above: one of tidal propagation and the other of surge propagation. These two models were operated concurrently with a cross linkage, in the form of perturbation terms, by which the tide model was influenced by the surge and the surge model by the tide. An examination of these perturbation terms shows the interaction to be proportional to a product of surge amplitude and tidal amplitude. The results from the models demonstrate the relative significance of the interaction effect of surge on tide and tide on surge, and enable an assessment to be made of the importance of the principal nonlinear

terms, namely quadratic friction and (representing shallow-water influence) products of the motion involving surface elevation. It is shown that, in the Thames, quadratic friction plays the dominant role by severely damping surge peaks. Also, it is concluded, both from the model studies and from the statistical analysis of recorded surges, that an important component in the observed interaction in the Thames originates outside the river. Finally, some deductions are made concerning the necessary meteorological conditions under which a large surge could be generated with a peak at, or very near, high tide in the Thames. References (19 items).

Prandle, D., et al. 1980. "The Use of Array Processors for Numerical Modelling of Tidal Estuary Dynamics," <u>Proceedings,</u> <u>Seventeenth Coastal Engineering Confer-</u> <u>ence, March 23-28, 1980, Sydney, Aus-</u> <u>tralia</u>, ASCE, III:2413-2432.

The use of array processors for the numerical modelling of estuarine systems is discussed in the context of "hybrid modelling"; however, it is shown that array processors may be used to advantage in independent numerical simulations. A hybrid model of the Bay of Fundy is described with details of the numerical scheme given along with various aspects relating to the usage of the array processor. A comparison is provided of the performance of the array processor against that of both a minicomputer and two mainframe machines. References (10 items).

- Price, W. A., Motyka, J. M., and Jaffrey, L. J. "The Effect of Offshore Dredging on Coastlines." (See complete entry in Section V.)
- Pritchard, D. W. 1973. "Hydrodynamics Models; Section 1: Three-Dimensional Models," <u>NATO Advanced Study Institute on</u> <u>Estuary Dynamics</u>, Lecture No. 4, Laboratório Nacional de Engenharia Civil, Lisbon, Portugal.

Basic time-dependent equations in three spacial dimensions, expressing the conservation of <u>mass</u>, <u>momentum</u>, and of a <u>dis-</u> <u>solved</u> or finely divided <u>suspended</u> <u>constituent</u> of the waters in an estuary are developed. References (9 items).

Pritchard, D. W. 1973. "Hydrodynamics Models; Section 2: Two-Dimensional Models," <u>NATO Advanced Study Institute on</u> <u>Estuary Dynamics</u>, Lecture No. 5, Laboratório Nacional de Engenharia Civil, Lisbon, Portugal.

The basic time-dependent equations expressing the conservation of <u>mass</u>, <u>momentum</u>, and of a <u>dissolved constituent</u> of the waters of an estuary in three spacial dimensions developed in Lecture 4, "Three-Dimensional Models," serve as the starting point for the treatment of twodimensional models of an estuary. Significance of terms which are neglected and simplifying assumptions which are made in order to develop a model composed of a tractable set of equations are discussed.

Proehl, J. A., and Rattray, M., Jr. 1984. "Low-Frequency Response of Wide Deep Estuaries to Non-Local Atmospheric Forcing," <u>Journal of Physical Oceanography</u>, 14(5):904-921.

An analytic linearized continuously stratified model which explains low-frequency response of wide deep estuaries to nonlocal forcing is developed. The dynamic model used for the coastal ocean is similar to that of McCreary with the effects of vertical friction and vertical and horizontal diffusion included. The response in the estuary, to lowest order, is governed by the free-wave equations. In the present study, the channel is not assumed to be narrow when compared to the local internal Rossby deformation radii. Therefore, rotation is included in the dynamics in the estuary which allows the propagation of energy upchannel as a Kelvin wave. Once obtained, the oceanic solution is matched to that in the estuary using the Green's-function matching technique of Buchwald. The results show that the response in the estuary is geostrophically controlled by the flow on the continental shelf. Additionally, the adjustment is strongest in the entrance and consists primarily of the first baroclinic mode. A simulation for real winds is run and results compared to current meter data collected in the Strait of Juan de Fuca. Washington. The comparisons show good agreement between observed and simulated response in the fjord. References (25 items).

Provis, D. G., and Lennon, G. W. 1983. "Eddy Viscosity and Tidal Cycles in a Shallow Sea," <u>Estuarine, Coastal and Shelf</u> <u>Science</u>, 16(4):351-361.

The very pronounced spring-neap tidal cycle in the South Australian gulfs leads to an unusually large variation in the magnitude of the tidal currents. Measurements of the currents in these gulfs show that the nontidal circulation depends on the strength of the tidal currents and hence on the spring-neap cycle. A simple model is produced in which the vertical eddy viscosity is a function of both wind strength and tidal currents. Results from the model agree with the observations and suggest a means whereby variations in tidal mixing may be accounted for in hydrodynamic modelling of the circulation in shallow seas. References (11 items).

- Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)
- Ramming, H.-G. "The Influence of River Normalization on the Distribution of Tidal Currents in the River Elbe." (See complete entry in Section I.)

Raney, D. C. 1977. "Los Angeles Harbor and Long Beach Harbor: A Numerical Model for Tidal Circulation," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Long Beach, Calif., March 9-11, 1977, I:85-100.

Los Angeles Harbor and Long Beach Harbor have expansion plans under study involving extensive modifications of port facilities to accommodate increased tanker and general cargo traffic. The proposed modifications involve dredging of deeper channels and the creation of additional berthing facilities adjacent to new fill areas. To assist in determining the environmental impact of proposed harbor modifications, physical and numerical modeling programs are being conducted at the US Army Corps of Engineers Waterways Experiment Station (WES). A large physical model of San Pedro Bay exists at WES. supplement and complement the physical modeling effort, a numerical model was developed to investigate tidal circulation. This paper deals with the numerical modeling of tidal circulation patterns in Los Angeles Harbor and Long Beach Harbor; its calibration for existing conditions; and its use as a predictive tool for potential modification to the existing harbor complex. References (7 items).

Richards, D. R., and Gulbrandsen, L. F. 1982. "Low Freshwater Inflow Study; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-82-3, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Future population increases in the Chesapeake Bay area will increase the demand for fresh water from its tributaries. A portion of this demand will be in the form of consumptive losses. In order to predict the impact of these consumptive losses on the Chesapeake Bay and future water resource programs, a study was initiated in a physical model of Chesapeake Bay to compare tide, velocity, and salinity data for a historical period of low flow with data resulting from freshwater inflow suppressed by the consumptive losses that may be expected some 50-60 years in the future. A base test simulating drought water years 1963-1966 was designed to reproduce known low-flow conditions, and a future test was designed to portray water years 1903-1466 combined with anticipated consumptive loades and diversions for 50.

to 60 years in the future. Both tests contained a number of consecutively run, average year hydrographs to assess the bay's rebound potential following a drought period. Sampling for each test resulted in a data set that includes 7 years of continuous hourly tide records at 22 stations distributed throughout the bay, hourly current velocities over complete (13 hr) tidal cycles taken at 16 stations 8 times, and approximately 250,000 salinity values during each test. There were 206 salinity sampling stations each having from 1 to 5 sampling depths. Analysis of the data could not address the entire data set; therefore, 32 stations were selected as being representative of the bay and generalizations were made on these stations to assess the effectiveness of the study. Results of the analysis show a general increase in salinity values in the future condition throughout the bay on the order of 1 to 3 ppt. The differences were greater or less locally depending on the station location. Little differences in tides and current velocities were noticed between tests. Variations in vertical salinity structures between spring and neap tide were seen at some stations in the bay, although there was generally little change resulting from the consumptive losses. The bay's rebound after drought conditions was assessed at several stations and the data indicated a return to a state of dynamic normalcy within 3 to 6 months at all stations analyzed for both tests.

Richards, D. R., and Morton, M. R. 1983. "Norfolk Harbor and Channels Deepening Study; Report 1, Physical Model Results; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-83-13, Report 1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

This report presents the findings of physical model tests of deepening the approach channels to Norfolk and Newport News, Virginia. The tests included a steady-state portion for the determination of the tide and current velocity effects of channel deepening as well as a dynamic portion where variable tide and freshwater inputs were used to study salinity redistributions. Results of the tests indicate salinity changes to the estuary which can be attributed to channel deepening. On the average, the changes are small, normaily less than 2 ppt, in an extremely dynamic portion of the estuary where natural salinity fluctuations due to variations in tides and freshwater input can cause weekly variations an order of magnitude greater. E ferences (9 items).

Rives, S. R., and Pritchard, D. W. (1978) "Adaptation of J. R. Hunter's Dis-Dimensional Model to the Presspears and Delaware Canal System," Special Report 66, Reference 78-6, Chesapeake Bay Institute, Johns Hopkins University, Baltimore, Md.

A one-dimensional mathematical model has been adapted to the Chesapeake and Delaware Canal. This study extends the modeling work of Gardner and Pritchard by including the portion of the canal system between Town Point Neck and Chesapeake City and the portion between St. Georges and Reedy Point. The model is driven by time series of observed water surface elevations at Town Point and Reedy Point. Model calibration was accomplished using current velocity measurements, and tracer dye data taken at interior points. Current meter measurements were made in April/May 1975 at two locations in the dredged section of the canal. Mean flows over single tidal cycles are plotted and listed for comparison with the results from 1973 data. The tidally averaged transport values computed from the current meter records for the two sections are in agreement within the accuracy of the observations. References (7 items).

Robinson, I. S. 1983. "A Tidal Flushing Model of the Fleet--An English Tidal Lagoon," <u>Estuarine, Coastal and Shelf Sci-</u> <u>ence</u>, 16(6):669-688.

Observations of the spatial distribution of salinity and tidal salinity fluctuations along the length of the Fleet are presented, and different structures are identified with different freshwater runoff conditions. The salinity distribution appears to be the result of a balance between weak tidal flushing and a small freshwater input. A tidal exchange box model is developed to represent this weak balance and is able to reproduce the semidiurnal, fortnightly, and seasonal fluctuations of salinity. By use of the tuned model, estimates are made of the flushing times of different segments of the lagoon, the distribution of water from particular stream inputs, and hence their polluting potential, and the likely effect on the salinity structure of changes in the tidal regime which could result from sediment deposition. References (5 items).

Hobinson, I. S., Warren, L., and Longbottom, J. F. 1983. "Sea-Level Fluctuation in the Fleet, an English Tidal Lagoon," <u>Estuarine, Coastal and Shelf Science</u>. 16(6):651-658.

Tidal elevation data are presented for places along the length of the Fleet, which is a tidal lagoon behind Chesil Beach on the south coast of England. Harmonic analysis of the data is not able to represent the observations adequately, particularly at the inner end of the 14zoor. However, careful inspection of the 136

data shows that the tidal regime is capable of being understood in terms of the nonlinear propagation of long waves in very shallow water. Distortion of the tidal wave by unequal progression speeds of high and low water and the setup of mean level by frictional effects are shown to be the important physical mechanisms controlling the observed water level fluctuations. A one-dimensional numerical model which incorporates these processes is able to reproduce the observations satisfactorily. While the model predicts strong effects of wind stress, the meteorological influences in the observed data appear to be largely due to external surges in the English Channel which propagate into the lagoon through its entrance. References (8 items).

Rodenhuis, G. S., Kjaer, O. B., and Bertelsen, J. A. 1977. "A North Sea Model That Can Provide Detailed Hydrographic Information," <u>Proceedings, Ninth Annual Offshore</u> <u>Technology Conference</u>, May 2-5, 1977, Houston, Tex., 2:325-330.

Severe storm conditions and normal tidal conditions in the North Sea have been used to verify a fast-running computer model based on the complete nonlinear equations for nearly horizontal flow, including wind stresses, barometric pressure gradients, Coriolis forces, and bottom shear stresses. The model can focus on freely selected areas where the mesh size is reduced to one-ninth of that of the coarsest grid. The detail of the local area is computed simultaneously in the fine grid from the general conditions in the coarse grid. When complemented with a short, intensive program of local measurements, the model can provide detailed information on currents and surface elevations. This allows forecasts of extreme conditions and statistics of occurrences and magnitudes on the basis of meteorological information. References (4 items).

- Rodger, J. G. "Simulation of Stratified Flows in Estuaries." (See complete entry in Section II.)
- Scheffner, N. W., et al. 1981. "Verification of the Chesapeake Bay Model; Chesapeake Bay Hydraulic Model Investigation," Technical Report HL-81-14, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The Chesapeake Bay model, a fixed-bed model constructed to a horizontal scale ratio of 1:1,000 and a vertical scale ratio of 1:100, reproduced the Chesapeake Bay from the ocean to the head of tides for each tributary. Reproduction extended to the +20 ft contour. The model was equipped with the necessary appurtenances to accurately reproduce and measure tidal heights, tidal currents, salinity distributions, and freshwater inflows. Due to the immense size of the model (8.6-acre model housed in a 14-acre building), complete computer control and data acquisition capabilities were provided. Severe limitations in prototype data in addition to substantial wind contamination of those data necessitated a detailed data analysis program which resulted in a modified ap- . proach to physical model verification. This was accomplished in the following two separate modes of operation: (a) verification for tidal heights and tidal velocities using an M₂ constituent tide and a constant long-term freshwater inflow and (b) verification for salinities using a typical 28-day tidal cycle (with longperiod wind energy filtered out) and inflow hydrographs reproduced in 2-week time-steps. A bubbler system was incorporated in the model to statistically reproduce the vertical mixing caused by wind fields acting on the prototype. Excellent verification of the model was achieved. References (8 items).

Schwarze, H., and Falldorf, W. 1978. "Influence on Temperature Increases in Tidal Rivers Caused by Waste Heat Injections with Respect to Tidal Cycles and Storm Surges," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-September 3, 1978, Hamburg, Germany</u>, ASCE, 111:2915-2924.

The influence of tidal cycles with neap and spring tides or of storm surge events on the distribution of temperature increases caused by heat injection in an estuary was investigated in a thermalhydraulic model. The results of the model tests have shown that under natural tidal conditions as of the Elbe River during tidal cycles as well as storm surge events in the far field region, no higher temperature increases occurred than under mean tidal conditions.

Seabergh, W. C. 1979. "Model Testing of Structures at a Tidal Inlet," <u>Coastal</u> <u>Structures 79, A Specialty Conference on</u> <u>the Design Construction, Maintenance and</u> <u>Performance of Port and Coastal Struc-</u> <u>tures</u>, March 14-16, 1979, Alexandria, Virginia, ASCE, II:690-709.

During the course of a model study of Masonboro Inlet which was part of the Corps of Engineers General Investigation of Tidal Inlets research program, a variety of structural changes to the inlet region were examined. One series of tests concerned the closure of bay channels. The bay system of Masonboro Inlet is composed of three distinct channels which diverge from the inlet's gorge. The tests were designed to investigate the effect of closing one of the three channels or the tidal hydraulics for each of the three possible cases. Possible effects on the inlet's morphology were then extrapolated from the model results and for one case were compared to an actual closure condition in the prototype. References (12 items).

Seabergh, W. C., and Lane, E. F. 1977. "Improvements for Little River Inlet, South Carolina; Hydraulic Model Investigation," Technical Report H-77-21, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The Little River Inlet fixed-bed model, constructed of concrete to scales of 1:300 horizontally and 1:60 vertically, reproduced an area extending to the -40 ft contour in the Atlantic Ocean and to the extent of the influence of the tidal prism on the AIWW. Areas throughout the lagoon were accurately reproduced, and model verification tests of tidal elevations, velocities, and salinities assured that the model hydraulic regimes were in satisfactory agreement with the prototype. Model testing concluded that Plan 2D-1 which included weir sections backed by deposition basins for both jetties would be the most feasible plan. The mean tide level weirs would permit sand transport to the basins on flood tide but would prevent ebb flows from existing over them due to the tidal elevation-velocity relations characteristic of Little River Inlet where maximum ebb velocities occur after the tide elevation has fallen below midtide. Also, flow in the entrance channel was ebb-dominant which would aid in flushing sediment out of the channel. The sand-trapping abilities of the deposition basins permitted shortening of the jetties since a large amount of sand fillet storage would not be needed and sand movement around the jetty tips would be minimized. Testing also indicated there would be no significant change to the bay tidal prism or salinities. References (12 items).

Seabergh, W. C., and Outlaw, D. G. 1984. "Los Angeles and Long Beach Harbors Model Study; Numerical Analysis of Tidal Circulation for the 2020 Master Plan," Miscellaneous Paper CERC-84-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A study to determine the effect of the proposed 2020 Master Plan on tidal circulation in Los Angeles and Long Beach Harbors was conducted using a numerical model with a two-dimensional depth-averaged formulation of the hydrodynamic equations. The model, which had been verified in a previous study, used an implicit finitedifference scheme to numerically solve the equations. To observe the dispersion of conservative substances, the model also incorporated the two-dimensional

conservative constituent transport equations. The 2020 Master Plan consists of placing 2,600 acres of landfill at various locations throughout the harbors. Tidal circulation was studied for 70-hr sequences of spring, mean, and neap tides for each of three harbor configurations: (a) existing configuration (1983), (b) landfills placed on existing bathymetry, and (c) landfills placed with increased channel depths. The 2020 Master Plan produced no changes in tidal elevation or phase throughout the harbors. The tidal prism was reduced by the amount of displacement of the landfill. Flow distribution entering and exiting the harbor through Angel's Gate, Queen's Gate, and the east end were not significantly affected. The net flow in the inner harbor (Main Channel and Cerritos Channel) was reversed from the existing westerly flow to an easterly flow; however, the net flow volumes for both existing and planned conditions were small relative to the total flow volumes. Channel deepening combined with the 2020 Master Plan reduced large horizontal eddies in the outer harbor, permitting more efficient flow into the inner harbor area from Angel's Gate to the Main Channel. Dye tests indicated good flushing and mixing in the outer harbor. References (10 items).

Seabergh, W. C., and Sager, R. A. 1980. "Supplementary Tests of Masonboro Inlet Fixed-Bed Model; Hydraulic Model Investigation," GITI Report 18, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

The report describes supplemental tests of the Masonboro Inlet fixed-bed model not reported in "Physical Model Simulation of the Hydraulics of Masonboro Inlet, North Carolina," GITI Report 15. The supplemental tests consist of three separate studies performed in the Masonboro Inlet fixed-bed model. The first study examines the effects of the closing of various bay channels on the inlet's hydraulics. The second study examines the effects of the addition of a south jetty to the existing condition which has a single north jetty and examines the resulting hydraulics for various weir elevations on both jetties. The third study examines the use of a tracer material and closely parallels the hydraulic testing sequence discussed in the previous Masonboro Inlet report. The tracer tests include verification of the 1969-1971 shoaling trends, testing of the prejetty 1964 condition, testing of the single jetty plan with the 1964 bathymetry, and testing of the postjetty construction 1966 condition. These tests were performed to evaluate the effectiveness of using sediment tracer materials in inlet model studies. Results indicate the closure of any of the three interior channels in Masonboro Inlet produces a

signiicant change in the inlet hydraulics and would most likely produce a significant change in morphology as illustrated by the prototype case history. References (18 items).

Seelig, W. M., and Sorensen, R. M. 1978. Numerical Model Investigation of Selected Tidal Inlet-Bay System Characteristics," <u>Proceedings, Sixteenth Coastal Engineering</u> <u>Conference, August 27-September 3, 1978,</u> <u>Hamburg, Germany, ASCE, II:1302-1319.</u>

A spatially integrated one-dimensional numerical model of inlet-bay hydraulics has been combined with a simple sediment transport model to investigate selected tidal inlet-bay system characteristics. A parametric study has been performed using the models to determine the effect of various factors on the net direction and order of magnitude of inlet channel flow and sediment transport. Factors considered include astronomical tide type, storm surge height and duration, variation in bay surface area, time-dependent channel friction factor, and the addition of a second inlet connecting the bay and sea. References (7 items).

Sengupta, S., Lee, S., and Bland, R. A. 1976. "Three-Dimensional Model Development for Thermal Pollution Studies," <u>Proceedings, Conference on Environmental</u> <u>Modeling and Simulation</u>, April 19-22, 1976, Cincinnati, Ohio, EPA 600/9-76-016:522-526.

A three-dimensional thermal pollution mathematical model is developed; this can include effects of winds, ocean currents, cyclic tidal flushing in bays and estuaries, variable winds, and realistic bottom topography. References (14 items).

Sengupta, S., Lee, S. S., and Miller, H. P. 1978. "Three-Dimensional Numerical Investigations of Tide and Wind-Induced Transport Processes in Biscayne Bay," Sea Grant Technical Bulletin No. 39, University of Miami, Coral Gables, Fla.

An outline is given of the tide and winddriven circulation in Biscayne Bay, South Florida, a shallow-water estuary. Present studies include calibrating two threedimensional numerical free surface models which can then be used to predict the distribution of sediment transport within the bay. Further investigations will be carried out into salinity effects using proven finite element techniques. References (39 items).

Sharp, J. J. 1981. <u>Hydraulic Modelling</u>, Butterworth, Boston.

This book provides a comprehensive guide to the theory and practice of hydraulic models and their design, construction, and operation. Hydraulic phenomena are too complex to be described by mathematical techniques. Scale models play a decisive part in the evaluation of many hydraulic schemes. Part 1, "General Theory," includes the necessary study of similarity theory and scale errors. Part 2, "Practice," describes the modelling of river, tidal, thermal, and effluent schemes. Included are sections on hydroelectric schemes and snow and ice models. References are given at the end of each chapter with a selected bibliography for Part 1. PSYSSER D22222 APPENDED

Sheng, Y. P. 1983. "Mathematical Modeling of Three-Dimensional Coastal Currents and Sediment Dispersion: Model Development and Application," Technical Report CERC-83-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

A comprehensive model of coastal currents and sediment dispersion has been formulated and applied to the Mississippi Sound and adjacent continental shelf waters. The study combines mathematical modeling of various hydrodynamic and sedimentary processes with laboratory and field experiments. Of primary importance is the development of an efficient and comprehensive three-dimensional, finite-difference model of Coastal, Estuarine, and Lake Currents (CELC3D). The model resolves currents driven by tide, wind, and density gradient. It has been applied to the Mississippi Sound, and results agree well with measured surface displacements and currents during two episodes. Rates of entrainment and deposition of the Mississippi Sound sediments have been studied in a laboratory flume. Effects of (a) bottom shear stress, (b) bed properties, (c) salinity of water, and (d) sediment type on the erodibility of sediments have been examined. Results of the laboratory study have been incorporated into the bottom boundary conditions for a threedimensional sediment dispersion model. Gravitational settling and particle size distribution of the Mississippi Sound sediments were also studied in laboratories. Bottom boundary layer dynamics and wave effect on sediment dispersion have been studied by means of a turbulent transport model and a wave model. Model simulations of sediment dispersion in the Mississippi Sound agree well with available data from ship surveys. References (120 items).

Sheng, Y. P. 1984. "Preliminary User's Manual, 3-D Mathematical Model of Coastal, Estuarine, and Lake Currents (CELC3D)," Instruction Report D-84-1, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

An efficient and comprehensive threedimensional finite-difference model of Coastal, Estuarine, and Lake Currents (CELC3D) has been developed and is

currently operative on a VAX-11/780 minicomputer. This user's manual discusses the special model features, general structure of the CELC3D computer code, subprogram summary, input/output information, data requirements, and example calculation.

Signorini, S. R. 1979. "A Three-Dimensional, Finite Element Numerical Model of Circulation and Diffusion-Advection Processes for Estuarine and Coastal Application (With Application to Bay of Ilha Grande, Brazil)," Ph. D. Dissertation, University of Rhode Island, Kingston.

This study consists of the development of a three-dimensional numerical model suitable for applications to tidal, winddriven, and density-driven flows in estuaries and coastal regions. Both velocity and density fields are solved for by using a coupled system of momentum, continuity, and conservation of density equations. This is to say, the density stratification plays a dynamic role in the solution scheme by means of a mutual adjustment of the velocity and density fields through the conservation of density equation. The solution strategy of the model developed in this study is an extension of the one employed in the barotropic model of Wang and White (1976). The model is capable of assuming Coriolis force effects and continuous density stratification and of including nonlinear effects by the use of the complete conservation of momentum and density equations and variable bottom topography. The transfer of mass and momentum between layers is achieved by the use of constant eddy viscosity and eddy diffusivity coefficients. The bottom friction and the wind stress are introduced by means of empirical relations similar to Wang's model. A coordinate transformation is used to transform the normal vertical coordinate into a stretched vertical coordinate in order to keep the domain boundaries constant at all layers. After using the finite element integration in space coordinates, the original system of partial differential equations becomes a system of ordinary differential equations with respect to time. The continuity, momentum, and density conservation equations are then integrated with respect to time in successive time steps. To model the tidal portion of the flow, the scheme uses a boundary condition at the ocean boundaries of the domain by imposing a cooscillating tidal signal to drive the free-surface elevation. Preliminary test runs were conducted to investigate the accuracy and general behavior of the three-dimensional model. The model was tested for river outflow and density stratification conditions which simulate the exact similarity solutions of Hansen and Rattray (1965) for an idealized recti-

linear estuary. Very good agreement was obtained between the model profiles and the similarity theory, with the model velocity profiles being more physically realistic at the bottom. An experiment involving the spin-up of an oblong-shaped lake by a linear wind stress distribution for an initially linearly stratified lake is also presented. The results showed to be consistent with the dynamics involved in the problem but no analytical comparison was available for this experiment. As its principal practical experiment, the model was applied to the estuarine system formed by Bay of Ilha Grande and Bay of Sepetiba (Rio de Janeiro, Brazil). A preliminary assessment to the tidal and wind-driven portions of the circulation was successfully accomplished by using a two-dimensional finite element model developed by Wang (1975). A limited amount of field data necessary to test the model's ability to reproduce and predict the circulation patterns observed in the region was provided by field work undertaken in September 1977 together with the data already available for the region. Next, the three-dimensional model was applied to the Bay of Ilha Grande region including bottom topography, density stratification, and tidal forcing. The initial density stratification was provided by a simple linear function of the three coordinates, with slopes calculated from the density gradients provided by the hydrographic field work. The model results proved to be in reasonable agreement with the available field data, and the accuracy obtained seems to be closely related to the ability of the grid system adopted to reproduce the real geometry and to the quality of the real initial and boundary conditions available to drive the model. References (45 items).

- Simpson, J. E., and Britter, R. E. "Experiments on the Dynamics of the Front of a Gravity Current." (See complete entry in Section I.)
- Smith, N. P., and Kierspe, G. H. 1981. "Local Energy Exchanges in a Shallow, Coastal Lagoon: Winter Conditions," <u>Estuarine, Coastal and Shelf Science,</u> 13(2):159-167.

A 110-day time series of estuarine water temperature is used to verify a numerical model of local air-water heat exchanges under winter conditions in a shallow, barbuilt estuary on South Florida's Atlantic coast. Quasi-periodic frontal passages during the winter of 1977-78 produced cycles of heating and cooling over time scales of about a week. Temperatures decrease 4°-7° C during the first few days following frontal passages. Model results suggest that the daily net water temperature change is most strongly correlated with, and is therefore primarily in response to, sensible and latent heat fluxes. Heating by insolation and cooling by long-wave radiation are substantial, but in both cases the correlation with the net daily temperature change is not statistically significant. Conductive exchanges with the underlying sediments appear to play a minor role in the estuarine heat budget. The root-mean-squared error of simulated water temperatures asymptotically approaches a value of approximately 1.0° C for time intervals of between 2 and 30 days. References (9 items).

Smith, T. J. 1982. "On the Representation of Reynolds Stress in Estuaries and Shallow Coastal Seas," <u>Journal of Physical</u> <u>Oceanography</u>, 12(8):914-921.

A model for the representation of the Reynolds-stress tensor in threedimensional hydrodynamic models of shallow-water flows is derived which combines the accuracy of turbulence energy closure schemes with the computational efficiency of algebraic eddy viscosity models. The proposed model assumes the eddy viscosity tensor to have structural similarity, from which it is shown that its magnitude is scaled on the depth-mean turbulence energy and the depth-mean turbulence energy dissipation rate, while the vertical structure is described by a suitable similarity function, two alternatives of which are derived. The similarity assumptions used in the analysis are verified and the model is tested by application to steady and tidal flows. References (19 items).

Smith, T. J., and O'Connor, B. A. 1977. "A Two-Dimensional Model for Suspended Sediment Transport," <u>Proceedings, Seventeenth</u> <u>Congress of the International Association</u> <u>for Hydraulic Research; Hydraulic Engi-</u> <u>neering for Improved Water Management,</u> <u>15-19 August 1977, Baden-Baden, Federal</u> <u>Republic of Germany, 1:79-86.</u>

The paper describes a two-dimensional mathematical model which enables the longitudinal and vertical distributions of velocity and suspended solids to be determined in estuarial-type flows. The model operates on a real-time basis and consists of an ADI-type finite difference solution of the basic laterally integrated momentum and continuity equations for fluid and sediment. The difficulties of modelling natural-shaped sediment channels by the laterally integrated approach is highlighted and suggestions given to enable the two-dimensional approach to be used in practice. A simplified form of the model is applied to a simple steady flow laboratory situation and shown to give good results as regards the fluid velocities but not as good results regarding the sediment field. The discrepancies are attributed to inaccurate laboratory results. Deposition rates can be predicted provided an appropriate reentrainment coefficient is used. References (9 items).

- Sorensen, R. M. "The Corps of Engineers General Investigation of Tidal Inlets." (See complete entry in Section I.)
- Spaulding, M. L. 1984. "A Vertically Averaged Circulation Model Using Boundary-Fitted Coordinates," <u>Journal of Physical</u> <u>Oceanography</u>, 14(5):973-982.

A two-dimensional vertically averaged circulation model using boundary-fitted coordinates has been developed for predicting sea level and currents in estuarine and shelf waters. The basic idea of the approach is to use a set of coupled quasilinear elliptic transformation equations to map the physical domain to a corresponding transformed plane such that all boundaries are coincident with coordinate lines and the transformed mesh is rectangular. The hydrodynamic equations are then solved by a multioperation finite difference technique in the rectangular mesh transformed grid. Comparisons of the circulation model predictions for tidally forced flows in a wedge section with both flat and quadratic bottom topography, and in a flat channel with exponential variation in width, were in excellent agreement with corresponding analytic solutions. Simulation of steady-state wind-induced setup in a closed basin formed using elliptic cylindrical coordinates also was in excellent agreement with the analytic solution. Finally, the model was applied to predict the M_2 tidal circulation in the North Sea and accurately reproduced the well-known amphidromic systems present in this region. References (37 items).

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Stark, K. P. 1978. "Simulation and Probabilities of Tide and Cyclonic Storm Surges," <u>Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:44-48.

A simulation model is presented for the determination of probabilities of water levels attained by the combination of astronomical tide and storm surge at a nominated location. The model uses a previously developed numerical hydrodynamic storm surge model SURGE which accounts for the shape of the coastline, the bathymetry of the area, and the cyclone characteristics. SATURN uses long-term Monte Carlo simulations to generate cyclones of the appropriate characteristics in a Poisson process and superimposes the associated astronomical tide on the accompanying storm surge. The

probabilities and return periods of combined water levels produced should prove useful to coastal engineers, developers, civil defense, mitigation, and insurance organizations. References (11 items).

- Stephens, H. S., and Stapleton, C. A., ed. <u>Papers Presented at the Second Interna-</u> <u>tional Symposium on Wave and Tidal Energy,</u> <u>September 23-25, 1981, Cambridge, England</u>. (See complete entry in Section I.)
- Stevens, H. H., et al. 1973. "Model for Sediment Transport Through an Estuary Cross Section," <u>Hydraulic Engineering and the Environment</u>, Proceedings, 21st Annual Hydraulics Division Specialty Conference, Montana State University, Bozeman, Montana, August 15-17, 1973, ASCE, 279-291.

The paper describes a semiempirical mathematical model used to define onedimensional temporal variation of suspended sediment concentration in the Columbia River near Astoria. The method of characteristics was used for solution of the model, and some values had to be adjusted to actual flow measurements. Maximum turbidity develops in different parts of the estuary and translates longitudinally, depending on flow conditions. Agreement between computed and observed concentrations was satisfactory. References (12 items).

- Stigebrandt, A. "A Mechanism that Regulates the Mean Longitudinal Density Gradient in the Brackish Layer in Fjords with Topographical Control at Their Mouths." (See complete entry in Section I.)
- Stroband, H. J., and Wijngaarden, N. J. V. 1977. "Modelling of the Oosterschelde Estuary by a Hydraulic Model and a Mathematical Model," <u>Proceedings, Seventeenth</u> <u>Congress of the International Association</u> for Hydraulic Research; Hydraulic Engineering for Improved Water Management, <u>15-19 August 1977</u>, Baden-Baden, Federal Republic of Germany, 2:271-278.

In the mouth of the Oosterschelde, an estuary in the southwestern part of The Netherlands, a movable storm surge barrier, closed only during a storm, will be built. To solve the hydraulic problems, one of the items needed is a simulation of the tide in that area. Therefore simultaneously a hydraulic (tidal) model and a one-dimensional mathematical model are used, both of which are described here. The total area represented by the models is about 180,000 acres. The hydraulic model has a fixed bottom and is distorted: the horizontal scale $n_1 = 400$ and the vertical scale $n_2 = 100$. In the mathematical model, the area is schematized by a network of one-dimensional tidal channels. The model approximates by its many

sections and knots the two-dimensional situation, leaving out of consideration the fall of water levels owing to the Coriolis force. The method used for computing the tidal motion is the so-called third implicit method. The models are calibrated on a prototype tide, namely, the tide of September 11, 1968. Both the horizontal and the vertical tide are in good correspondence with the prototype. The hydraulic model is mainly used for measuring the boundary conditions for detail models, defining the changes in velocity at places important for the environment, and defining the dispersion of fresh water in the salt water of the estuary by predominantly convective transport. The mathematical model is used, among other things, for defining the relation between the tidal range in the estuary and the effective cross section of the storm surge barrier available. In addition, the mean stream velocities in the channels are computed, and also the translatory waves, which can appear by closing the storm surge barrier. References (4 items).

Sündermann, J., and Elahi, K. Z. 1979. "Constructional Effects on the Dynamical Processes in a Tidal Inlet," <u>Hydraulic</u> <u>Engineering in Water Resources Development</u> <u>and Management, Proceedings, Eighteenth</u> <u>Congress, International Association for</u> <u>Hydraulic Research, Cagliari, Italia,</u> 10-14 September 1979, 4:215-221.

Different constructional alternatives for a harbor in the Bight of Sonmiani, Pakistan, are investigated by means of a hydrodynamical-numerical model. Due to the very poor field data available, the boundary values are obtained from a hierarchy of nested models for the tides in the Arabian Sea. Reference (1 item).

Sündermann, J., and Holz, K.-P., ed. <u>Mathe-</u> <u>matical Modelling of Estuarine Physics,</u> <u>Lecture Notes on Coastal and Estuarine</u> <u>Studies</u>. (See complete entry in Section I.)

- Sündermann, J., and Krohn, J. "Numerical Simulation of Tidal Caused Sand Transport in Coastal Waters." (See complete entry in Section II.)
- Sündermann, J., Vollmers, H., and Berndt, D. "Protection Against Storm Surges in a Tidal River." (See complete entry 1., Section I.)

Sündermann, J., Vollmers, H., and Puls, W. 1978. "The Influence of Dune and Flow Parameters on the Friction Factor," <u>Proceedings, Sixteenth Coastal Engineering</u> <u>Conference, August 27-September 3, 1978,</u> <u>Hamburg, Germany, ASCE, II:1787-1800.</u>

Taking for example the flow over a ripple, some results of a hydrodynamic numerical

model are presented and compared with experimental results. Special importance is attached to the pressure. On the basis of the equations used, the physical reason for the horizontal pressure gradient is investigated. The influence of some dune and flow parameters on the friction is examined. References (6 items).

Svasek, J. N., and Versteegh, J. 1977. "Mathematical Model for Quantitative Computations of Morphological Changes Caused by Man-Made Structures Along Coasts and in Tidal Estuaries," <u>Proceedings, Seventeenth</u> <u>Congress of the International Association</u> for Hydraulic Research; Hydraulic Engineering for Improved Water Management, <u>15-19 August 1977</u>, Baden-Baden, Federal Republic of Germany, 4:189-198.

The mathematical model TRAM9/TAPRAM is based upon refraction computations (TRAM9) and computations of energy-flux-losses (TAPRAM) of the statistically distributed significant wave heights. It is set up for calculations of the sediment transport capacity of breaking waves between depth contours along a coast. The model is twice calibrated by hindcasts of morphological changes along the artificial coastline of the Europort land reclamation. Comparison of the results of the two hindcasts with the volumetric changes computed from soundings showed a difference of approximately 30 percent for the maximum resulting transports which were in the order of $800,000 \text{ m}^3$ in a period of 15 months and 300,000 m³ in a period of 2.5 months, respectively. References (4 items).

Swakon, E. A., Jr., and Wang, J. D. 1977. "Modeling of Tide and Wind Induced Flow in South Biscayne Bay and Card Sound," Sea Grant Technical Bulletin No. 37, University of Miami, Coral Gables, Fla.

A recently developed model using the finite element technique to solve the vertically integrated equations of motion and continuity was applied to South Biscayne Bay and Card Sound to investigate the wind- and tide-induced flow. The time integration scheme of this model was modified by using the trapezoidal rule to improve computational efficiency. With this new scheme, greater time steps can be used; however, the model seems more susceptible to instability by resonance. A grid consisting of 105 elements and 73 nodes was designed to investigate the transient flow in the bay. Six different combinations of tide and wind forcing are presented. Tide and wind data were collected over a 4-month period to determine model boundary conditions. Tide gages were installed at six locations on the bay side of the ocean-bay boundary to provide time series of water surface elevations. Wirl data were obtained from Miami Inter-

national Airport and Homestead Air Force Base. A comparison of the records from the two stations for the month of November revealed no significant spatial variation, and it was therefore assumed that the wind field over Biscayne Bay as a first approximation is uniform. Preliminary analysis of the tide data showed significant differences in both tidal ranges and phase lags from the average conditions as presented in the tide tables. Through analysis of the wind and tide data, an estimate of the wind-induced setup was found to be 7.6 cm (3 in.) from Cape Florida to Adams Key for an average 7.5-m/sec wind from the north. Similarly a setdown of 5.1 cm (2 in.) was found for a 5.0-m/sec wind from the south. The inclusion of these wind-induced surface gradients into the model forcing was found to have an important effect on predicted residence times. Predicted velocity patterns and "Lagrangian particle" drifts are presented for average spring and neap tide conditions with and without wind. Estimates of flushing times based on these results are also given. The convective transport in the bay system was found to be strongly influenced by wind whereas normal tidal variations played a minor role. References (20 items).

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- Swenson, E. M., and Chuang, W.-S. "Tidal and Subtidal Water Volume Exchange in an Estuarine System." (See complete entry in Section VIII.)
- Swift, M. R. 1980. "Spatially Varying Turbulence Production in Tidal Channels," <u>Marine Forecasting: Predictability and</u> <u>Modelling in Ocean Hydrodynamics; Proceedings, 10th International Liège Colloquium on Ocean Hydrodynamics, J. C. J. Nihoul, ed., Elsevier Oceanography Series 25, Elsevier, Amsterdam.</u>

Effects of spatially varying turbulence production in tidal channels are calculated using an analytical model. The model is developed from the boundary layer form of the equation of motion and an eddy viscosity representation for Reynolds shear stress. The eddy viscosity is calculated using the turbulence kinetic energy equation. A perturbation method is applied to solve for turbulence kinetic energy and the vertical distribution of current. It is found that when turbulence production is spatially varying, advection of the inhomogeneous turbulence field introduces an asymmetric time dependence into the effective viscosity. One result of the nysteresis in the stress current relationship is the formation of residual currents. References (26 items).

Thatehen, M. L., and Harleman, D. F. F. 1981. "Lenc-Term Salinity Calv.lation in Lensage Estimat," (Scoral, 1997).

Environmental Engineering Division, ASCE, 107(EE1):11-27.

A mathematical model of time-varying salinity distribution is selected and further developed for the purpose of calculating over a period of time equal to a year or more. These calculations are required to evaluate the effects of different scenarios or plans involving reservoir regulation and consumptive freshwater withdrawals. The tidal estuary portion of the Delaware River is the subject of this application. A hydrodynamic and coupled salinity model is described in terms of its governing equations. The model is one-dimensional and contains a dispersion relationship which is predictive over a broad range of tidal and freshwater inflow conditions. Treatment of boundary conditions is described with respect to the processing of large amounts of data and with respect to the definition of the salinity concentration of tributary and upstream inflows. A comparison is given between calculated and observed concentrations over a yearlong period. References (17 items).

Thienpont, M., and Berlamont, J. 1978. "Mathematical Modelling of Thermal Discharge in Rivers and Estuaries," <u>Papers</u>, <u>7th International Harbour Congress</u>, K.V.I.V. (Royal Society of Flemish Engineers), Antwerp, Belgium, 22-26 May 1978, I:6.01/1-6.01/10.

The program is a first step in the study of a mathematical model of the near field zone of a thermal discharge. To proceed to the calculations, the method of finite elements was used first of all with triangular elements, whereby the reliability of the results has been checked on a physical model (rectangular channel). To obtain greater generality, isoparametric elements with a variable number of nodes was used. References (15 items).

- Timmerman, H. "Forecasting Meteorological Effects on Water Levels on a Routine Basis with a Numerical Model." (See complete entry in Section I.)
- Tucci, C. E. M., and Chen, Y. H. 1981. "Unsteady Water Quality Model for River Network," Journal, Water Resources Planning and Management Division, ASCE, 107(WR2):477-493.

A complex river network system consisting of branches and loops is sometimes complicated by downstream effects from tides, lakes, and other factors. The management of water quality in such rivers is a difficult task. A model was developed to simulate hydraulic behavior and water quality of a river network on a onedimensional representation. The two complete St. Venant equations and the transport equation were solved by a finite difference implicit method using a modified Gauss elimination procedure. The model can simulate biochemical oxygen demand, dissolved oxygen, and any conservative substance. The hydraulic module of the model was adjusted and verified with data from the Jacui Delta, Brazil, showing good agreement between the calculated results and the observed data. The water quality model was tested under hypothetical conditions for the same delta to demonstrate the utility of the model in making managerial decisions. References (10 items).

Turner, K. A., and Durham, D. L. 1984. "Documentation of Wave-Height and Tidal Analysis Programs for Automated Data Acquisition and Control Systems," Miscellaneous Paper HL-84-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Detailed documentation of two major programs, Wave Height and Tidal Analysis, for the Automated Data Acquisition and Control Systems (ADACS) is presented in this report. The Wave-Height program is used to analyze model data from hydraulic wave models and calculates various statistical parameters of wave height for specified model tests at selected locations in the model. Similarly, the Tidal Analysis program analyzes model data from hydraulic tidal models and calculates various tidal parameters for specified model tests at selected locations in the model. For each of these programs, the program functions, specifics, input (output), listing, tape formats, etc., are discussed in detail.

Uncles, R. J. 1981. "A Note on Tidal Asymmetry in the Severn Estuary," <u>Estuarine</u>, Coastal and Shelf Science, 13(4):419-432.

A one-dimensional, nonlinear numerical model is used to investigate the tidally averaged frictional stress and setup of water level due to tidal asymmetry in the Severn Estuary; these quantities depend on the overtides in the region. A linearized model of the overtides is applied to calculations of the $M_{\rm \perp}$ currents in order to delineate the mechanisms responsible for their generation. The relative importance of individual nonlinear mechanisms to the tidally averaged stress and setup is determined; these mechanisms are interactions between tidal flow and changes in depth or breadth over a cross section, frictional interaction between the tidal flow and Stokes drift, interaction between the tidal fluctuations in water depth and frictional retardation and nonlinear advection. References (8 items).

Uncles, R. J. 1982. "Residual Currents in the Severn Estuary and Their Effects on

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Dispersion," <u>Oceanologica Acta</u>, 5(4):403-410.

Depth-averaged residual currents and associated water levels resulting from M, tidal oscillations in a numerical model of the Severn Estuary, UK, are presented. Current patterns are dominated by eddies. Residual currents produce enhanced transverse and axial dispersion by the mechanism of tidal "random walk." The axial dispersion coefficient due to residual current eddies is shown to be comparable to the observed long-term value for the seaward section of estuary considered, and is much greater than values which can be attributed to vertical shear in tidal and residual currents, or transverse shear in tidal currents. Transverse mixing due to tidal "random walk" is found to be much greater than that which can be attributed to other known mechanisms. Estuarine width is shown to be important in that it limits the size of horizontal eddies, and therefore controls the dispersion for given tidal and residual current speeds. References (25 items).

Uncles, R. J., and Jordan, M. B. 1980. "A One-Dimensional Representation of Residual Currents in the Severn Estuary and Associated Observations," <u>Estuarine and Coastal</u> Marine Science, 10(1):39-60.

A one-dimensional hydrodynamical model is used to describe the cross-sectionally averaged Stokes drift and Eulerian residual (tidally averaged) currents in a section of the Severn Estuary between Porthcawl and Sharpness. Residual variables are contacted for periodic M, tides, and as functions of time during simulated spring-neap cycles. The results for periodic M, tides show that the landwarddirected Stokes drift has a spatially averaged value of 3.5 cm s⁻¹ in the Severn Estuary, which, in the absence of freshwater inputs and meteorological perturbations, is balanced by seaward-flowing Eulerian residual currents. The residual setup of water (i.e., the mean surface elevation relative to the value at the seaward boundary) is mainly determined by the magnitudes of the axial density gradients and friction, with the friction dominating for typical salinity distributions; the landward flow of water due to the Stokes drift contributes to the setup. which drives the seaward residual currents against the opposing frictional forces. It is shown that the magnitude of the Stokes drift is mainly determined by the estuary's geometry, the strength of the tidal streams, and the friction (regardless of whether a quadratic or linearized friction law is assumed), the effects of density gradients and axial momentum advection and dispersion being negligible. The frictional dissipation in the Severn Estuary, which amounts to 3 + 109 watts

for M, tides in the region between Porthcawl and Sharpness, is balanced by a landward residual flow of energy across the mouth, which is very nearly proportional to the Stokes drift at the mouth. The axial residual currents and Stokes drift have maximum and minimum speeds at spring and neap tides, respectively, the speeds at average spring tides being roughly seven times those for average neap tides, and twice those for M_2 tides. The neap to spring part of the tidal regime is a period of increasing estuarine residual volume and landward-flowing Lagrangian residual currents (-1 mm s^{-1} near the mouth); the reverse is true for spring to neap tides. The computed values of the Stokes drift are compared with observations at nine anchor stations and covering 28 tidal cycles; the agreement between observations and theory is generally good. References (22 items).

- van de Kreeke, J., and Chiu, A. A. "Tide-Induced Residual Flow in Shallow Bays." (See complete entry in Section I.)
- van de Kreeke, J., and Wang, J. D. 1978. "Tidal Hydraulics and Salt Balance of Lake Worth, Florida," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2827-2839.</u>

During the rainy season large quantities of fresh water are discharged through the canals into the estuaries surrounding the Florida coast, resulting in a considerable lowering of the salinities. The following specific problems are addressed in this paper: identification and quantification of freshwater sources; determination of freshwater 'saltwater transport mechanisms and the resulting salinity distribution; and the effect of reducing the freshwater inflow on the flushing time. For this purpose a series of field measurements was carried out and mathematical models describing the hydrodynamics and salinity distribution were developed. References (4 items).

- van de Ree, W. J., Voogt, J., and Leendertse, J. J. "A Tidal Survey for a Model of an Offshore Area." (See complete entry in Section VII.)
- Vongvisessomjai, S., and Srikanthan, R. "The Regimen of Takuapa Tidal Channel." (See complete entry in Section I.)
- Vreugdenhil, C. B. "Application of Finite-Difference Methods to Estuary Problems." (See complete entry in Section 1.)
- Walters, R. A., and Cheng, R. T. 1978. "A Two-Dimensional Hydrodynamic Model of a Tidal Estuary," <u>Proceedings, Second Inter-</u> national Conference on Finite Elements in

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Water Resources, Imperial College, London, July 1978, 2.3-2.21.

This paper describes a finite element model which is used in the computation of tidal currents in an estuary. This numerical model is patterned after an existing algorithm and has been carefully tested in rectangular and curve-sided channels with constant and variable depth. One of the common uncertainties in this class of twodimensional hydrodynamic models is the treatment of the lateral boundary conditions. Special attention is paid specifically to addressing this problem. To maintain continuity within the domain of interest, "smooth" curve-sided elements must be used at all shoreline boundaries. The present model uses triangular, isoparametric elements with quadratic basis functions for the two velocity components and a linear basis function for water surface elevation. An implicit time integration is used and the model is unconditionally stable. The resultant governing equations are nonlinear owing to the advective and the bottom friction terms, and are solved at each time step iteratively by the Newton-Raphson method. Further model test runs have been made in the southern portion of San Francisco Bay, California, USA (South Bay), where a twodimensional model is justifiable. Due to the complex bathymetry, the hydrodynamic characteristics of South Bay are dictated by the generally shallow basin which contains deep, relict river channels. Great care must be exercised to ensure that the conservation equations remain locally as well as globally accurate. Simulations have been made over several representative tidal cycles using this finite element model and the results compared to existing data. References (27 items).

- Walther, A. W. "Hydraulic Research in the Oosterschelde Estuary." (See complete entry in Section I.)
- Walton, R., Granat, M. A., and Shubinski, R. P. 1980. "Calibrating the Chesapeake Bay Circulation Model?" <u>Proceedings, Spe-</u> <u>cialty Conference on Computer and Physical</u> <u>Modeling in Hydraulic Engineering</u>, McCormick Inn, Chicago, Illinois, August 6-8, 1980, ASCE, 387-396.

The discussion in this paper centers around the future calibration of a three-dimensional, numerical, circulation model being developed for the Environmental Protection Agency to model the bay and its tributaries. The authors attempt to identify its important calibration parameters, and review similar coefficients used in previous models and measured in the field. Finally, the calibrations and areas of applicability of this model are compared with the Corps of Engineers hydraulic model located at Matapeake, Maryland. References (17 items).

- Wang, D. P. "Two-Dimensional Branching Salt Intrusion Model." (See complete entry in Section III.)
- Weisman, R. N., Collins, A. G., and Parks, J. M. 1982. "Maintaining Tidal Inlet Channels by Fluidization," Journal, Waterway, Port, Coastal and Ocean Division, ASCE, 108(WW4):526-538.

Along the barrier islands off the east coast of the United States and at other areas of the world, there exist many tidal inlet channels which connect the ocean to back bay areas. An innovative technique is tested to maintain a stable, navigable channel. Water is pumped into a perforated pipe buried beneath the sand, and the water flowing through the perforations fluidizes the overlying sand. The fluidized sand along the pipe is then removed either by gravity flow, slurry pump, or entrainment in the overlying ebb tidal current. Laboratory experiments provided information necessary for the design of such a fluidization system, specifically, data on hole orientation, hole size, hole spacing, flow rate necessary for fluidization, and the effect of slurry removal on the channel shape. A small-scale field test, designed from the laboratory data and performed on a beach face, shows that the technique is technically feasible and that the design data are sound. In the field test, full fluidization along fluidization pipe was achieved and the fluidized sand was removed by pumping the slurry or, when the pipe was sloped, by gravity flow. References (11 items).

- Welch, J. M., and Parker, B. B. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina." (See complete entry in Section I.)
- Whalin, R. W. 1977. "Los Angeles Harbor and Long Beach Harbor: Plan of Study," <u>Ports '77, 4th Annual Symposium of the</u> <u>Waterway, Port, Coastal and Ocean Division</u> <u>of ASCE</u>, Long Beach, Calif., March 9-11, 1977, 1:1-9.

The US Army Corps of Engineers in concert with personnel from the Port of Los Angeles and the Port of Long Beach realized that major expansion plans for both ports should be accompanied by a comprehensive analysis, from both an engineering and environmental viewpoint, in order to ensure that the optimal plans for expansion were realized. Factors complicating this analysis included a lack of quantitative knowledge regarding (a) incident long wave energy levels, (b) response characteristics of the existing harbors complex, (c) existing circulation and flushing 146

conditions in the present harbor, (d) mooring methods, (e) moored ship response, and (f) effect of proposed expansion plans on all these factors. A comprehensive study plan was developed that included the following objectives: (a) determine the incidence and severity of troublesome oscillations in the present harbor complex, (b) investigate tidal circulation characteristics of the present and improved harbors, (c) determine optimum plans for future expansions to provide safe and economical berthing areas, and (d) analyze effects of proposed expansions on existing harbors. Major elements of the study plan were measurement of the long-period wave climate in the harbors; observations of moored ship response in the existing harbors; design and construction of a hydraulic model and necessary model equipment; use of appropriate numerical models of ship response, tidal circulation, and harbor response; and conduct of hydraulic model tests to define the existing and future harbor response to long-period energy and to study circulation and flushing of the existing and improved harbors. It is envisioned that the hydraulic model and associated numerical models can be used to study effects of a multitude of related developments in the area from Point Fermin to Huntington Beach. Some such potential studies include the effect of proposed future discharges (LNG discharge, sewer outfalls, power plant discharges, etc.) on tidal circulation and flushing, tsunami effects (both distant and local seismic events), methods of improving circulation and flushing in Bolsa Chica Wildlife Reserve and the Huntington Harbor development, swell and circulation design criteria for small craft harbors and for potential Naval developments, and design criteria for development of the shelf area seaward of the existing breakwaters (offshore airport, future port developments, etc.).

Whalin, R. W. 1977. "Los Angeles Harbor and Long Beach Harbor: Summary of Results and Future Plans," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Long Beach, Calif., March 9-11, 1977, I:169-177.

An extremely complex study plan has evolved during the past 5 years; and vast quantities of hydraulic model, numerical model, and prototype data have been generated. The objective of this paper is to summarize results of all these studies, delineate the relation of each element to the overall study plan, and describe future plans in this investigation. Prototype wave measurements from 6 sec to the tidal period have culminated in the most comprehensive and most successful data base ever obtained on long-period waves. Simultaneous observations of moored ship

response, measurement of long-period waves, numerical computations of moored ship response, numerical harbor oscillation studies, and hydraulic model data on harbor oscillations have resulted in a comprehensive understanding of oscillations both in the existing harbor complex and for various proposed improvement plans. The verified hydraulic and numerical tidal circulation models, coupled with the computation of residence times for various basins and subbasins in the harbors, have provided a quantitative knowledge of circulation conditions in the existing harbors and for proposed improvement plans. Consequently, proposed improvement plans can be formulated in order to optimize the compatibility of safe and economical berthing areas with environmentally acceptable water quality conditions in the harbor complex. As a result of the studies conducted by the Corps of Engineers, the Port of Los Angeles, and the Port of Long Beach for the purpose of assuring optimal functional and environmentally compatible development of the harbors, the Los Angeles and Long Beach Harbors complex has undoubtedly become the best understood and most studied major harbor complex with respect to harbor oscillations, tidal circulation, and flushing. The hydraulic model has been referred to as the "living model," which is especially appropriate in view of its ability to be used to quantitatively investigate the effect of future plans as they evolve from the constantly changing requirements of the various political entities and private developments associated with San Pedro Bay. Potential use of the model for future studies of San Pedro Bay truly appears to be endless. The model can be ideally used as a tool for the planning, design, operation, and maintenance of practically all water quality-related developments, harbor oscillation problems, coastal or offshore structures, and many related studies of either small craft harbors or coastal evolution. References (16 items).

Wilkinson, D. L. 1978. "Periodic Flows from Tidal Inlets," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, II:1336-1346.

A study was undertaken of the flow produced in the offshore region by tidal currents at the entrance of a coastal inlet. The gross features of the offshore flow structure were examined in an idealized two-dimensional model in which a sinusoidally reversing flow was discharged from an open channel into a large stagnant basin. During each period of ebb flow, the discharge from the simulated inlet developed a structure very similar to that of a starting jet, and a vortex pair was
observed to form and ultimately became the dominant feature of the flow. Although variable bottom topography and longshore currents will distort the flow pattern, the rotational motions observed in these experiments would be expected to persist. The study was restricted to coastal inlets in which the sectional area of the entrance channel is several orders of magnitude smaller than the area of water surface inside the inlet. Reference (1 item).

- Winterwerp, J. C. "Decomposition of the Mass Transport in Narrow Estuaries." (See complete entry in Section III.)
- Wolanski, E. "The Fate of Storm Water and Stormwater Pollution in the Parramatta Estuary, Sydney." (See complete entry in Section III.)
- Wong, K.-C. "Subtidal Volume Exchange and the Relationship to Atmospheric Forcing in Great South Bay, New York." (See complete entry in Section I.)
- Wong, K.-C., and Wilson, R. E. "An Assessment of the Effects of Bathymetric Changes Associated with Sand and Gravel Mining on Tidal Circulation in the Lower Bay of New York Harbor." (See complete entry in Section I.)
- Wood, T. 1980. "Discrete-Time Modelling of Dispersion in Estuaries," <u>Proceedings,</u> <u>Seventeenth Coastal Engineering Confer-</u> <u>ence, March 23-28, 1980, Sydney, Aus-</u> tralia, ASCE, III:3078-3086.

This paper aims to put forward a case in favor of a simple discrete-time model describing mixing in an estuary. The

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model derives from the remarkably simple concepts developed by Ketchum (1951) which describe mixing in terms of tidal prism exchanges between segments. The author's view is that Ketchum's ideas were abandoned before they were fully explored. major factor was the advent of the highspeed computer which opened up the possibility of using an approach based on the space-time formulation of the problem in terms of the partial differential equations of transport theory. Intrinsically this approach, based on a continuum description, is more attractive than a gross description based on relatively large segments: one obvious reason is the possibility of providing a comprehensive spacetime prediction of the spread of a pollutant. In practice, though, significant problems arise in its use. In particular, the following can be mentioned: (a) substantial computing costs relating to computer program development and machine time; (b) specification of transport parameters inherent in the partial differential equations of transport: for example, dispersion coefficients; and (c) model validation and state/parameter estima-The last of these is the primary tion. concern of this paper. It is probably true to say that, to date, too little attention has been given to these topics, in the context of estuarine modelling. The point to be made is that there is small justification in using a sophisticated description of a system if the resulting predictions of the model cannot be effectively validated. The ideas used in this paper stem from those put forward by Beck and Young (1975) in studies on nontidal river pollution. The subsequent discussion suggests an extension to estuarine systems. References (6 items).

SECTION VII. SURVEYS AND INSTRUMENTS

Methods and techniques of field surveys, observation sampling, measurements, and data collection, and various types of instruments, gages, and sampling devices.

- Bohlen, W. F., and Marine Sciences Department, University of Connecticut. "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events." (See complete entry in Section II.)
- Blair, C. 1983. "Tidal Corrections in Hydrographic Surveying," <u>Journal, Water-</u> way, Port, Coastal and Ocean Engineering, ASCE, 109(1):31-40.

Depth errors may occur in hydrographic surveys if tidal corrections are determined from water surface heights measured at points distant from the immediate vicinity of the soundings. Use of predicted rather than measured heights is another potential cause of error. Errors are presented for a hypothetical calculation of dredging pay quantities. Procedures for reducing errors are suggested, and methods of measuring tide height described. References (7 items).

- Breusers, H. N. C., and van Os, A. G. "Physical Modelling of the Rotterdamse Waterweg Estuary." (See complete entry in Section VI.)
- Chelton, D. B., Jr. "Low Frequency Sea Level Variability Along the West Coast of North America." (See complete entry in Section VI.)
- Christiansen, H., and Siefert, W. "Storm Surge Prediction by Combined Wind and Tide Data." (See complete entry in Section VIII.)
- Dandy, G. C., Mills, D. A., and Hinwood, J. B. "Water Movement Studies Required for Port Planning." (See complete entry in Section I.)
- Davies, A. M. "Role of 2D and 3D Models in JONSDAP '76." (See complete entry in Section VI.)
- Diamante, J. M., et al. 1982. "Tidal and Geodetic Observations for the SEASAT Altimeter Calibration Experiment," <u>Journal</u> of Geophysical Research, 87(C5):3199-3206.

A calibration experiment for the SEASAT radar altimeter was conducted in the Bermuda calibration area during September and October of 1978 by a group of Federal Government agencies, universities, and research organizations. As part of the SEASAT calibration activities, a tide gage was installed by the National Ocean Survey at an open coastal location on Bermuda to provide a determination of the instantaneous sea surface height during the SEASAT overflights of the island. The tide gage was geodetically tied to the laser tracking station on Bermuda, so that SEASAT's position relative to the sea surface could

be determined independently and compared with the value provided by the altimeter measurements. The root sum square error in the determination of the vertical position of the laser, relative to the sea surface, has been estimated to be 4.0 cm exclusive of possible errors arising from the present lack of precise information on the elevation of the geoid at Bermuda. References (10 items).

Dyer, K. R. 1980. "The Mixing Processes in a Partially Mixed Estuary: Southampton Water," <u>Proceedings, Second International</u> <u>Symposium on Stratified Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:934-943.

Measurements have been carried out in Southampton Water using four current meters in the vertical, with regular temperature and salinity profiles and continuous salinity and temperature measurements close to the halocline. These revealed that a Richardson number $\ R_{i} < 0.25$, indicative of turbulent mixing, occurred for only short periods of the tidal cycle at high velocities. Mixing was shown by the spectra of salinity fluctuations to occur with velocities in excess of 15 cm sec⁻¹. This mixing may result from the presence of standing internal waves created by a lateral seiche, interacting with the velocity shear close to the seabed. References (9 items).

Egan, J. T., and Jones, H. L. 1967. "Tidal Measurement, Analysis, and Prediction," Report No. RN-28, Experimental Astronomy Laboratory, Massachusetts Institute of Technology, Cambridge.

For HYSURCH (Hydrographic Surveying and Charting System) survey operations, tidal analysis is necessary in order to establish a datum plane reference for depth soundings and to provide a basis for longrange tide predictions. Because of the brevity of the survey, conventional analysis techniques must be replaced by more approximate methods. The primary sources of tidal energy are reviewed, and the accuracy with which their effect can be predicted is estimated. Special attention is given to meteorological interference and local tidal anomalies. Section II gives a brief description of the instrumentation required for tidal measurements and the telemetry requirements. It includes a survey of existing instrumentation and design recommendations. The need for lightweight systems and rapid deployment techniques is emphasized.

Essen, H.-H., Gurgel, K.-W., and Schirmer, F. "Tidal and Wind-Driven Parts of Surface Currents, as Measured by Radar." (See complete entry in Section I.)

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- Evans, J. J., and Pugh, D. T. "Analysing Clipped Sea-Level Records for Harmonic Tidal Constituents." (See complete entry in Section I.)
- Filloux, J. H., and Snyder, R. L. "A Study of Tides, Setup and Bottom Friction in a Shallow Semi-Enclosed Basin; Part I: Field Experiment and Harmonic Analysis." (See complete entry in Section VIII.)
- Fornerino, M., and Chabert d'Hieres, G. "Study of M₂ Tidal-Currents in the English Channel Using the Physical Model at Grenoble." (See complete entry in Section VI.)
- Gatto, L. W. "Estuarine Processes and Intertidal Habitats in Grays Harbor, Washington; A Demonstration of Remote Sensing Techniques." (See complete entry in Section I.)
- Glen, N. C. 1979. "The Tidal Survey of the British Isles," <u>Symposium on Long Waves in</u> <u>Ocean</u>, June 6-8, 1978, Marine Sciences Directorate, Manuscript Report Series No. 53, Department of Fisheries and the Environment, Ottawa, Ontario, 18-22.

The survey began on the east coast of Norfolk and has proceeded in clockwise direction around the English coast. Each year, except when such events as the fuel crisis in the United Kingdom have prevented operations, a section of coastline has been carefully surveyed. The length of coast has depended on the complexity of the tidal regime in the area. The result of this work was a series of time and height differences which were, as far as possible, independent of meteorological effects.

Graff, J., and Karunaratne, A. 1980. "Accurate Reduction of Sea Level Records," <u>International Hydrographic Review</u>, 57(2):151-166.

The established procedures for the reduction of tide gage sea level records have been critically reviewed and adapted for systematic processing. Various new methods have been developed for screening and verification of digitized sea level data, and a computer-based system has been developed to process and archive these data in a uniform fashion. The system, intended for the routine processing of the class A network of tide gages around the British Isles, presents a new level of standards in the processing of coastal sea level records. References (7 items).

Haury, L. R., et al. "Tidally Generated High-Frequency Internal Wave Packets and Their Effects on Plankton in Massachusetts Bay." (See complete entry in Section VIII.)

- Hawley, N. "Intertidal Sedimentary Structures on Macrotidal Beaches." (See complete entry in Section I.)
- Hinwood, J. B., and Colman, R. S. 1978. "Use of an Echo Sounder to Map Vertical Stratification in an Estuary," <u>Managing</u> <u>the Coast, Fourth Australian Conference on</u> <u>Coastal and Ocean Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:231-236.

Ship-borne echo sounders are being used to obtain longitudinal profiles of density discontinuities in the Yarra River. The echo sounders are commercially available units operating near 200 kHz. The records obtained reveal details of the vertical structure of salinity, temperature, and silt concentration. Small sharp interfaces show up clearly while larger, more gradual gradients do not. Typical results and some limitations are presented. References (3 items).

Howarth, M. J. 1980. "Intercomparison of Current Meters in Fast Tidal Currents," Report No. 94, Institute of Oceanographic Sciences, Birkenhead, U.K. (Unpublished Manuscript).

Six Aanderaa and three vector-averaging current meters were deployed for 1 month in water 45 m deep where the M, tidal current has an amplitude of 0.8 m/s. The mean flow was less than 0.04 m/s, but there were two storm surges with currents up to 0.15 m/s. There was good agreement between the meters for tidal and surge currents and in the main for low-frequency currents, but an Aanderaa and an American Machine and Foundry, Inc., vector averaging current meter (AMF VACM) with rotors 1.5 m apart showed poor agreement for lowfrequency currents in the direction perpendicular to the tidal flow. References (17 items).

Howell, G. 1980. "Florida Coastal Data Network," <u>Proceedings, Seventeenth Coastal</u> Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, I:421-431.

The application of wave and tide data to coastal engineering problems has been demonstrated frequently by university and government research organizations. However, problems faced by practicing coastal engineers are often solved without recourse to such data, since it is frequently not available for the required location. The high cost and low reliability of long-term wave measurement is the primary factor limiting the wider application of analysis techniques requiring wave energy and wave direction parameters. In order to improve this situation, several organizations, notably the US Army Corps of Engineers Coastal Engineering Research

Center (CERC) (Peacock 1974), and the California Department of Navigation and Ocean Development (Seymour 1976), have employed advanced electronics and computer techniques to reduce the cost of wave measurement. The Florida Coastal Data Network (CDN) is a similar effort which, due to the special problems of Florida wave climate, has employed advanced instrumentation not only to reduce cost, but to provide additional capability. Like other tropical and subtropical regions, Florida's coastal environment is characterized by relatively infrequent but severe tropical storms. In many coastal engineering applications, the specification of the hurricane-associated storm surge and storm waves will be the major design criteria. The Florida CDN was created in order to provide field measurements of waves and tides year round as well as during hurricanes. References (3 items).

Huntley, D. A., and Nummedal, D. 1978. "Velocity and Stress Measurements in a Tidal Inlet," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, II:1320-1335.

Fast-response electromagnetic flowmeters were used in a marginal flood channel of an ebb tidal delta to assess the importance of wave contributions to the flood dominance of these channels. Measurements were made at a single point in the channel in both ebb and flood currents. The oscillatory motion of waves was a very significant feature of the velocity records, and its magnitude was comparable with the mean flow at all stages of the tide. This observation shows that flowmeters capable of responding accurately to wave velocities are needed to obtain accurate values of mean flow. Some earlier measurements made with slow-response flowmeters are probably unreliable. Wave contributions to the mean flow were assessed by looking at the correlation between the low frequency (>17.5 sec) oscillations of the along-channel current and the low frequency envelope of the wave velocities. Surprisingly little correlation was found for any time lag, suggesting that wave effects were not important in the mean tidal currents in the channel studied. However, close to low tide on the ebb, conditions existed which appear to have been favourable for the "wave pump" mechanism suggested by Bruun and Viggisson. Significant correlation between the wave envelope and low frequency fluctuations was observed at this time. It is therefore suggested that wave effects can be important to the mean flow in marginal channels with rapidly converging and shoaling mouths which are oriented toward the dominant incident wave direction. References (13 items).

- Kato, M. "Observation of Crustal Movements by Newly-Designed Horizontal Pendulum and Water-Tube Tiltmeters with Electromagnetic Transducers (2)--Variations in the Amplitude and Phase of Tidal Tilts Observed with a Water-Tube Tiltmeter at Kamitakara." (See complete entry in Section I.)
- Khorram, S. 1982. "Remote Sensing of Salinity in the San Francisco Bay Delta," <u>Remote Sensing of Environment</u>, 12(1):15-22.

Salinity of the San Francisco Bay Delta has been studied for the past seven decades. There is a significant gradient in salinity within this estuarine system that influences the growth and distribution of phytoplankton as well as the abundance and migration of shrimp and fish population. Several government agencies which have jurisdictions over this area are attempting to gather extensive data for effective monitoring of this estuary. Repetitive remotely sensed data acquired from Landsat may be considered by these agencies as having the potential to provide a costeffective method for gathering and processing water quality related data. In this study, Landsat multispectral scanner (MSS) data and color and color infrared photographs acquired from a U-2 aircraft were combined with surface measurements for salinity mapping of the San Francisco Bay Delta. The salinity measurements and U-2 photography were obtained simultaneously and coincident with Landsat overpass. A regression model was developed between the surface truth data and Landsat digital data for 29 preselected sample sites and was then extended to the entire study area. The results included a salinity map of the study area and the statistical summaries. The results were in general agreement with the reported distribution of salinity values in the literature for the same time of the year. Based on the results and the associated analyses of natural color and color infrared photographs and Landsat color composite imagery, it was concluded that: (a) it was virtually impossible, at least within this test site, to establish any quantitative judgment regarding the salinity values by visual interpretation of the imagery; and (b) the present study constitutes the first effort to successfully use Landsat digital data for salinity mapping, by means of digital processing, for this geographic area. References (32 items).

Kjerfve, B. 1982. "Calibration of Estuarine Current Crosses," <u>Estuarine, Coastal</u> <u>and Shelf Science</u>, 15(5):553-559.

Tethered current crosses are simple, reliable tools in making measurements of estuarine currents in the absence of surface waves. The standard error of the estimate artitita artistia artista statia artista artista

of current speed is less than 5 cm sec⁻¹ for the particular crosses and weights used in a calibration experiment. The useful velocity range of these current crosses was 8-147 cm sec⁻¹, corresponding to a measured angle, α , from 2° to 30°. Regression of the independently measured current speed on $(\tan \alpha)^{\frac{1}{2}}$ yielded coefficients of determination greater than 0.94. indicating that the drag coefficient is not a function of current speed. However, the calculated drag coefficients varied widely from 0.66 to 2.55, depending on the particular combination of cross and weight, varying drastically from the commonly assumed drag coefficient value of 1.12. Thus, in using current crosses, it is imperative to calibrate each cross against a current meter reading to determine an appropriate value for the drag coefficient for a particular current cross and weight. . References (6 items).

Knight, D. W., et al. 1980. "The Measurement of Vertical Turbulent Exchange in Tidal Flow," <u>Proceedings, Second International Symposium on Stratified Flows</u>, The Norwegian Institute of Technology, Trondheim, 24-27 June 1980, Torkild Carstens and Thomas McClimans, ed., 2:722-730.

Mathematical models are useful tools for predicting the effects that proposed engineering works will have on the movement of water, solutes, and suspended solids in estuaries. The predictive capabilities of these models are, however, strongly influenced by the representation of the principal physical processes being modeled. In particular, any numerical model concerned with the vertical structure of the flow depends heavily on the accuracy of its representation of the vertical turbulent exchange of mass and momentum. The objective of the research described in this paper was to measure the turbulent fluctuations in velocity in weakly stratified tidal flows in order to evaluate the vertical Reynolds stresses. The research was a planned extension of earlier field observations made in the presence of a marked halocline (Odd and Rodger 1978). Field measurements were considered more rewarding than laboratory experiments, which can suffer from scale effects, despite difficulties resulting from a lack of control over the conditions being measured. One of the objectives of the new work was to test the semi-empirical functions proposed by Odd and Rodger in cases of weakly stratified flows. References (3 items).

Knowles, C. E. 1981. "Estimation of Surface Gravity Waves from Subsurface Pressure Records for Estuarine Basins," Working Paper 81-6, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Paleigh.

This report presents two basic ways of measuring surface gravity waves in coastal and estuarine waters: one uses a surface wave profiler (e.g., continuous wire or step resistance gages) that produces a time series record that should represent the actual surface wave profile, while the other (a sensitive, subsurface pressure transducer) produces a time series of pressure fluctuations proportional to the elevation of the surface waves. According to small-amplitude theory, the surface gravity wave energy spectrum can be estimated from a subsurface pressure fluctuation spectrum by applying a factor K that compensates for the attenuation of surface wave amplitude as the depth below the water surface and the wave frequency increase. There are a number of linear and nonlinear environmental factors, however, that cause K to be invalid over most of the spectrum's frequency range. Numerous attempts have been made to empirically derive a valid correction factor n that could be applied to K to give a better estimate of the surface spectrum. This report discusses some of the reasons why the empirical factors vary so greatly and recommends Grace's (1978) equation for n as a function of the nondimensional frequency parameter kh (where $k = 2\pi/L$ is the local wave number, h the local depth, and L the wavelength) specifically for use in an estuarine environment. References (11 items).

- Knowles, C. E. "Wind-Wave Climatology and Wind-Tides for Fort Raleigh Wave-Gauge Site, 1979." (See complete entry in Section VII1.)
- Lees, B. J. "Observations of Tidal and Residual Currents in the Sizewell-Dunwich Area, East Anglia, U.K." (See complete entry in Section VIII.)
- Le Fèvre, J., et al. "Remote Sensing Observations of Biological Material by LANDSAT along a Tidal Thermal Front and Their Relevancy to the Available Field Data." (See complete entry in Section VIII.)
- Ludwick, J. C., and Johnson, P. B. 1977.
 "Hydraulic Sensor Instrumentation in a Shore Face in a Tidal-Nontidal Coastal Convergence Zone, Cape Henry, Virginia," <u>Hydraulic Sensor Instrumentation of a</u> <u>Shore Face in a Tidal Current Convergence</u> <u>Zone-Cape Henry, Virginia, Technical</u> Report No. 25, Institute of Oceanography, Old Dominion University, Norfolk, Virginia, Part I:1-106.

The question as to whether coastal currents are competent to erode unconsolidated and semiconsolidated sediments of sand size on the inner continental shelf is a subject of much ongoing research. The present investigation relates to this question. Instrumentation and data analysis procedures are presented. The basic data-gathering technique planned for use in this study employs a rigid instrument platform installed on the sea floor. An armored cable is used to transmit sampled data to recording instruments on shore. The advantages and disadvantages of this system are compared in the report to the more conventional techniques of using surface vessels, radio-link buoys, and selfcontained recording and storage within the sensor housing for periodic retrieval. The design, operation, and installation of the measurement system are discussed in detail. This includes the design, fabrication, and deployment of the sea floor platform, the selection and laying of the armored cable, and the design and theory of operation of the data acquisition system. The data acquisition system controller, a PDP-8E minicomputer, is discussed, and the documentation for a complete software package is provided. The data analysis methodology which uses the discrete Fourier transform (DFT) and the fast Fourier transform (FFT) to find the power spectral density is given along with an example of its application. References (21 items).

- Milliman, J. D., et al. "Tidal Phase Control of Sediment Discharge from the Yangtze River." (See complete entry in Section II.)
- Mills, D. A., Colman, R. S., and Dandy, G. C. 1978. "Water Movement in a Complex Estuarine Embayment--A Methodology for Data Collection and Analysis," <u>Managing the Coast, Fourth Australian Conference on Coastal and Ocean Engineering</u>, Adelaide, 8-10 November 1978, The Institution of Engineers, Australia, National Conference Publication No. 78/11:153-159.

The environmental assessment of Hobsons Bay required a detailed knowledge of water circulation and its response to tidal, wind, and riverine influences, each of which can be of comparable importance. In order to meet this requirement, an integrated program of data collection and analysis was developed and put into effect. This paper discusses some of the complementary monitoring techniques and methods of analysis which were employed. The program encompasses many variables, and its applicability may not be confined to only one location. References (4 items).

- Nece, R. E. "Planform Effects on Tidal Flushing of Marinas." (See complete entry in Section VI.)
- Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in

Marinas." (See complete entry in Section VI.)

- Novak, P., and Čábelka, J. <u>Models in</u> <u>Hydraulic Engineering; Physical Principles</u> <u>and Design Applications</u>. (See complete entry in Section VI.)
- Onishi, S., and Nishimura, T. "Study on Vortex Current in Strait with Remote-Sensing." (See complete entry in Section VIII.)
- Pickett, E. B., and Greer, H. C. "Los Angeles Harbor and Long Beach Harbor: Prototype Data Acquisition and Coservations." (See complete entry in Section VIII.)
- Prandle, D., et al. "The Use of Array Processors for Numerical Modelling of Tidal Estuary Dynamics." (See complete entry in Section VI.)
- Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)
- Rives, S. R., and Pritchard, D. W. "Adaptation of J. R. Hunter's One-Dimensional Model to the Chesapeake and Delaware Canal System." (See complete entry in Section VI.)
- Sharp, J. J. <u>Hydraulic Modelling</u>. (See complete entry in Section VI.)
- Shelley, P. E. "Sediment Measurement in Estuarine and Coastal Areas." (See complete entry in Section II.)
- Stacey, M. W. "The Interaction of Tides with the Sill of a Tidally Energetic Inlet." (See complete entry in Section I.)
- Stigebrandt, A. "Some Aspects of Tidal Interaction with Fjord Constrictions." (See complete entry in Section I.)
- Streif, H. "A New Method for the Representation of Sedimentary Sequences in Coastal Regions." (See complete entry in Section II.)
- Sündermann, J., and Holz, K.-P. <u>Mathemati-</u> <u>cal Modelling of Estuarine Physics, Lec-</u> <u>ture Notes on Coastal and Estuarine</u> <u>Studies</u>. (See complete entry in Section I.)

- Swakon, E. A., Jr., and Wang, J. D. "Modeling of Tide and Wind Induced Flow in South Biscayne Bay and Card Sound." (See complete entry in Section VI.)
- Thompson, R. O. R. Y. 1983. "Low-Pass Filters to Suppress Inertial and Tidal

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Frequencies," Journal of Physical Oceanography, 13(6):1077-1083.

A systematic way is given to design digital filters which allow clear separation of signals with periods of a few days from noise of higher frequency, particularly tidal and inertial. Several examples are given which pass little high-frequency power and none at the principal tidal frequencies. The Lanczos-cosine filter passes too much energy near diurnal frequencies; the Godin filter is better but not optimal. A longer filter is recommended, with flat low-frequency response, a sharp cutoff, and very low noise. For current meter records containing inertial motions, it appears desirable to design a filter which specifically suppresses the local inertial frequency. References (6 items).

van de Ree, W. J., Voogt, J., and Leendertse, J. J. 1978. "A Tidal Survey for a Model of an Offshore Area," <u>Proceedings,</u> <u>Sixteenth Coastal Engineering Conference,</u> <u>August 27-September 3, 1978, Hamburg, Ger-</u> many, ASCE, III:2656-2670.

In support of engineering and environmental investigations for the construction of a storm surge tarrier in the southwestern part of The Netherlands, the Randdelta II model was used in conducting this survey. An extensive field survey was made of tides and currents to establish the boundary conditions and to adjust and verify the model. The data from the water level recording stations were analyzed and the instrumentation for current and pressure recording is presented. In view of the importance of the pressure data obtained at the boundary of the model area for the studies, a detailed analysis of these data is given in this paper. References (3 items).

Wang, Y.-H. 1980. "Satellite Applications on a Coastal Inlet Stability Study," <u>Proceedings, Seventeenth Coastal Engineering</u> <u>Conference, March 23-28, 1980, Sydney,</u> <u>Australia</u>, ASCE, III:2581-2594.

It is known that longshore drift of alluvial material occurs along sandy barrier islands. Inlets between these barrier islands intercept the normal littoral drift, resulting in a net loss of sand from the beaches. During a flood tide, sand is brought into the inlet and part of it is retained to form the inner bar; during ebb cycle, part of the sand is jetted out into the ocean to form an outer bar. The reversing flows of flood and ebb cycles may also cause deposition or scouring on the bottom of inlet channels. There

are two sets of parameters pertinent to the behavior of inlets. The first set deals with the changes in the dynamic bottom configuration (i.e., the movement of inner and outer bars, the choking or scouring of the inlet channel). The second set of parameters regards the driving forces of the coastal system (i.e., wave climate, tide, wind, and currents). Understanding the interrelationship of these two sets of parameters leads to the solution of stabilizing the inlet. The time-sequential dynamic interrelationships and natural tendencies of inlets are well portrayed on available Landsat imageries. Mapping the sandbars and their movements is traditionally done by a sounding boat and survey team. The derived point and line information is then used to produce the contour map of the bottom. Extensive interpolations are needed because many details between the points and lines are missing. The operation is expensive and the procedures are time consuming. Techniques using remote sensing can be used to monitor the changes that take place, reducing costs and increasing efficiency. Even though standard procedures have not yet been established, the satellite sensi 3 of bottom features has progressed considerably in recent years. Sherman (1975), Middleton and Barber (1976), Hubbard (1977), and Lyzenga and Thomson (1978) all demonstrated that it is possible to correlate the radiance values of multispectral images, such as Landsat imagery, with the depth-related information in shallow water. The present study is one more example of such an effort. References (6 items).

- Weisman, R. N., Collins, A. G., and Parks, J. M. "Maintaining Tidal Inlet Channels by Fluidization." (See complete entry in Section VI.)
- Welch, J. M., and Parker, B. B. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina." (See complete entry in Section I.)
- Wells, J. T., Coleman, J. M., and Wiseman, W. J., Jr. "Suspension and Transportation of Fluid Mud by Solitary-Like Waves." (See complete entry in Section II.)
- Williamson, A. N. "Movement of Suspended Particles and Solute Concentrations with Inflow and Tidal Action." (See complete entry in Section VIII.)
- Yarbro, L. A., et al. "A Sediment Budget for the Choptank River Estuary in Maryland, U.S.A." (See complete entry in Section II.)

SECTION VIII. BASIC PHYSICAL DATA

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Tide tables, datum planes, tidal current charts, and the results, tabulation, and discussion of basic physical data obtained from field surveys, investigations, and data collection programs. Physical features of ports, harbors, estuaries, etc., when related to tidal hydraulic problems.

- Abbott, M. B., Schrøder, H., and Warren, I. R. "Modelling of the Salinity Intrusion in the Sound Between Denmark and Sweden." (See complete entry in Section VI.)
- Abraham, G. "On Internally Generated Estuarine Turbulence." (See complete entry in Section I.)
- Ambrose, R. B., Jr., and Roesch, S. E. "Dynamic Estuary Model Performance." (See complete entry in Section VI.)
- Amin, A., and Graff, J. 1980. "Some Notes on Simplifying the HSWC Method of Tidal Analysis," <u>International Hydrographic</u> <u>Review</u>, 57(2):167-173.

The method of least squares, as used in the Harmonic Shallow Water Correction (HSWC) technique by Amin (1977), is adapted under restrictions of fixed data length and specified constituents, imposed by Doodson's (1957) method. It is shown that the technique provides a quick and simple method of computing HSWC coefficients. Also some simple graphic explanation of the criteria for selection of data length, essential to resolve constituents having given speeds, is provided. References (3 items).

- Anwar, H. O. "Turbulence Measurements in Stratified and Well-Mixed Estuarine Flows." (See complete entry in Section I.)
- Anwar, H. O., and Weller, J. A. "An Experimental Study of the Structure of a Freshwater-Saltwater Interfacial Mixing." (See complete entry in Section III.)
- Aston, S. R., and Stanners, D. D. "The Transport to and Deposition of Americium in Intertidal Sediments of the Ravenglass Estuary and Its Relationship to Plutonium." (See complete entry in Section IV.)
- Baliga, B. R., and Hudspeth, R. T. "Evaluation of Sand Waves in an Estuary." (See complete entry in Section IV.)
- Basu, A. N. "Composite Mathematical Model of Saptamukhi River System Including Outfall Channels for Studying the Effect of Closure." (See complete entry in Section VI.)
- Battisti, D. S., and Clarke, A. J. "A Simple Method for Estimating Barotropic Tidal Currents on Continental Margins with Specific Application to the M₂ Tide off the Atlantic and Pacific Coasts of the United States." (See complete entry in Section I.)

- Battisti, D. S., and Clarke, A. J. "Estimation of Nearshore Tidal Currents on Nonsmooth Continental Shelves." (See complete entry in Section I.)
- Benque, J. P., et al. "New Method for Tidal Current Computation." (See complete entry in Section I.)
- Bohlen, W. F. 1978. "Factors Governing the Distribution of Dredge-Resuspended Sediments," <u>Proceedings, Sixteenth Coastal</u> <u>Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany</u>, ASCE, II:2001-2019.

Field observations are analyzed to determine the primary factors governing the distribution of sediments suspended by clamshell bucket dredge operations. These data show the plumes produced under typical estuarine conditions to be relatively small-scale features having maximum longstream dimensions of approximately 700 m. Plumes can be considered to consist of three contiguous zones: an initial mixing zone, a secondary zone, and a final mixing zone. The initial mixing zone immediately adjacent to the dredge has dimensions governed by bucket-induced mixing and suspended material concentrations determined by dredge efficiency. Observations indicate that dimensions can be reasonably estimated using wake theory and that efficiencies result in the introduction of 2-4 percent of the sediment mass contained in each bucket load. Resultant concentrations range between 200 and 400 mg/t. Progressing downstream into the secondary mixing zone, concentrations decay rapidly due primarily to gravitational settling. The observed decay rates indicate an average settling velocity of 4.7 cm/sec well in excess of values based on the grain size characteristics of the dredged sediment. The behavior suggests significant particle agglomeration within this area. At the downstream limit of this zone, distributions become essentially exponential in character and remain so through the final mixing zone. In this area concentrations progressively approach the upstream background levels and variations are governed primarily by diffusion. In each of these zones the observed distributions appear amenable to relatively straightforward modeling. References (13 items).

Bohlen, W. F., and Marine Sciences Department, University of Connecticut. "A Comparison Between Dredge Induced Sediment Resuspension and That Produced by Natural Storm Events." (See complete entry in Section II.)

Bowman, M. J., et al. "Shelf Fronts and Tidal Stirring in Greater Cook Strait, New Section VIII. Basic Physical Data

Zealand." (See complete entry in Section VI.)

- Boyden, C. R., Aston, S. R., and Thornton, I. "Tidal and Seasonal Variations of Trace Elements in Two Cornish Estuaries." (See complete entry in Section II.)
- Brown, W. D., and Arellano, E. "The Application of a Segmented Tidal Mixing Model to the Great Bay Estuary, N.H." (See complete entry in Section VI.)
- Brown, W. S. "A Comparison of Georges Bank, Gulf of Maine and New England Shelf Tidal Dynamics." (See complete entry in Section I.)
- Buchak, E. M., and Edinger, J. E. "User Guide for CE-QUAL-ELV2: A Longitudinal-Vertical, Time-Varying Estuarine Water Quality Model." (See complete entry in Section VI.)
- Byrne, R. J., Gammisch, R. A., and Thomas, G. R. "Tidal Prism-Inlet Area Relations for Small Tidal Inlets." (See complete entry in Section I.)
- Callender, E., and Hammond, D. E. "Nutrient Exchange Across the Sediment-Water Interface in the Potomac River Estuary." (See complete entry in Section II.)
- Carton, J. A. "The Variation with Frequency of the Long-Period Tides." (See complete entry in Section I.)
- Chelton, D. B., Jr. "Low Frequency Sea Level Variability Along the West Coast of North America." (See complete entry in Section VI.)
- Christiansen, H., and Siefert, W. 1978. "Storm Surge Prediction by Combined Wind and Tide Data," <u>Proceedings, Sixteenth</u> <u>Coastal Engineering Conference, August 27-</u> <u>September 3, 1978, Hamburg, Germany, ASCE,</u> 1:965-985.

The authors suggest a storm tide forecasting method that allows high-water predictions for a coastline 3 to 4 hours in advance with an accuracy of ±30 min in time and ± 20 to 30 cm in height. It is based on actual (not on predicted) data, i.e., exact wind velocity and direction data from a reference station and tide data from two gages. The method was developed by analyzing storm surge curves and wind data of those 50 storm tides that occurred since 1965 in the German Bight. Another 50 storm tides back to the year of 1930 were taken into account, though without exact wind data. The method was proved at all storm tides since 1965 and applied with good success to the events during fall and winter 1977/78 for the

coastline off Cuxhaven. Reference
(1 item).

- <u>Coastal Sediments '77, Fifth Symposium of</u> <u>the Waterway, Port, Coastal and Ocean</u> <u>Division of ASCE</u>. (See complete entry in Section II.)
- Connell, D. W., et al. "Effects of a Barrage on Flushing and Water Quality in the Fitzroy River Estuary, Queensland." (See complete entry in Section V.)
- Crout, R. L., and Murray, S. P. 1978. "Shelf and Coastal Boundary Layer Currents, Miskito Bank of Nicaragua," <u>Pro-</u> <u>ceedings, Sixteenth Coastal Engineering</u> <u>Conference, August 27-September 3, 1978,</u> <u>Hamburg, Germany, ASCE, III:2715-2729.</u>

A 2-year study of the currents and salinity (density) fields has been conducted on the broad, shallow Miskito Bank of the eastern coast of Nicaragua. Observations across the bank show a southward-flowing low-salinity, seaward-thinning wedge of highly turbid water trapped against the coast within the first 25-40 km offshore. This so-called coastal boundary layer grades seaward into a northward-flowing shelf current of open-sea salinity that is essentially free of suspended sediment. Detailed transects across the coastal boundary layer show the salinity (density) structure to be closely coupled to the high-speed jet of south-flowing water. Velocity and density measurements from the coastal boundary layer allow quantitative evaluation of each of the terms in the momentum balance equation and of the effect that each has on the circulation dynamics. The Coriolis force, the baroclinic and barotropic pressure gradient forces, and the internal friction force make important contributions to the onoffshore force balance. In the longshore balance, only the baroclinic pressure gradient force was found to be insignificant. A marked difference in this balance of forces was observed in the upper and lower layers of the water column in both the alongshore and on-offshore balances. References (12 items).

Daifuku, P. R., and Beardsley, R. C. 1983. "The K₁ Tide on the Continental Shelf from Nova Scotia to Cape Hatteras," <u>Journal of</u> <u>Physical Oceanography</u>, 13(1):3-17.

A description is given of the K_1 tide over the northeast continental shelf off North America from Nova Scotia to Cape Hatteras. Analyzed pressure data obtained from W. Brown and J. Irish (University of New Hampshire) have been used to draw up the K_1 cotidal map and existing current data have been analyzed to give the associated velocity map. Offshore, there is a sweep of the tide from north to south, in general agreement with what is known of

the oceanic K, tide in the North Atlantic. On the shelf, there is a trapping of phase lines to the coast, creating, in particular, a virtual amphidrome south of Cape Cod. Maximum amplitudes of around 15 cm are found in the Gulf of Maine, lowest around 7 cm south of Cape Cod. The K, currents are generally barotropic and current ellipses are aligned with the local topography. Maximum currents of about 10 cm s^{-1} are found south of Cape Cod. A simple model for the K, pressure field is developed using the free and forced inviscid barotropic waves on a twodimensional shelf. The theoretical solutions are fitted to the K, pressure data using a least-squares method. The model results confirm that the K_1 tide is composed of both a Kelvin wave and a shelf wave, with the Kelvin wave dominating the pressure field, and the shelf wave dominating the current field. The two free waves account for 99 percent of the variance of the difference of the observed pressures and the calculated forced wave. but unfortunately some of the observed features are not accurately reproduced. Possible model improvements should include the addition of bottom friction and longshore topographic variations (especially the changes in shelf geometry associated with the Gulf of Maine). References (20 items).

- Dandy, G. C., Mills, D. A., and Hinwood, J. B. "Water Movement Studies Required for Port Planning." (See complete entry in Section I.)
- Davesne, M., and Graff, M. "Mathematical and Physical Models for Navigation in Approach Channels and Harbour Entrances." (See complete entry in Section V.)
- Dennis, W. A., Lanan, G. A., and Dalrymple, R. A. "Case Studies of Delaware's Tidal Inlets: Roosevelt and Indian River Inlets." (See complete entry in Section VI.)
- Diamante, J. M., et al. "Tidal and Geodetic Observations for the SEASAT Altimeter Calibration Experiment." (See complete entry in Section VII.)
- Drapeau, G., and Fortin, G. "Tidal Sedimentation in Gros-Cacouna Harbor." (See complete entry in Section II.)
- Druery, B. M. "Estuarine Response to Dredging in the Tweed River, Australia." (See complete entry in Section V.)
- Druery, B. M., and Nielsen, A. F. "Mechanisms Operating at a Jettied River Entrance." (See complete entry in Section II.)

Durham, D. L. 1977. "Los Angeles Harbor and Long Beach Harbor: Analyses of Prototype Wave and Ship Motion Data," <u>Ports</u> <u>'77, 4th Annual Symposium of the Waterway,</u> <u>Port, Coastal and Ocean Division of ASCE,</u> Long Beach, Calif., March 9-11, 1977, I:27-46.

Procedures and results of analyses of prototype ship motion and wave data collected in Los Angeles and Long Beach Harbors during a 13-month data acquisition program are discussed. Prototype data were required to identify wave and tidal conditions and mooring problems in the existing harbors and for use in various physical and numerical modeling studies of proposed harbor expansions. Observations of ship characteristics, movement, and mooring line configurations were parametrically studied for various statistical information regarding ship mooring and movement. A numerical analysis of moored ship response to wave excitation was conducted to define the periods or frequency ranges of maximum surge response for specific ships and mooring configurations in the East Channel of Los Angeles Harbor. Estimates of wave energy for wave periods ranging from 15 sec to 30 min were calculated by spectral analyses of prototype wave data. Time-dependent spectral estimates were calculated for 10 time histories during which concurrences of medium and/or heavy ship movement occurred in the East Channel. From such spectral techniques. frequency bands containing significant energy levels were identified for 13 wave gage locations in the harbors. In addition to identifying characteristic frequency bands of wave energy at each gage and the frequency for maximum wave energy in each characteristic band, time variations of energy levels within each frequency band and the distribution of swell throughout the harbors were estimated. Observations of significant ship motion in the East Channel of Los Angeles Harbor were correlated with time variations of wave energy in characteristic frequency bands. Subjective analyses of analog wave records were conducted to provide indications of the frequency of occurrence and wave-height distributions for characteristic harbor oscillations and swell. References (10 items).

- Dyer, K. R. "Mixing Caused by Lateral Internal Seiching Within a Partially Mixed Estuary." (See complete entry in Section III.)
- Dyer, K. R. "The Mixing Processes in a Partially Mixed Estuary: Southampton Water." (See complete entry in Section VII.)
- Ebbesmeyer, C. C., and Barnes, C. A. 1980. "Control of a Fjord Basin's Dynamics by Tidal Mixing in Embracing Sill

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Zones," <u>Estuarine and Coastal Marine Science</u>, 11(3):311-330.

A common configuration in fjords is a basin embraced by sills. This paper addresses the dynamics of a large fjord basin lying between comparatively deep sills where tidal mixing is vigorous: Puget Sound's Main Basin (~10 km × 90 km \times 0.3 km) between 44 m (landward) and 66 m (seaward) depth sills. Tidal action over the sills causes a vigorous two-layer circulation in the basin where no net motion occurs near the average depth of the embracing sills. On the flood tide lowerlayer water is upwelled at the landward sill and upper-layer water is downwelled at the seaward sill. The resultant circulation in the basin is guite active at all depths throughout the year. Currents computed from differences in dissolved oxygen between hydrographic stations compare favorably with measured currents. Based on differences between the ends of the basin. the bulk residence time in the lower layer is about 3 weeks -- a short time for a large fjord basin. Experiments in a hydraulic model demonstrate the marked sensitivity of basin circulation to tidal action in the sill zones: transport in the upper layer is directly proportional to the tidal prism inland of the landward sill zone, and there is an exponential type of response to abrupt changes in fresh water flowing into the seaward sill zone (approximately 60 percent of equilibrium attained in 2 months). The rapid response causes the basin's lower-layer water properties to follow closely both the primary and secondary features of the seasonal cycles of local air temperature and runoff. References (35 items).

- Egan, J. T., and Jones, H. L. "Tidal Measurement, Analysis, and Prediction." (See complete entry in Section VII.)
- Elliott, A. J. "Observations of the Meteorologically Induced Circulation in the Potomac Estuary." (See complete entry in Section I.)
- Elsinger, R. J., and Moore, W. D. "226Ra and ²²⁸Ra in the Mixing Zones of the Pee Dee River-Winyah Bay, Yangtze River and Delaware Bay Estuaries." (See complete entry in Section IV.)
- Escoffier, F. F. "Hydraulics and Stability of Tidal Inlets." (See complete entry in Section I.)
- Essen, H.-H., Gurgel, K.-W., and Schirmer, F. "Tidal and Wind-Driven Parts of Surface Currents, as Measured by Radar." (See complete entry in Section I.)
- Evans, J. J., and Pugh, D. T. "Analysing Clipped Sea-Level Records for Harmonic

Tidal Constituents." (See complete entry in Section I.)

- Fandry, C. B. "Development of a Numerical Model of Tidal and Wind-Driven Circulation in Bass Strait." (See complete entry in Section VI.)
- Filloux, J. H., and Snyder, R. L. 1979. "A Study of Tides, Setup and Bottom Friction in a Shallow Semi-Enclosed Basin; Part I: Field Experiment and Harmonic Analysis," <u>Journal of Physical Oceanography</u>, 9(1):158-169.

The paper describes three month-long field experiments in the Bight of Abaco, Bahamas, employing 15 tide gages and four weather stations distributed throughout the bight. The amplitude and phase of five principal tidal constituents and the M4 and M6 overtides are estimated for all stations and errors computed from a generalization/hybridization of the algorithm of Munk and Hasselman for tidal doublets. The resulting tidal distributions constitute an unusually complete data base against which to optimize the numerical models reported in Parts II and III of the series. The relatively small amplitude of the overtide constituents are locally generated. Residual fluctuations are highly coherent with the wind field. Significant differential setup effects are apparent. References (6 items).

- Fornerino, M., and Chabert d'Hieres, G. "Study of M_2 Tidal-Currents in the English Channel Using the Physical Model at Grenoble." (See complete entry in Section VI.)
- Franco, A. d. S. "On the Shallow-Water Harmonic Tidal Constituents." (See complete entry in Section I.)
- Freeland, H. J. "Tidal Analysis and the Energy Budget of a Deep Stratified Inlet." (See complete entry in Section I.)
- Funke, E. R., and Crookshank, N. L. "A Hybrid Model of the St. Lawrence River Estuary." (See complete entry in Section VI.)
- Garofalo, D. "The Influence of Wetland Vegetation on Tidal Stream Channel Migration and Morphology." (See complete entry in Section III.)
- George, K. J. "Application of the Species Concordance Method to the Tidal Currents in the Loire." (See complete entry in Section I.)
- George, K. J., and Simon, B. "The Species Concordance Method of Tide Prediction in Estuaries." (See complete entry in Section I.)

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- Gibbs, R. J. "Currents on the Shelf of North-eastern South America." (See complete entry in Section I.)
- Glen, N. C. "The Tidal Survey of the British Isles." (See complete entry in Section VII.)
- Göhren, H., and Christiansen, H. "Ecological Aspects of a Deep Water Port in the Tidal Flats off the German Coast (Scharhörn)." (See complete entry in Section V.)
- Gopalakrishnan, T. C., and Machemehl, J. L. "Boundary Conditions for Analysis of Flow in Tidal Inlets." (See complete entry in Section I.)
- Grabemann, I., Krause, G., and Siedler, G. "Long-Time Changes of Salinity in the Lower Weser." (See complete entry in Section III.)
- Graff, J., and Karunaratne, A. "Accurate Reduction of Sea Level Records." (See complete entry in Section VII.)
- Graham, D. S., Hill, J. M., and Christensen, B. A. "Verification of Estuarine Model for Apalachicola Bay, Florida." (See complete entry in Section VI.)
- Granat, M. A., and Gulbrandsen, L. F. "Baltimore Harbor and Channels Deepening Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Harleman, D. R. F. "Diffusion and Dispersion Processes." (See complete entry in Section VI.)
- Hartnoll, R. G., and Hawkins, S. J. 1982. "The Emersion Curve in Semidiurnal Tidal Regimes," <u>Estuarine, Coastal and Shelf</u> <u>Science</u>, 15(4):365-371.

Emersion curves are presented for eight locations in Britain experiencing semidiurnal tides. Curves were produced by computer analysis of reduced hourly tide gage observations over a one-year period, and were not based upon predicted times of high water and low water as mostly used hitherto. The locations differ in tidal constants and the form of the tide curve. The shape of the emersion curve varies markedly between locations, and for each curve the slope, which indicates the rate of change of environmental conditions, is analyzed with respect to height at the tide gage. Critical tide levels, where conditions change particularly rapidly, are obvious on some curves but less evident on others. References (10 items).

Haury, L. R., et al. 1983. "Tidally Generated High-Frequency Internal Wave Packets and Their Effects on Plankton in Massachusetts Bay," Journal of Marine Research, 41(1):65-112.

Tidally generated internal wave packets occur twice a day during late summer in Massachusetts bay, U.S.A. The packets are formed at Stellwagen Bank and propagate into the bay at about 60 cm sec⁻¹; they dissipate in shallow water at the western side of the bay. The dominant waves in packets have lengths of about 300 m, periods of between 8 and 10 min, and amplitudes of up to 30 m. Overturning of the waves has been observed acoustically over Stellwagen Bank, in the deep (80 m) waters in the center of the bay, and during dissipation in shallow water. The effects of the internal waves on the distribution of plankton were investigated in August 1977 using an instrument package (Longhurst-Hardy Plankton Recorder, in situ fluorometer, conductivity, temperature, depth (CTD)) towed either at a constant depth or following an isotherm through wave packets. Phytoplankton and zooplankton appear to be carried passively up and down by the internal waves; the data were insufficient to resolve any active response by zooplankton to vertical displacements by the waves. Vertical distributions of the plankton were altered by overturning of waves and subsequent mixing. Patterns of horizontal distributions of plankton determined by constant-depth tows were dominated by the effects of internal wave vertical displacements. Isothermfollowing tows removed much of the variability due to wave displacement, but problems of following rapidly moving isotherms introduced considerable smaller-scale variability. Changes in zooplankton abundance on tow length scales (600-1200 m) were not correlated with temperature, salinity, or density; some significant correlations with chlorophyll fluorescence occurred when internal wave activity was present. Twice a day for several hours or more, phytoplankton were vertically displaced by as much as 30 m, with a period of about 10 min. The light level plant cells experienced varied from 0.1 to 26 percent of the ambient surface illumination. This rapid change in light should alter fluorescence yields of plant cells and affect continuous in situ measurements of chlorophyll fluorescence. The timing of internal wave packets varies with the semidiurnal tidal cycle and therefore interacts with the day-night cycle to significantly alter the light regime experienced by plant cells over a 2-week period. This could affect the primary productivity of the bay in the area affected by internal wave packets. The sporadic occurrence of internal wave overturning and mixing events in the deep waters of the bay could enhance primary production by increasing nutrient input to

the mixed layer. This effect should be greatly enhanced in the shallow waters where the internal waves dissipate. Comparison of acoustic and plankton recorder data showed that much of the intense acoustic backscattering seen in highamplitude (10-20 m) internal waves is due to physical structure and processes, and not to the presence of zooplankton. References (60 items).

- Hawley, N. "Intertidal Sedimentary Structures on Macrotidal Beaches." (See complete entry in Section I.)
- Hayes, M. O., Kana, T. W., and Barwis, J. H. 1980. "Soft Designs for Coastal Protection at Seabrook Island, S.C.," <u>Proceedings, Seventeenth Coastal Engineering Conference, March 23-28, 1980, Sydney, Australia, ASCE, 1:897-912.</u>

To gain a better understanding of the cycles of shoreline changes on Seabrook Island, South Carolina, and advise a private developer on how to deal with localized erosion problems, a detailed field survey and historical study were completed. The data base included historical charts dating from 1661, vertical aerial photographs from 1939, field surveys of beach profiles and nearshore bathymetry over a 6-month period, and sediment cores through the entire Holocene section. Seabrook Island, less than 6 km in length, is bounded by tidal inlets with extensive seaward shoals. With a 2-m tidal range for the area, changing exposure and orientation of the shoals over time have had a profound effect on the adjacent shoreline of Seabrook Island. Historical evidence points to the importance of offshore shoals which act as natural breakwaters and sediment storage systems. At various times in recent history, these shoals have supplied sediment to Seabrook beaches by means of bypassing mechanisms around tidal inlets. On the other hand, migration of shoals has allowed excess wave energy to strike portions of the shore causing local erosion. Along a portion of the shoreline, shortterm erosion is jeopardizing the development. Based on the present study, a set of "soft" engineering designs was proposed which attempt to manipulate offshore sand bodies in a way that will be beneficial to the development and preserve the inherent beauty of the shoreline. Remedial measures recommended for the developer included dredging new inlet channels and construction of a breakwater in the position of a former protective shoal. References (7 items).

Hayter, E. J., and Mehta, A. J. "Verification of Changes in Flow Regime Due to Dike Breakthrough Closure." (See complete entry in Section VI.)

- Heaps, N. S. "Three-Dimensional Modelling of the Irish Sea." (See complete entry in Section VI.)
- Heaps, N. S., and Jones, J. E. "Recent Storm Surges in the Irish Sea." (See complete entry in Section VI.)
- Heathershaw, A. D., Carr, A. P., and Blackley, M. W. L. "Swansea Bay (SKER) Project, Topic Report 8; Coastal Erosion and Nearshore Sedimentation Processes." (See complete entry in Section II.)
- Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations and Their Response to Meteorological Conditions." (See complete entry in Section I.)
- Heathershaw, A. D., and Hammond, F. D. C. "Swansea Bay (SKER) Project, Topic Report 6; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)
- Heathershaw, A. D., and Lees, B. J. "Sizewell-Dunwich .anks Field Study, Topic Report 4; Tidal Currents: Observed Tidal and Residual Circulations." (See complete entry in Section I.)
- Helwick, S. J., and Bryant, W. R. "Geology and Geotechnical Characteristics of Sediments in East Bay Area, Mississippi Delta." (See complete entry in Section II.)
- Hickel, W. "The Influence of Elbe River Water on the Wadden Sea of Sylt (German Bight, North Sea)." (See complete entry in Section III.)
- Higgs, K., Treloar, P. D., and Lawson, N. V. "Comparison of Results from Physical and Mathematical Tidal Flow Models with Prototype Data in Botany Bay." (See complete entry in Section V.)
- Hinrichs, H. "Coastal and Catastrophe Protection in the Area of the German Bay." (See complete entry in Section V.)
- Hinwood, J. B. "Large Scale Turbulence in Tidal Currents." (See complete entry in Section I.)
- Hinwood, J. B., and Colman, R. S. "Use of an Echo Sounder to Map Vertical Stratification in an Estuary." (See complete entry in Section VII.)
- Hodgson, R. T., Pettibone, B., and Sullivan, S. M. "Siltation Study of Humboldt Bay Marina, California." (See complete entry in Section II.)

Holloway, P. E. 1983. "Internal Tides on the Australian North-West Shelf: A Preliminary Investigation," <u>Journal of Physical Oceanography</u>, 13(8):1357-1370.

An analysis of current meter data and cross-shelf temperature measurements from the Australian North-West Shelf shows the existence of internal waves of semidiurnal period. Vertical displacements of density interfaces are seen to reach ~30 m, a value nearly half the water depth. Baroclinic currents are isolated from the measurements and have amplitudes reaching 0.2 m sec^{-1} in the cross-shelf direction. The baroclinic motion is shown to be consistent with a first-mode internal wave propagating in the onshore direction at phase speed of approximately 0.4 m sec-1 with wavelength of 20 km and being rapidly damped in amplitude while propagating across the shelf. The dissipation of the internal tide across the shelf appears to result from the influence of turbulent mixing processes. There is little coherence between the barotropic tide and the internal tide, and it is suggested that this results from the internal tide being generated over a large section of the shelf slope down to a depth of approximately 900 m. There is no obvious point source of generation for the internal tide. References (8 items).

Holloway, P. E. 1983. "Tides on the Australian North-West Shelf," <u>Australian</u> <u>Journal of Marine and Freshwater Research</u>, <u>34(1):213-230.</u>

Harmonic analysis of the records from 14 current meters and 3 offshore tide gages from the Australian north-west shelf and continental slope regions and a number of coastal stations shows that tidal motion is dominated by the principal lunar (M,) and principal solar (S_2) constituents. The tidal velocities are essentially barotropic with flow predominantly in the cross-shelf direction at the shelf break changing to predominantly along-shelf near the coast. The elevations of the M_2 and S, constituents are amplified across the shelf off Dampier by 1.3 times and by approximately 5 times along the length of the shelf, a distance of around 1,000 km. Several features of the semidiurnal shelf tide are discussed with the aid of a simple analytical model. The cross-shelf bathymetry is shown to produce cross-shelf amplification of the semidiurnal tide in good agreement with the observations off Dampier. An along-shelf pressure gradient results from the change in elevation of the tide along the coast and this pressure gradient is shown to be the main driving mechanism of the along-shelf component of the M, and S, velocities. The gradient also influences, but to a lesser extent, the cross-shelf component of the velocity and the cross-shelf amplification of the

semidiurnal tidal elevation. Results of a world ocean tidal model are presented and indicate the existence of a gradient in the shelf-edge M_2 tide along the shelf, and this is shown to have an important effect on the shelf tide. References (7 items).

Hopkins, T. S., Salusti, E., and Settimi, D. 1984. "Tidal Forcing of the Water Mass Interface in the Strait of Messina," Journal of Geophysical Research, 89(C2):2013-2024.

The tidal currents of the Strait of Messina and their effect on the displacement of the water-mass interface are discussed utilizing the historical velocity data of Francesco Vercelli, taken from ~100 anchor stations during 1922 and 1923. The data show a complex, strongly tidal behavior. in which speeds of 200-300 cm/s are attained over the sill. Messina is an amphidromic point for the tides of the two main basins of the Mediterranean Sea, and two distinct water masses flow through the strait at different stages of the tide: the subsurface Levantine intermediate water flowing north alternating with surface Tyrrhenian water flowing south. The time evolution of the interface between the two marine water layers at the semidiurnal periodicity is computed from the observed distribution of acceleration term for the baroclinic component. This interface shows large vertical oscillations with amplitudes of ~100 m intersecting both the surface and bottom. The results are in reasonable agreement with recent satellite data and other recent field observations and numerical experiments. An estimate of the mean position of the interface is made by assuming that the potential energy required to uplift the interface, from the equilibrium depth of 150 m to the observed 30-m depth over the sill, is derived from the time-independent contribution of the nonlinear field acceleration term. The results are in reasonable agreement with observations. Reference: (24 items).

Howarth, M. J., and Huthnance, J. M. 1984. "Tidal and Residual Currents Around a Norfolk Sandbank," <u>Estuarine, Coastal</u> <u>and Shelf Science</u>, 19(1):105-117.

Currents on either side of Well Bank were recorded for 41 days in May-June 1981, in order to distinguish locally tidally generated asymmetries (pertinent to maintenance of the bank) from larger scale and wind-driven flows. Semidiurnal currents were dominant, nearly rectilinear, and slightly inclined to the bank axis. Fourth-diurnal currents were consistent with previously observed and computed fourth-diurnal tides for the area overall; amplitudes varied as the square of the semidiurnal amplitude. Hence they appear 166

to be generated by tides, but only a small part locally. Residual currents (average over a tidal cycle) were always in the sense of clockwise circulation around the bank, consistent with simple models and giving strong evidence of local generation by tides. This circulation combines with the semidiurnal currents to maintain the bank. The slow increase of the residuals with the semidiurnal amplitude is interpreted as an effect of strong semidiurnal currents. A persistent component onto the bank 7 m above the bottom at one position may indicate distortion of the frictional layer by the sloping bottom or by bank curvature. References (19 items).

- Hsueh, S. F., and Ahlert, R. C. "Mixing in Shallow Coastal Sea: Case Study." (See complete entry in Section VI.)
- Hunkins, K. "Salt Dispersion in the Hudson Estuary." (See complete entry in Section III.)
- Huntley, D. A., and Nummedal, D. "Velocity and Stress Measurements in a Tidal Inlet." (See complete entry in Section VII.)
- Hutchison, I. P. G., and Midgley, D. C. "Mathematical Modelling of Water Level and Salinity Regimes in Some South African Lake and Estuary Systems." (See complete entry in Section VI.)
- Jain, S. C. "Movable-Bed Tidal Inlet Model." (See complete entry in Section VI.)
- Jenkins, S. A., Inman, D. L., and Bailard, J. A. "Opening and Maintaining Tidal Lagoons & Estuaries." (See complete entry in Section VI.)
- Jiang, J. X., and Falconer, R. A. "On the Tidal Exchange Characteristics of Model Rectangular Harbours." (See complete entry in Section VI.)
- Jones, I. S. F., and Padman, L. "Semidiurnal Internal Tides in Eastern Bass Strait." (See complete entry in Section I.)
- fKarthegisan, J., and Thomas, M. P. "The Effect of Tidal Heights on the Distribution and Abundance of Coliform Bacteria in the Sediments of Two Sites in the Mersey Estuary." (See complete entry in Section IV.)
- Karunartne, D. A. "An Improved Method for Smoothing and Interpolating Sea Level Data." (See complete entry in Section I.)
- Kato, M. "Observation of Crustal Movements by Newly-Designed Horizontal Pendulum and Water-Tube Tiltmeters with Electromagnetic Transducers (2)--Variations in the

Amplitude and Phase of Tidal Tilts Observed with a Water-Tube Tiltmeter at Kamitakara." (See complete entry in Section I.)

- Kelley, J. T. "Composition and Origin of the Inorganic Fraction of Southern New Jersey Coastal Mud Deposits." (See complete entry in Section II.)
- Khorram, S. "Remote Sensing of Salinity in the San Francisco Bay Delta." (See complete entry in Section VII.)
- King, H. L., Scott, M. A., and Smith, T. J. 1983. "Some Remarks on the Analysis of Short Tidal Records," <u>Deutsche Hydro-</u> <u>graphische Zeitschrift</u>, 36(2):45-59.

The errors inherent in the harmonic analysis of short tidal records have been investigated using synthetic elevation and real velocity records. The sources of error were identified as the presence of noise, tidal constituents not included in the analysis, and the duration of the record. Of these sources, the record duration was shown to be the greatest contributor to the total error. By analyzing a synthetic tidal record, an empirical estimate of the variation of the error in the M₂ component with record length is obtained. This is then shown to predict the errors in the analysis of an actual velocity record. A method is also presented for separating the M_2 and S_2 constituents in records of 36 hours' duration or less. References (6 items).

- Kirby, R., and Parker, W. R. "A Suspended Sediment Front in the Severn Estuary." (See complete entry in Section II.)
- Knebel, H. J., et al. "Sedimentary Framework of the Potomac River Estuary, Maryland." (See complete entry in Section II.)
- Knight, D. W. 1981. "Some Field Measurements Concerned with the Behaviour of Resistance Coefficients in a Tidal Channel," <u>Estuarine, Coastal and Shelf Science</u>, 12(3):303-322.

Measurements of the individual terms in the one-dimensional unsteady flow momentum equation in a 1.2-km tidal reach of the Conwy estuary, North Wales, have yielded values for the resistance coefficients commonly adopted in open channel flow hydraulics. The results indicate clearly that Manning's n or Darcy-Weisbach's f varies significantly with stage, and to a lesser extent with flow direction. The relative importance of the various terms in the one-dimensional momentum equation are illustrated, and the techniques employed in measuring them indicated. Values of Nikuradse's roughness parameter, $k_{\rm e}$, have also been computed and are shown

to vary significantly with water level. Mean bed shear stresses have been evaluated, and the variation in bed shear velocity throughout different tidal cycles determined. The results indicate the inadvisability of selecting a single roughness parameter to represent the hydraulic characteristics of any individual element in a numerical tidal model. References (20 items).

- Knowles, C. E. "Estimation of Surface Gravity Waves from Subsurface Pressure Records for Estuarine Basins." (See complete entry in Section VII.)
- Knowles, C. E. 1981. "Wind-Wave Climatology and Wind-Tides for Fort Raleigh Wave-Gauge Site, 1979," Working Paper 81-8, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University, Raleigh.

The wave data presented and discussed were recorded almost continuously from January 26 to December 31, 1979, by a pressure transducer mounted 30 cm above the bottom offshore immediately adjacent to the Fort Raleigh National Historic Site. The data were collected as part of a shoreline stabilization project. The monthly wave climatologies and wind tides at the Fort Raleigh site for 1979 are given. References (9 items).

Kowalik, Z. and Matthews, J. B. 1982. "The M₂ Tide in the Beaufort and Chukchi Seas," <u>Journal of Physical Oceanography</u>, 12(7):743-746.

The amplitude and phase of the M_2 tide for the Beaufort and Chukchi seas were derived from the vertically integrated equations of motion and continuity. The boundary conditions at the open boundaries were taken both from previous numerical models and observations. The results are shown as cotidal and corange lines and a distribution of current ellipses. The results are compared with the few available measurements. Cotidal and corange lines support the existence of amphidromes at the entrance to the Amundsen Gulf and in the Chukchi Sea. The former amphidrome has been confirmed by Canadian observers. It is believed that the latter amphidrome is reported for the first time. References (11 items).

Kranck, K. 1980. "Variability of Particulate Matter in a Small Coastal Inlet," <u>Canadian Journal of Fisheries and Aquatic</u> <u>Sciences</u>, 37(8):1209-1215.

Total suspended particulate matter concentration and grain size spectra, total and living particulate carbon, and dissolved nitrogen and carbon were measured at stations along the length of Petpeswick Inlet and over several tidal cycles. Distinct particle populations were associated with the water at the head and at the mouth of the inlet. Mixing of water masses and temporal periodicities cause variances in particle concentration and spectral shape which correspond to seasonal, tidal, and seiche variations. To explain the last, a process of transformation of organic matter between dissolved and particulate states by aggregate formation and breakup in response to turbulent changes is proposed.

- Lake, C. A., and MacIntyre, W. G. "Phosphate and Tripolyphosphate Adsorption by Clay Minerals and Estuarine Sediments." (See complete entry in Section II.)
- Lara-Lara, J. R., Alvarez-Borrego, S., and Small, L. F. "Variability and Tidal Exchange of Ecological Properties in a Coastal Lagoon." (See complete entry in Section I.)
- Lee, G. F. "Persistence of Chlorine in Cooling Water from Electric Generating Station." (See complete entry in Section IV.)
- Leenknecht, D. A., Earickson, J. A., and Butler, H. L. "Numerical Simulation of Oregon Inlet Control Structures' Effects on Storm and Tide Elevations in Pamlico Sound." (See complete entry in Section VI.)

Lees, B. J. 1983. "Observations of Tidal and Residual Currents in the Sizewell-Dunwich Area, East Anglia, U.K.," <u>Deutsche</u> <u>Hydrographische Zeitschrift</u>, 36(1):1-24.

Current meter data from the shallow nearshore Sizewell-Dunwich area, off the coast of East Anglia, U.K., have been harmonically analyzed, enabling the tidal and residual currents of the region to be described. The area is close to the amphidrome in the southern part of the North Sea, and this dominates the tidal current pattern. Thus the astronomical tides are mixtures of standing and progressive waves and for M₂ are in the proportion 3:2. The tidal currents are nearly rectilinear, flowing parallel to the coast with maximum midwater velocities up to 1.20 m s^{-1} . Estimations have been made of the tidal energy flux through the area and of the frictional dissipation at the seabed, showing that energy fluxes are weaker inshore. The residual circulation is complex although there is evidence of an anticlockwise eddy over the seaward flank of the Sizewell Bank. References (29 items).

Lees, B. J., and Heathershaw, A. D. "Sizewell-Dunwich Banks Field Study, Topic Report 5; Offshore Sediment Movement and Its Relation to Observed Tidal Current and Wave Data." (See complete entry in Section II.)

Two images recorded on two successive summer days by LANDSAT satellite over the western approaches to the English Channel show bright pattern of complex shape the origin of which is puzzling. Among the wavelength bands available on LANDSAT's multispectral scanner, these patterns are apparent only in the green region of the spectrum, and they are located toward the stratified side of a well-marked tidal thermal front. Spectral signature analysis and available knowledge on hydrography and plankton in the area are used to derive a proposed interpretation. Phytoplankton would accordingly be the best candidate for being responsible for the observed patterns. References (51 items).

- Leitass, R. "Wave Damages to Stone Slope Under Marginal Wharves." (See complete entry in Section VI.)
- Lentsch, J. W., et al. "Stable Manganese and Manganese-54 Distributions in the Physical and Biological Components of the Hudson River Estuary." (See complete entry in Section IV.)
- Le Provost, C., and Poncet, A. "Finite Element Method for Spectral Modelling of Tides." (See complete entry in Section I.)
- Lewis, R. E., and Lewis, J. O. "The Principal Factors Contributing to the Flux of Salt in a Narrow, Partially Stratified Estuary." (See complete entry in Section III.)
- Liou, Y.-C., and Herbich, J. B. "Velocity Distribution and Sediment Motion Induced by Ship's Propeller in Ship Channels." (See complete entry in Section II.)
- Liu, S. K., Hou, H. S., and Chang, C. C. "Simulation of Wave/Wind Forced Harbor Oscillation." (See complete entry in Section VI.)

Ludwick, J. C. 1977. "Jet-Like Coastal Currents and Bottom Sediment Transport off Virginia Beach, Virginia," <u>Hydraulic Sensor Instrumentation of a Shore Face in a</u> <u>Tidal Current Convergence Zone--Cape</u> <u>Henry, Virginia</u>, Technical Report No. 25, Institute of Oceanography, Old Dominion University, Norfolk, Virginia, Part II:1-60.

Synoptic data on near-surface and nearbottom currents for two 1-month periods are analyzed for six stations located in the coastal boundary zone 3.5 to 7 km

offshore in water depths from 8.2 to 23.8 m. Data were taken with savonius rotor devices and represent 15-minute time averages of speed and direction. Highfrequency noise was removed with a numerical smoothing filter. Tidal currents, separated out by harmonic analysis, are rotary with long ellipse axes approximately parallel to the shoreline and are nearly synchronous. Principal tidal constituents are M_2 , S_2 , N_2 , K_1 , O_1 , J_1 , and SO_1 . Maximum tidal current speed decreases with distance to the south away from the entrance to Chesapeake Bay. Near the surface, tidal current speeds at spring strength decrease progressively from 52.3 cm/sec in the entrance area to Chesapeake Bay to 18.5 cm/sec at a point 22 km to the south. Near the bottom corresponding tidal currents decrease from 32.4 cm/sec in the entrance to 8.2 cm/sec at the southernmost location. Near-bottom tidal currents are incapable by themselves of moving fine sand. Forty-hour lowpassed currents are wind- and slopedriven, but reach peak speeds near the surface of 48 cm/sec in events of up to 6 days' duration. In summer a strong pycnocline inhibits downward propagation of these high-speed surface currents. In the fall, southward-directed high-speed coastal jets penetrate readily to the bottom. Response time of the surface waters to wind events is less than 3 hours. South-directed winds in summer generate stronger currents than north-directed winds of the same speed. Spatial accelerations and seasonal variations in wind regimes and corresponding currents seem to require a strong south slope to the sea surface in summer and a very gentle slope to the north in the fall. These slopes may be related to seasonal changes in efflux from the bay entrance. Between strong aperiodic wind events, a weak estuarine circulation exists. Waves entrain the bed sediment 60 to 83 percent of the time in depths of 8 to 13 m. With a corresponding lowered threshold taken at 20 cm/sec, only the south-directed lowpass currents supplement the incompetent tidal currents so as to produce sediment transport. Threshold exceedance in 8 to 13 m occurs 5 to 12 percent of the time under south-directed low-pass currents in summer and 19 to 28 percent of the time under south-directed low-pass currents in the fall. At 15 m, the transport threshold was not reached during the observation period. A coastwise parallel belt of frequent but intermittent bed sediment transport is thus defined. The frequency of exceedance decreases to the south away from the entrance area. From the sediment transport continuity relationship, it is reasoned that deposition occurs and at a decreasing rate with distance to the south away from the entrance to Chesapeake Bay, thus matching the seaward bulging

configuration of isobaths east of Cape Henry. If a null should be reached with increasing distance to the south, a depocenter would occur at that point. References (31 items).

- Ludwick, J. C., and Johnson, P. B. "Hydraulic Sensor Instrumentation in a Shore Face in a Tidal-Nontidal Coastal Convergence Zone, Cape Henry, Virginia." (See complete entry in Section VII.)
- McAnally, W. H., Jr. "Los Angeles Harbor and Long Beach Harbor: Physical Model of San Pedro Bay Tidal Circulation." (See complete entry in Section VI.)
- McAnally, W. H., Jr., Brogdon, N. J., Jr., and Stewart, J. P. "Columbia River Estuary Hybrid Model Studies; Report 4, Entrance Channel Tests." (See complete entry in Section VI.)
- McAnally, W. H., Jr., and Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: Physical and Numerical Tidal Models: A Comparison." (See complete entry in Section VI.)
- McAnally, W. H., Jr., et al. "Columbia River Estuary Hybrid Model Studies; Report 1, Verification of Hybrid Modeling of the Columbia River Mouth." (See complete entry in Section VI.)
- MacArthur, R. C. "Turbulent Mixing Processes in a Partially Mixed Estuary." (See complete entry in Section I.)
- MacAyeal, D. R. "Numerical Simulations of the Ross Sea Tides." (See complete entry in Section VI.)
- McCave, I. N., and Geiser, A. C. 1979. "Megaripples, Ridges and Runnels on Intertidal Flats of the Wash, England," <u>Sedi-</u> <u>mentology</u>, 26(3):353-369.

Observations have been made of parts of the channels and the outer portions of the sand banks in the Wash using 1:10,000 air photographs and brief ground surveys at low spring tides. Two principal structures are found. In the channels, megaripples 0.3-0.6 m high and of 10- to 15-m modal spacing are dominantly flood orientated: they do not reverse during ebb tide. On the outer parts of banks, low ridges of 0.5-m height and 50- to 100-m spacing are interpreted as wave-formed ridge and runnel structure. They contain wave-rippled mud patches in the runnels and although they have shorewards asymmetry do not appear to migrate to any great extent. It is suggested that only in sheltered areas do the Wash intertidal flats show a lower mudflat subfacies; the norm is outer bank sand flats with ridge

and runnel structure eventually overlain by Arenicola sand flats during progradation. References (28 items).

- McClimans, T. A., and Gjerp, S. A. "Numerical Study of Distortion in a Froude Model." (See complete entry in Section VI.)
- Macdonald, G. J., and Weisman, R. N. "Oxygen-Sag in a Tidal River." (See complete entry in Section IV.)
- Machemehl, J. L., and Gopalakrishnan, T. C. "Comparison of Numerical Simulation Flow Models for Coastal Inlets." (See complete entry in Section VI.)
- Macpherson, J. M. "Response to Urbanization of the Avon-Heathcote Estuary, Christchurch, New Zealand." (See complete entry in Section II.)
- Magnell, B. A., et al. "The Relationship of Tidal and Low-Frequency Currents on the North Slope of Georges Bank." (See complete entry in Section I.)
- Marche, C., et al. "A Study of the Influence of River Discharge Regulation on the Salinity Equilibrium in the Estuary." (See complete entry in Section III.)
- Markofsky, M. "Design of a Tunnel Discharge in an Estuary--Physical Model and Field Studies." (See complete entry in Section VI.)
- Martin, J.-M., and Salvadori, F. "Fluoride Pollution in French Rivers and Estuaries." (See complete entry in Section IV.)
- Maza, J. A., Munoz, M. L., and Porraz, M. "Jetties Studies Contribution." (See complete entry in Section V.)
- Milford, S. N., and Church, J. A. "Simplified Circulation and Mixing Models of Moreton Bay, Queensland." (See complete entry in Section VI.)
- Muir, L. R. "Internal Tides in a Partially-Mixed Estuary." (See complete entry in Section I.)
- Murty, T. S., and Henry, R. F. 1983. "Tides in the Bay of Bengal," <u>Journal of</u> Geophysical Research, 88(C10):6069-6076.

The amplitudes and phases of the tidal constituents M_2 , S_2 , K_1 , and O_1 in the Bay of Bengal are deduced from tide gage records at 112 locations with the aid of numerical models based on the vertically integrated equations of motion and continuity. Tidal elevations along the southern open boundary of the bay were obtained by interpolation from observations. The results are presented in the form of cotidal charts. These show that

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the constituents examined have no amphidromic points in the Bay of Bengal apart from a degenerate amphidrome for M_2 in the northwest part of the bay. References (8 items).

- Najarian, T. O., et al. "Application of Nitrogen-Cycle Model to Manasquan Estuary." (See complete entry in Section VI.)
- National Oceanic and Atmospheric Administration. "Tidal Current Tables" (issued yearly), National Ocean Survey, US Department of Commerce, Rockville, Md.

Current tables for the use of mariners have been published by the National Ocean Service (formerly the Coast and Geodetic Survey) since 1890. Tables for the Pacific coast first appeared in 1898 as a part of the tide tables and consisted of brief directions for obtaining the times of slack water for a few locations from the times of high and low waters. Daily predictions of slack water for two stations were given for the year 1899, and by 1923 the tables had so expanded that they were then issued as a separate publication entitled Current Tables, Pacific Coast. A companion volume, Current Tables, Atlantic Coast, was also issued that year. In 1926 predictions were extended to include the times and velocities of maximum current. Daily predicted times of slack water and predicted times and velocities of maximum current (flood and ebb) are presented for a number of reference stations. Similar predictions for many other locations may be obtained by applying the correction factors to the predictions of the appropriate reference station. The velocity of a current at times between slack water and maximum current may be approximated. The duration of weak current near the time of slack water may be computed.

National Oceanic and Atmospheric Administration. "Tide Tables, High and Low Water Predictions" (issued yearly), National Ocean Survey, US Department of Commerce, Rockville, Md.

Tide tables for the use of mariners have been published by the National Ocean Service (formerly the Coast and Geodetic Survey) since 1853. For a number of years these tables appeared as appendixes to the annual reports of the Superintendent of the Survey, and consisted of more or less elaborated means for enabling the mariner to make his own prediction of tides as occasion arose. The first tables to give predictions for each day were those for the year 1867. They gave the times and heights of high waters only and were published in two separate parts, one for the Atlantic coast and the other for the Pacific coast of the United States. Together they contained daily predictions for 19 stations and tidal differences for

124 stations. A few years later, predictions for the low waters were also included, and for the year 1896 the tables were extended to include the entire maritime world, with full predictions for 70 ports and tidal differences for about 3.000 stations. The tidal tables are now issued in four volumes, as follows: Europe and West Coast of Africa (including the Mediterranean Sea); East Coast of North and South America (including Greenland): West Coast of North and South America (including the Hawaiian Islands); Central and Western Pacific Ocean and Indian Ocean. Together, they contain daily predictions for 198 reference ports and differences and other constants for about 6,000 stations. The following items are included: a table to obtain the approximate height of the tide at any time, a table of local mean time of sunrise for every fifth day of the year for different latitudes, a table for the reduction of local mean time to standard time, a table for converting feet of the moon's phases, apogee, perigee, greatest north and south and zero declination. the time of the solar equinoxes and solstices, and a glossary of terms. Up to and including the tide tables for the year 1884. all the tide predictions were computed by means of auxiliary tables and curves constructed from the results of tide observations at the different ports. From 1885 to 1911, inclusive, the predictions were generally made by means of the Ferrel tide-predicting machine. From 1912 to 1965, inclusive, they were made by means of the Coast and Geodetic Survey tidepredicting machine No. 2. Since 1966, predictions have been made by electronic computer.

Nece, R. E., and Scheffner, N. W. 1978. "Field Data Analysis for Chesapeake Bay Model Verification," <u>Proceedings, Six-</u> teenth Coastal Engineering Conference, August 27-September 3, 1978, Hamburg, Germany, ASCE, III:2870-2886.

Currents and salinities in the generally shallow, partially mixed estuary are strongly influenced by winds in addition to tides and to time-variable freshwater inflows from the drainage basin of approximately 166,000 sq km. The large size of the actual estuary ruled out the possibility of obtaining synoptic prototype data of sufficiently fine-grained detail against which to verify the recently constructed Chesapeake Bay model. This paper presents the procedures used in an initial treatment of the prototype data. References (8 items).

Nece, R. E., and Smith, H. N. "Tidal Exchange in Proposed Sitka, Japonski Lagoon, Small Boat Harbor." (See complete entry in Section VI.)

- Nece, R. E., et al. "Effects of Planform Geometry on Tidal Flushing and Mixing in Marinas." (See complete entry in Section VI.)
- Nihoul, J. C. J., ed. <u>Marine Forecasting;</u> <u>Predictability and Modelling in Ocean</u> <u>Hydrodynamics; Proceedings, 10th International Liege Colloquium on Ocean Hydrodynamics. (See complete entry in Section I.)</u>
- Noble, M., Butman, B., and Williams, E. "On the Longshelf Structure and Dynamics of Subtidal Currents on the Eastern United States Continental Shelf." (See complete entry in Section I.)
- Novak, P., and Čábelka, J. <u>Models in Hy-</u> draulic Engineering, Physical Principles and Design Applications. (See complete entry in Section VI.)
- O'Connor, D. J., and Lung, W. "Suspended Solids Analysis of Estuarine Systems." (See complete entry in Section VI.)
- O'Connor, D. J., Mueller, J. A., and Farley, K. J. "Distribution of Kepone in the James River Estuary." (See complete entry in Section IV.)
- Onishi, S., and Nishimura, T. 1980. "Study on Vortex Current in Strait with Remote-Sensing," <u>Proceedings, Seventeenth Coastal</u> <u>Engineering Conference, March 23-28, 1980,</u> <u>Sydney, Australia</u>, ASCE, III:2655-2670.

With rapid increases of industrial activity in the present, water pollution in the coastal environment has become an urgent problem to cope with. This problem is especially serious in enclosed bays or inland seas. The hydrodynamic character of the strait connecting the inland sea to the open ocean must be understood well in order to analyze the diffusion of pollutants in the inland sea, because its character determines boundary conditions in the mathematical models of the water pollution problem. So far, however, it seems that the main efforts exerted by coastal engineers have concentrated mainly on the development of mathematical models, lacking satisfactory knowledge of the boundary conditions through field measurements. One reason for this state results from the fact that the relating phenomena in the field are of too large a scale, in general, to perform the field measurements. In connection with this point, the authors present in this paper that remote-sensing technology is very useful to get information on the hydrodynamical phenomena occurring in the water body around the strait. To show the above, the authors selected as an object of the study Naruto Strait in the Seto Inland Sea, which is world famous for the existence of rapid

tidal currents and dynamic vortices. Remote-sensing data both from the airplanes and from a space satellite Landsat are analyzed with the aid of theoretical considerations and hydraulic model tests to disclose the behavior of the vortices of various scales and their roles in the seawater mixing phenomena at the strait. References (2 items).

- Outlaw, D. G. "Lake Pontchartrain and Vicinity Hurricane Protection Plan; Report 1, Prototype Data Acquisition and Analysis." (See complete entry in Section I.)
- Owen, M. W., and Thorn, M. F. C. "Effect of Waves on Sand Transport by Currents." (See complete entry in Section II.)
- Ozturk, Y. F. "Mathematical Modeling of Dispersion in Mixed Estuaries." (See complete entry in Section VI.)
- Pape, E. H., III, and Garvine, R. W. "The Subtidal Circulation in Delaware Bay and Adjacent Shelf Waters." (See complete entry in Section VI.)
- Pearson, C. "Far-Field Matching for Tidal Calculations in Nearshore Regions." (See complete entry in Section I.)
- Pethick, J. S. "Long-Term Accretion Rates on Tidal Salt Marshes." (See complete entry in Section II.)
- Pethick, J. S. "Velocity Surges and Asymmetry in Tidal Channels." (See complete entry in Section VI.)
- Pickett, E. B., and Greer, H. C. 1977. "Los Angeles Harbor and Long Beach Harbor: Prototype Data Acquisition and Observations," Ports '77, 4th Annual Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE, Long Beach, Calif., March 9-11, 1977, I:10-26.

Wave data were obtained at 1-sec intervals from 1 June 1971 to 1 July 1972 at 13 wave gage stations in the Los Angeles and Long Beach Harbors. Tidal height data were obtained from three float-type tide gages operated by the Los Angeles and Long Beach Port Authorities. Barometric pressure was monitored at the central receiving station onshore. For 15 stations in the harbors, tidal current measurements at three depths in the water column were collected at 1-hr intervals for a 25-hr observation period beginning at 0600 PDT on 5 March 1974. Data on ship characteristics, mooring configurations, and ship motion (degree, type, and time of occurrence) were collected for vessels berthed in the east channel and west basin of Los Angeles Harbor and in the southeast basin and east basin (slip 1) of Long Beach Harbor. The

Section VIII. Basic Physical Data

purpose of this prototype wave observation program was to obtain for a 1-yr period continuous, accurate, and reliable wave data to be used in hydraulic and mathematical models and in evaluating surge conditions in the existing harbors. Tidal heights and currents were measured to provide data for physical hydraulic model verification and to aid in identifying potential circulation problems. Ship movement and mooring configuration data were collected to allow correlation of ship motions with prototype wave conditions. References (3 items).

Prandle, D. 1980. "Co-Tidal Charts for the Southern North Sea," <u>Deutsche Hydrographische Zeitschrift</u>, 33(4):68-81.

Co-tidal charts have been constructed for the region of the North Sea south of 53°30' N for the constituents O_1 , K_1 , N_2 , M_2 , S_2 , M_4 , MS_4 , and M_6 . The charts are based on elevation data from about 50 coastal sites and 25 offshore sites together with current data from 17 locations. The current data and most of the offshore tide gage data were collected during the international oceanographic exercise JONSDAP '73 carried out in September and October of 1973. In constructing the charts reference was made to the pattern of tidal propagation produced by a numerical model of the area. References (7 items).

- Prandle, D., and Wolf, J. "The Interaction of Surge and Tide in the North Sea and River Thames." (See complete entry in Section VI.)
- Price, W. A., Motyka, J. M., and Jaffrey, L. J. "The Effect of Offshore Dredging on Coastlines." (See complete entry in Section V.)
- Proehl, J. A., and Rattray, M., Jr. "Low-Frequency Response of Wide Deep Estuaries to Non-Local Atmospheric Forcing." (See complete entry in Section VI.)
- Provis, D. G., and Lennon, G. W. "Eddy Viscosity and Tidal Cycles in a Shallow Sea." (See complete entry in Section VI.)
- Pruszak, Z., and Zeidler, R. B. "Sediment Transport and Ripples Due to Waves and Currents." (See complete entry in Section II.)
- Pugh, D. T., and Vassie, J. M. "Extreme Sea Levels from Tide and Surge Probability." (See complete entry in Section I.)
- Raney, D. C. "Los Angeles Harbor and Long Beach Harbor: A Numerical Model for Tidal Circulation." (See complete entry in Section VI.)

- Richards, D. R., and Gulbrandsen, L. F. "Low Freshwater Inflow Study; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Richards, D. R., and Morton, M. R. "Norfolk Harbor and Channels Deepening Study; Report 1, Physical Model Results; Chesapeake Bay Hydraulic Model Investigation." (See complete entry in Section VI.)
- Riedel, H. P., and Gourlay, M. R. "Inlets/ Estuaries Discharging into Sheltered Waters." (See complete entry in Section I.)
- Rives, S. R., and Pritchard, D. W. "Adaptation of J. R. Hunter's One-Dimensional Model to the Chesapeake and Delaware Canal System." (See complete entry in Section VI.)
- Robinson, I. S., Warren, L., and Longbottom, J. F. "Sea-Level Fluctuation in the Fleet, an English Tidal Lagoon." (See complete entry in Section VI.)
- Schwarze, H., and Falldorf, W. "Influence on Temperature Increases in Tidal Rivers Caused by Waste Heat Injections with Respect to Tidal Cycles and Storm Surges." (See complete entry in Section VI.)
- Schwing, F. B., and Kjerfve, B. 1980. "Longitudinal Characterization of a Tidal Marsh Creek Separating Two Hydrographically Distinct Estuaries," <u>Estuaries</u>, 3(4):236-241.

Jones Creek, South Carolina, connects two hydrographically distinct estuarine systems: North Inlet and Winyah Bay. One hundred fifty-two sets of hydrographic measurements from February 1978 indicate the existence of a Jones Creek nodal point, an effective barrier limiting flow exchange between the end regions of the creek. Morphologic and vegetation observations and water quality ratings suggest that this nodal point is a permanent feature of Jones Creek and may be present in other similar systems. References (18 items).

- Seabergh, W. C. "Model Testing of Structures at a Tidal Inlet." (See complete entry in Section VI.)
- Seabergh, W. C., and Outlaw, D. G. "Los Angeles and Long Beach Harbors Model Study; Numerical Analysis of Tidal Circulation for the 2020 Master Plan." (See complete entry in Section VI.)
- Seibert, G. H. "Tidally Forced Circulation in the Saguenay Fjord." (See complete entry in Section I.)

- Sengupta, S., Lee, S. S., and Miller, H. P. "Three-Dimensional Numerical Investigations of Tide and Wind-Induced Transport Processes in Biscayne Bay." (See complete entry in Section VI.)
- Sharp, J. J. <u>Hydraulic Modelling</u>. (See complete entry in Section VI.)
- Sheng, Y. P. "Mathematical Modeling of Three-Dimensional Coastal Currents and Sediment Dispersion: Model Development and Application." (See complete entry in Section VI.)
- Siefert, W. "On Storm Tides in Rivers" ("Über das Sturmflutgeschehen in Tideflüssen"). (See complete entry in Section I.)
- Signorini, S. R. "A Three-Dimensional, Finite Element Numerical Model of Circulation and Diffusion-Advection Processes for Estuarine and Coastal Application (With Application to Bay of Ilha Grande, Brazil)." (See complete entry in Section VI.)
- Simon, M. B. 1982. "Prediction of Tidal Currents at Brest" ("Prediction De La Marée À Brest"), <u>Annales Hydrographiques</u>, 10(757):33-50 (In French).

Tide tables for French coasts published by the Service Hydrographique et Océanographique de la Marine are based upon tidal prediction at Brest from which the predictions for the other ports are deduced by applying time and height differences. This article explains and estimates the formula called Formule de Laplace used to predict the tide at Brest. Two other methods, opposed to it, are found more efficient. However the traditional formula has been maintained owing to the repercussion -- not yet evaluated -- of the change of method on the tide tables quality. The concept Brest-reférence, a fictious port where tide complies with the Formule de Laplace, is introduced. References (9 items).

- Simpson, J. H., Hughes, D. G., and Morris, N. C. G. "The Relation of Seasonal Stratification to Tidal Mixing on the Continental Shelf." (See complete entry in Section I.)
- Smita, N. P. 1980. "A Comparison of Tidal Harmonic Constants Computed at and Near an Inlet," <u>Estuarine and Coastal Marine Sci</u> ence, 10(4):383-391.

Time series of bottom pressure and surface water level are used to compute harmonic constants and thus compare tidal conditions at and near an inlet along Florida's Atlantic coast. Supportive hydrographic and surface atmospheric pressure data are incorporated to estimate the probable maximum errors in comparing pressure fluctuations with water level variations. The M,

tidal amplitude decreases from 0.45 decibar $(0.45 \text{ m} \pm 0.02 \text{ m})$ over the inner shelf to 0.28 m in the nearby inlet. There is an 11-deg phase lag of the M, tide in the inlet. The K, and O, constituent amplitudes show essentially no decrease from the shelf to the inlet, though the tidal wave form is delayed by 9 deg and 18 deg, respectively. Locally damped amplitudes and phase lags are attributed to estuarine-shelf exchanges through the inlet. Local perturbations in the tidal harmonic constants may have a significant effect on the construction of cotidal and corange charts for the adjacent ocean basin. References (9 items).

- Sorensen, R. M. "The Corps of Engineers General Investigation of Tidal Inlets." (See complete entry in Section I.)
- Soulsby, R. L. "Selecting Record Length and Digitization Rate for Near-Bed Turbulence Measurements." (See complete entry in Section I.)
- Soulsby, R. L., and Dyer, K. R. "The Form of the Near-Bed Velocity Profile in a Tidally Accelerating Flow." (See complete entry in Section I.)
- Stacey, M. W. "The Interaction of Tides with the Sill of a Tidally Energetic Inlet." (See complete entry in Section I.)
- Stigebrandt, A. "A Mechanism Governing the Estuarine Circulation in Deep, Strongly Stratified Fjords." (See complete entry in Section I.)
- Stigebrandt, A. "Some Aspects of Tidal Interaction with Fjord Constrictions." (See complete entry in Section I.)
- Stumpf, R. P. "The Process of Sedimentation
 on the Surface of a Salt Marsh." (See
 complete entry in Section II.)
- Sündr mann, J., and Holz, K.-P., ed. <u>Mathe-</u> <u>matical Modelling of Estuarine Physics,</u> <u>Lecture Notes on Coastal and Estuarine</u> <u>Studies</u>. (See complete entry in Section I.)
- Sündermann, J., Vollmers, H., and Puls, W. "The Influence of Dune and Flow Parameters on the Friction Factor." (See complete entry in Section VI.)
- Swakon, E. A., Jr., and Wang, J. D. "Modeling of Tide and Wind Induced Flow in South Biscayne Bay and Card Sound." (See complete entry in Section VI.)
- Swenson, E. M., and Chuang, W.-S. 1983. "Tidal and Subtidal Water Volume Exchange in an Estuarine System," Estuarine, Coastal and Shelf Science, 16(3):229-240.

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Estuarine water movements occur over a broad range of time scales. In this study, moored current meter data were used to investigate water volume exchange in the tidal passes of Lake Pontchartrain, Louisiana, on the tidal and subtidal time scales. A calibration technique, employing cross-channel measurements of water velocity, was used to calibrate the moored current meters, thus allowing for calculation of volume flow over a 35-day period. The local diurnal tide accounted for 50 percent of the total volume exchange, the rest being due to subtidal events (frontal passage). This subtidal exchange occurs primarily as large-scale events characterized by volume fluxes up to six times greater than the normal tidal prism. Neglecting this subtidal component in the determination of the volume fluxes for a system such as Lake Pontchartrain could result in substantial underestimation (by as much as 50 percent) of these volume and their corresponding material fluxes. References (15 items).

Swift, M. R., and Brown, W. S. 1983. "Distribution of Bottom Stress and Tidal Energy Dissipation in a Well-Mixed Estuary," <u>Estuarine, Coastal and Shelf Science</u>, 17(3):297-317.

Estimates of area-averaged tidal bottom stress are made for four channel segments of the Great Bay Estuary, N. H. Current and sea level measurements are used to estimate acceleration and pressure gradient terms in the equation of motion, while the equation of motion itself is used to infer the remaining stress term. Dynamic terms, bottom stress values, friction coefficients, and energy dissipation rates are estimated for each site. The analysis shows that while throughout the estuary the principal force balance is between the frictional stress and the pressure gradient forcing, RMS values of total bottom stress range from 2.67 to 10.38 Nm⁻² and friction coefficients vary from 0.015 to 0.054. Both stress and energy dissipation are largest in the seaward portion of the estuary with an order of magnitude decrease in dissipation at the most inland site. These distributions of stress and energy dissipation are consistent with cotidal charts of the principal semidiurnal tidal constituent (M_2) which indicate that the estuary is composed of a highly dissipative more progressive tidal wave regime seaward and a less dissipative standing wave regime landward. References (19 items).

Thimakorn, P., and Gupta, A. D. "Concentration of Suspended Clay in Tidal Estuary." (See complete entry in Section II.)

- Thompson, R. O. R. Y. "Low-Pass Filters to Suppress Inertial and Tidal Frequencies." (See complete entry in Section VII.)
- Timmerman, H. "Forecasting Meteorological Effects on Water Levels on a Routine Basis with a Numerical Model." (See complete entry in Section I.)
- Trawle, M. J. "Effects of Depth on Dredging Frequency; Report 2, Methods of Estuarine Shoaling Analysis." (See complete entry in Section V.)
- Trump, C. L. 1983. "A Current-Induced Ekman Spiral in the St. Lawrence Estuary," Journal of Physical Oceanography, 13(8):1540-1543.

Current meter measurements indicate the presence of a mean Ekman spiral imposed upon the dominant tidal oscillation of the St. Lawrence Estuary. Estimates of vertical eddy coefficients are consistent with previous estimates. It is hypothesized that the spiral results from a steady, fresh, river outflow layer flowing over the tidal prism. References (5 items).

- Tucci, C. E. M., and Chen, Y. H. "Unsteady Water Quality Model for River Network." (See complete entry in Section VI.)
- Uncles, R. J., and Jordan, M. B. "Residual Fluxes of Water and Salt at Two Stations in the Severn Estuary." (See complete entry in Section III.)
- Uncles, R. J., et al. "Salinity of Surface Water in a Partially-Mixed Estuary, and Its Dispersion at Low Run-off." (See complete entry in Section III.)
- US Army Engineer Division, New England. "Long Island Sound, Thamesville Tidal-Flood Management Water Resources Study, Norwich, Connecticut." (See complete entry in Section V.)
- Ünlüata, Ü. A., and Özsoy, E. "Tidal Jet Flows Near Inlets." (See complete entry in Section I.)
- van de Kreeke, J., and Wang, J. D. "Tidal Hydraulics and Salt Balance of Lake Worth, Florida." (See complete entry in Section VI.)
- van de Ree, W. J., Voogt, J., and Leendertse, J. J. "A Tidal Survey for a Model of an Offshore Area." (See complete entry in Section VII.)
- Vongvisessomjai, S., and Srikanthan, R. "The Regimen of Takuapa Tidal Channel." (See complete entry in Section I.)

- Wada, A., and Miyaike, Y. "Characteristics of Circulation in Bay Waters due to Wind Action." (See complete entry in Section I.)
- Wadsworth, J. R., Jr. "Structural Control of Drainage Morphology of Salt Marshes on St. Catherine's Island, Georgia." (See complete entry in Section I.)
- Walters, R. A. 1982. "Low-Frequency Variations in Sea Level and Currents in South San Francisco Bay," <u>Journal of Physical</u> <u>Oceanography</u>, 12(7):658-668.

In order to examine physical processes in the subtidal time range, sea level and current meter data for south San Francisco Bay (South Bay) were filtered using a lowpass digital filter to remove tidal period variations, and then subjected to an empirical orthogonal function analysis. For the sea level data, there is one dominant empirical mode that is correlated with nonlocal coastal forcing. A small amount of the variance is associated with local wind setup. For the current meter data, there are two dominant empirical modes that correlate with local wind forcing and tidal forcing over the spring-neap cycle. In general, South Bay is dominated by coastal forcing on sea level during all seasons, and dominated by wind and tidal forcing on the residual currents during the summer. References (17 items).

Walters, R. A., and Heston, C. 1982. "Removing Tidal-Period Variations from Time-Series Data Using Low-Pass Digital Filters," Journal of Physical Oceanography, 12(1):112-115.

Several low-pass digital filters are examined for their ability to remove tidal period variations from a time series of water surface elevation for San Francisco Bay. The most efficient filter is the one which is applied to the Fourier coefficients of the transformed data, and the filtered data recovered through an inverse transform. The ability of the filters to remove the tidal components increased in the following order: (a) cosine-Lanczos filter; (b) cosine-Lanczos squared filter; (c) Godin filter; and (d) a transform filter. The Godin filter is not sufficiently sharp to prevent severe attenuation of 2- to 3-day variations in surface elevation resulting from weather events. References (4 items).

- Wang, Y.-H. "Satellite Applications on a Coastal Inlet Stability Study." (See complete entry in Section VII.)
- Ward, G. H., Jr. "Pass Cavallo, Texas: Case Study of Tidal-Prism Capture." (See complete entry in Section V.)

- Welch, J. M., and Parker, B. B. "Circulation and Hydrodynamics of the Lower Cape Fear River, North Carolina." (See complete entry in Section I.)
- Wells, J. T., Coleman, J. M., and Wiseman, W. J., Jr. "Suspension and Transportation of Fluid Mud by Solitary-Like Waves." (See complete entry in Section II.)
- West, J. R., Knight, D. W., and Shiono, K. "A Note on Flow Structure in the Great Ouse Estuary." (See complete entry in Section I.)
- Williamson, A. N. 1978. "Movement of Suspended Particles and Solute Concentrations with Inflow and Tidal Action," Technical Report M-78-2, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Landsat (formerly called ERTS-1) data recorded on computer-compatible tapes (CCT's) augmented by data derived from ground control measurements were used to determine the feasibility of detecting alterations of the optical properties of water caused by the movement of suspended particles and solutes in selected portions of the Chesapeake Bay area. Techniques were developed to process CCT's on a PDP-15 computer, establish correlations of radiance and suspended material concentrations, and produce suspended material distribution photomaps. This report discusses these techniques, and includes in appendixes a discussion of experience with automated data collection systems in connection with this study, validation of the computer algorithms for high suspended material concentrations, and by-products that resulted from this study. Reference (16 items).

- Wong, K.-C. "Subtidal Volume Exchange and the Relationship to Atmospheric Forcing in Great South Bay, New York." (See complete entry in Section I.)
- Wong, K.-C., and Wilson, R. E. "An Assessment of the Effects of Bathymetric Changes Associated with Sand and Gravel Mining or Tidal Circulation in the Lower Bay of New York Harbor." (See complete entry in Section 1.)
- Yakuwa, I., Takahashi, S., and Ohtani, M. "Behaviors of the Salt Wedge and the Salinity Distribution at Estuaries." (See complete entry in Section 111.)
- Yoshida, S. "Mixing Mechanisms of Density Current System at a River Mouth." (See complete entry in Section 111.)
- Youakim, S., and Reiswig, H. M. "The Distribution and Elux of Particulate Matter in the Bideford Hiver Estuary, Primee Edward Island, Carata " indee complete entry in Section 11.

REPORTS OF COMMITTEE ON TIDAL HYDRAULICS

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Report No.	Title	Date
1	Evaluation of Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomena	Feb 1950
2	Bibliography on Tidal Hydraulics	Feb 1954
	Supplement No. 1, Material Compiled Through May 1955	Jun 1955
	Supplement No. 2, Material Compiled from May 1955 to May 1957	May 1957
	Supplement No. 3, Material Compiled from May 1957 to May 1959	May 1959
	Supplement No. 4, Material Compiled from May 1959 to May 1965	May 1965
	Supplement No. 5, Material Compiled from May 1965 to May 1968	Aug 1968
	Supplement No. 6, Material Compiled from May 1968 to May 1971	Jul 1971
	Supplement No. 7, Material Compiled from May 1971 to May 1974	Jun 1975
	Supplement No. 8, Material Compiled from June 1974 to June 1980	Dec 1980
	Supplement No. 9, Material Compiled from June 1980 to June 1983	Jun 1985
3	Evaluation of Present State of Knowledge of Factors Affecting Tidal Hydraulics and Related Phenomena (revised edition of Report No. 1)	May 1965

Technical Bulletin No.	Title	Date
1	Sediment Discharge Measurements in Tidal Waterways	May 1954
2	Fresh Water-Salt Water Density Currents, a Major Cause of Siltation in Estuaries	Apr 1957
3	Tidal Flow in Entrances	Jan 1960
4	Soil as a Factor in Shoaling Processes, a Literature Review	Jun 1960
5	One-Dimensional Analysis of Salinity Intrusion in Estuaries	Jun 1961
6	Typical Major Tidal Hydraulic Problems in United States and Research Sponsored by the Corps of Engineers Committee on Tidal Hydraulics	Jun 1963
7	A Study of Rheologic Properties of Estuarial Sediments	Sep 1963
8	Channel Depth as a Factor in Estuarine Sedimentation	Mar 1965
9	A Comparison of an Estuary Tide Calculation by Hydraulic Model and Computer	Jun 1965
10	Significance of Clay Minerals in Shoaling Problems	Sep 1966
11	Extracts from the Manual of Tides	Sep 1966
12	Unpublished Consultation Reports on Corps of Engineers Tidal Projects	Dec 1966
13	Two-Dimensional Aspects of Salinity Intrusion in Estuaries, Analysis of Salinity and Velocity Distributions	Jun 1967
14	Tidal Flow in Entrances, Water-Level Fluctuations of Basins in Communication with Seas	Jul 1967
15	Special Analytic Study of Methods for Estuarine Water Resources Planning	Mar 1969
16	The Computation of Tides and Currents in Estuaries and Canal	Sep 1969
	Appendix A. A User's Manual	Jun 1973
17	Estuarine Navigation Projects	Jan 1971
18	History of the Corps of Engineers Committee on Tidal Hydraulics	Jun 1972
19	A Field Study of Flocculation as a Factor in Estuarial Shoaling Processes	Jun 1972
20	Unsteady Salinity Intrusion in Estuarines	
	Part L. One-Dimensional Transient Salinity Intrusion with Varying Freshwater Inflow	Jul 1974
	Part II Two Dimensional Analysis of Time-Averaged Salinity and Velocity Profiles	Jul 1974
21	Evaluation of Numerical Storm Surge Models	Dec 1980

