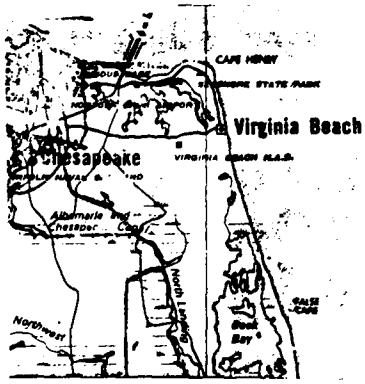
US Army Corps of Engineers



PROCEEDINGS OF THE 50TH MEETING OF THE COASTAL ENGINEERING RESEARCH BOARD

15-17 November 1988

VIRGINIA BEACH, VIRGINIA

Hosted by

US Army Engineer Division, North Atlantic
and
US Army Engineer District, Norfolk

November 1989
Final Report

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These proceedings provide summaries of the papers presented at the semiannual meeting of the Coastal Engineering Research Board (CERB). Also included are discussions of CERB business, recommendations for research and development by CERB members, and public comment.

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PREFACE

The Proceedings of the 50th meeting of the Coastal Engineering Research Board (CERB) were prepared for the Office, Chief of Engineers, by the Coastal Engineering Research Center (CERC), of the US Army Engineer Waterways Experiment Station (WES). These proceedings provide a record of the papers presented, the questions and comments in response to them, and the interaction among program participants and the CERB.

The meeting was hosted by the US Army Engineer Division, North Atlantic, under the direction of MG James W. van Loben Sels, Commander, and the US Army Engineer District, Norfolk (NAO), under the direction of COL Joseph J. Thomas, Commander.

Acknowledgments are extended to the following: Mr. Ronald G. Vann, NAO, who assisted with the coordination of the meeting; Mr. Samuel E. McGee III, NAO, who assisted with the coordination of the field trip; Messrs. Jerry W. Swean, Karl B. Kuhlmann, and Thomas J. Lochen, NAO, LTC William T. Hicok, LTC Charles Groom and CPT Randal C. Baragona, Fort Story, Mr. Jack E. Frye, Commonwealth of Virginia, Dr. Suzette M. Kimball, Virginia Institute of Marine Science, Mr. Carl Thoren, City of Virginia Beach, Mr. James W. Holton, Waterway Surveys and Engineering Ltd., Messrs. Dewey Simmons and Kenneth R. Melson, Virginia Beach Erosion Council, and Mr. James Wright, Historian, all of whom assisted in the field trip. Thanks are extended to all NAO personnel who assisted with various administrative details for the meeting; Mr. Edward Huntington, NAO, photographer, and Mr. Robert Swanson, Video Horizons, who provided audio-visual support. Thanks are extended to guest participants Dr. David R. Basco, Old Dominion University; Dr. Hans Burcharth, University of Aalborg, Denmark; Honorable John W. Daniel, II, Secretary of Natural Resources, and Mr. Jack E. Frye, Commonwealth of Virginia; Dr. Bernard Le Me'haute' and Dr. John D. Wang, University of Miami; Dr. Ole S. Madsen, Massachusetts Institute of Technology; Dr. Edward B. Thornton, Naval Postgraduate School; Dr. J. Richard Weggel, Drexel University; Dr. William L. Wood, Purdue University; and Dr. L. D. Wright, Virginia Institute of Marine Science. Thanks are extended to Mrs. Sharon L. Hanks for coordinating and assisting in setting up the meeting and assembling information for this publication; Dr. Fred E. Camfield for preparing the draft proceedings from the transcript; the Information Technology Laboratory for editing these proceedings; Mrs. Karen R. Wood for typing, all of whom are at WES. Thanks are extended also to Ms. Dale N. Milford, Certi-Comp Court Reporters, for taking verbatim dictation of the meeting.

The proceedings were reviewed and edited for technical accuracy by Dr. James R. Houston, Chief, CERC, and Mr. Charles C. Calhoun, Jr., Assistant Chief, CERC. COL Dwayne G. Lee, Executive Secretary of the Board and Commander and Director, WES, provided additional review.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

PATRICK J. KELLY
Brigadier General, US Army
President, Coastal Engineering Research Board

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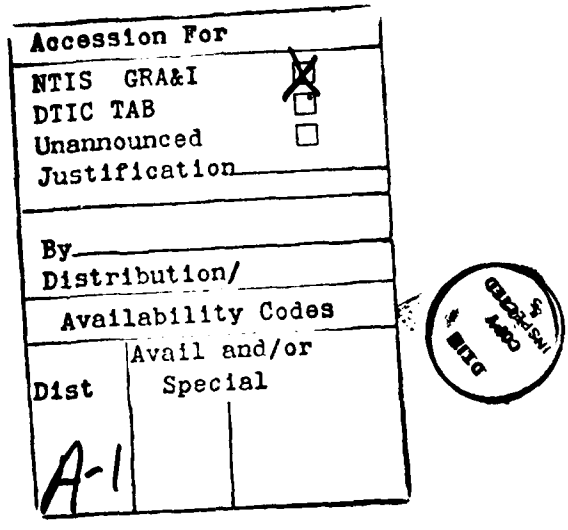

INTRODUCTION

The 50th Meeting of the Coastal Engineering Research Board (CERB) was held at the Sheraton Beach Inn in Virginia Beach, Virginia, on 15-17 November 1988. It was hosted by the US Army Engineer Division, North Atlantic (NAD), under the direction of MG James W. van Loben Sels, Commander, and the US Army Engineer District, Norfolk (NAO), under the direction of COL Joseph J. Thomas, Commander.

The Beach Erosion Board (BEB), forerunner of the CERB, was formed by the Corps in 1930 to study beach erosion problems. In 1963, Public Law 88-172 dissolved the BEB by establishing the CERB as an advisory board to the Corps and designating a new organization, the Coastal Engineering Research Center (CERC), as the research arm of the Corps. The CERB functions to review programs relating to coastal engineering research and development and to recommend areas for particular emphasis or suggest new topics for study. The Board's four military and three civilian members officially meet twice a year at a particular coastal Corps District or Division to do the following:

a. Disseminate information of general interest to Corps coastal Districts and Divisions.

b. Obtain reports on coastal engineering projects in the host (local) District or Division; receive requests for research needs.

c. Provide an opportunity for State and private institutions and organizations to report on local coastal research needs, coastal studies, and new coastal engineering techniques.

d. Provide a general forum for public inquiry.

e. Provide recommendations for coastal engineering research and development.

Presentations during the 50th CERB meeting dealt with long-range research needs in coastal engineering. Documented in these proceedings are summaries of presentations made at the meeting, discussions which followed these presentations, and recommendations by the Board. A verbatim transcript is on file at CERC.

THE COASTAL ENGINEERING RESEARCH BOARD
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50TH COASTAL ENGINEERING RESEARCH BOARD MEETING

Virginia Beach, Virginia
15-17 November 1988
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50TH COASTAL ENGINEERING RESEARCH BOARD MEETING
ATTENDEES (Continued)

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Mr. Robert F. Athow, CEWES-HE-E
Mr. Eugene W. Bichner, CEWES-CD-F
Mr. Charles C. Calhoun, Jr., CEWES-CV-A
Dr. Fred E. Camfield, CEWES-CW-D
Mr. C. E. Chatham, CEWES-CW
Ms. Sharon L. Hanks, CEWES-CV-AC
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CPT(P) James N. Marino, CEWES-CV
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Mr. H. Carl Miller, CEWES-CD-F
Ms. Joan Pope, CEWES-CD-S
Dr. Lawson M. Smith, CEWES-GR-G
Dr. C. Linwood Vincent, CEWES-CP-C

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Dr. Hans F. Burcharth, University of Aalborg, Aalborg, Denmark
Honorable John W. Daniel, II, Secretary of Natural Resources, Richmond, Virginia
Mr. Jack E. Frye, Virginia Public Beach Board, Gloucester Point, Virginia
Dr. Bernard Le Me'haute', University of Miami, Miami, Florida
Dr. Ole S. Madsen, Massachusetts Institute of Technology, Cambridge, Massachusetts
Dr. Edward B. Thornton, Naval Postgraduate School, Monterey, California
Dr. John D. Wang, University of Miami, Miami, Florida
Dr. J. Richard Weggel, Drexel University, Philadelphia, Pennsylvania
Dr. William L. Wood, Purdue University, West Lafayette, Indiana
Dr. L. D. Wright, Virginia Institute of Marine Science, Gloucester Point, Virginia

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Mr. Ernest E. Ball, F. R. Harris, Inc., Virginia Beach, Virginia
Mr. Mark A. Barath, Environmental Protection Agency, Philadelphia, Pennsylvania
Mr. Donald F. Bennis, Virginia Beach Erosion Council, Virginia Beach, Virginia

GUESTS (Continued)
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Mr. Al Craft, Virginia Beach Erosion Council, Virginia Beach, Virginia
Mr. Thomas H. Daniel, City of Hampton, Hampton, Virginia
Mr. Robert W. Grabb, Marine Resources Commission, Newport News, Virginia
Mr. Lee Hill, Dept. of Conservation and Historic Resources, Gloucester Point, Virginia
Mr. James W. Holton, Waterway Surveys and Engineering, Ltd, Virginia Beach, Virginia
Ms. Nancy Ibison, Dept. of Conservation and Historic Resources, Gloucester Point, Virginia
Ms. Ellie Irons, Council on the Environment, Richmond, Virginia
Dr. Suzette M. Kimball, Virginia Institute of Marine Science, Gloucester Point, Virginia
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Mr. Jack W. Mace, Hampton Roads Maritime Association, Hampton Roads, Virginia
Mr. Robert R. Matthias, City of Virginia Beach, Virginia Beach, Virginia
Mr. Kenneth R. Melson, Virginia Beach Erosion Council, Virginia Beach, Virginia
Ms. Ernestine K. Middleton, Virginia Beach Erosion Council, Virginia Beach, Virginia
Ms. Mary R. Morris, City of Virginia Beach, Virginia Beach, Virginia
Honorable Meyera E. Oberndorf, Mayor, City of Virginia Beach, Virginia Beach, Virginia
Mr. Donald W. Perkins, Marine Board, National Research Council, Washington, DC
Mr. John Poland, Dept. of Conservation and Historic Resources, Gloucester Point, Virginia
Mr. Leif T. Rasmussen, Beach Management Systems, Columbia, Maryland
Mr. Edwin L. Rosenberg, City of Norfolk, Norfolk, Virginia
Mr. Edward Scheff, F. R. Harris, Inc., Virginia Beach, Virginia

50TH COASTAL ENGINEERING RESEARCH BOARD MEETING
ATTENDEES (Concluded)

GUESTS (Continued)

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Mr. G. Dewey Simmons, Virginia Beach Erosion Council, Virginia Beach, Virginia

Mr. Carl A. Thoren, City of Virginia Beach, Virginia Beach, Virginia

Mr. John B. Walsh, Waterway Surveys and Engineering, Virginia Beach, Virginia

Mr. Donald T. Williams, City of Virginia Beach, Virginia Beach, Virginia

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50TH MEETING OF THE COASTAL ENGINEERING RESEARCH BOARD

15-17 November 1988
Sheraton Beach Inn
Virginia Beach, Virginia

AGENDA

THEME: Long-Range Research Needs in Coastal Engineering

MONDAY, 14 November

1830 -	Registration and Social Function	

TUESDAY, 15 November

0800 - 0830	Registration	
0830 - 0840	Opening Remarks and Introduction of New Board Members	BG Patrick J. Kelly
0840 - 0850	Welcome to North Atlantic Division	MG James W. van Loben Sels
0850 - 0900	Welcome to Norfolk District	COL Joseph J. Thomas
0900 - 0945	Review of CERB Business	COL Dwayne G. Lee
0945 - 1000	BREAK	
1000 - 1040	Coastal Issues and Needs in the Commonwealth of Virginia	Honorable John W. Daniel, II, Secretary of Natural Resources
1040 - 1120	Virginia Public Beach Board/Summary of Virginia Coastal Needs and the Use of Section 933 Authority for Beach Nourishment	Mr. Jack E. Frye, Virginia Public Beach Board
1120 - 1200	Review of Federal Coastal Projects in Virginia: Channel Deepenings and Beach Nourishment, Maintenance Dredging and Beach Nourishment, Virginia Beach Hurricane Protection, and other projects	Mr. Samuel E. McGee III, Norfolk District
1200 - 1300	LUNCH	
1300 - 1700	Field Trip	Mr. Ronald G. Vann, Norfolk District Coordinator

Site 1 - Virginia Beach

Hurricane Protection Project, Seawall Design, Beach, Dunes and Interior Drainage	Norfolk District
55-Foot Channel Deepening Section 933 Report	Norfolk District
City of Virginia Beach Perspective on Coastal Needs	City of Virginia Beach

Site 2 - Rudee Inlet

Inlet Processes, Dredging Program, and Virginia Beach Nourishment Project	Director, Virginia Beach Erosion Commission
Rudee Inlet Federal Navigation Project and Impact on Adjacent Shoreline	Norfolk District

Site 3 - Fort Story

Commander's Briefing on Military Coastal Engineering Issues	Commander, Fort Story
LAC-V-30 Military Hovercraft Demonstration	11th Transportation Battalion
Briefing on the Historical Significance of the Cape Henry Lighthouse which is the First Civil Works Project Authorized by the US Congress	Mr. James Wright, Historian
Break and Refreshments	

Site 4 - Lynnhaven Inlet

Briefing on the Successful Use of Maintenance Dredging for Beach Nourishment at Lynnhaven Inlet	Norfolk District

1700 - Social Hour and Dinner

AGENDA (Continued)

WEDNESDAY, 16 November

0830 - 0845	Opening Remarks	BG Patrick J. Kelly
0845 - 1000	Long-Range Outlook for Coastal Engineering in the Corps	Mr. James D. Davidson, Deputy Chief, Planning Division Mr. John A. McPherson, Assistant Chief, Engineering Division Mr. John J. Parez, Operations and Readiness Division Mr. Ted A. Pellicciotto, Assistant Chief, Dredging Division
1000 - 1020	BREAK	
1020 - 1040	Introduction and Review of Coastal R&D Program	Dr. James R. Houston, CERC
1040 - 1700	Future Directions in Coastal R&D	
1040-1210	Hydrodynamics (Waves, currents, Panel wave/structure interaction, storm surge, tidal circulation, etc.)	Dr. C. Linwood Vincent, CERC, Moderator Dr. Edward B. Thornton, Naval Postgraduate School Dr. Hans E. Burcharth, University of Aalborg, Denmark Dr. John D. Wang, University of Miami
1210 - 1310	LUNCH	
1310 - 1440	Sediment Transport (longshore, navigation channel shoaling, erosion, beach fills, etc.	Panel Dr. Nicholas C. Kraus, CERC, Moderator Dr. Ole S. Madsen, Massachusetts Institute of Technology Dr. J. Richard Weggel, Drexel University Dr. L. Donelson Wright, Virginia Institute of Marine Science
1440 - 1500	BREAK	
1500 - 1545	Instrumentation (National Research Council Study)	Dr. William L. Wood, Purdue University
1545 - 1700	Facilities	Dr. Bernard Le Me'haute', University of Miami

AGENDA (Concluded)

THURSDAY, 17 November

0800 - 0805	Opening Remarks	BG Patrick J. Kelly
0805 - 0830	Structure Design Criteria	Dr. Steven A. Hughes, CERC
0830 - 0845	Report on the Workshop for Practicing Coastal Engineers	Dr. David R. Basco, Old Dominion University
0845 - 0915	National Science Foundation Science and Technology Centers	Dr. Dag Nummedal, Louisiana State University
0915 - 0945	Public Comment	
0945 - 1000	Joint Logistics-Over-The-Shore Briefing	CPT(P) James N. Marino, CERC
1005 - 1015	BREAK	
1015 - 1115	Board Recommendations	CERB
1141 - 1130	Closing Business and Remarks	BG Patrick J. Kelly
1130	ADJOURN	

OPENING REMARKS AND WELCOME TO NORTH ATLANTIC DIVISION

BG Theodore Vander Els opened the 50th meeting of the Coastal Engineering Research Board (CERB) on behalf of BG Patrick J. Kelly, President of the Board. He noted that since the previous meeting, LTG Henry J. Hatch had become Chief of Engineers, and BG Kelly had become Director of Civil Works and President of the Board. MG Robert M. Bunker, Commander of the South Atlantic Division, and BG Robert C. Lee, Commander of the Southwestern Division, had also been appointed as military members of the Board. On the civilian side, Professor Robert O. Reid of Texas A&M University had been appointed to the Board.

BG Kelly said he would cover some topics to show how the CERB is fulfilling its mission of looking at the coastal needs of the United States. Three years previously, LTG E. R. Heiberg III, then Chief of Engineers, laid out a series of initiatives for the CERB to consider. The CERB established working groups and held special meetings to address those initiatives. One initiative was to involve the US Army Engineer Waterways Experiment Station (WES) in assisting the private sector to make United States firms competitive with foreign firms on overseas projects, and at that time we found that we did not have the authority. The Corps offered legislation supported by the Assistant Secretary of the Army for Civil Works and the Office of Management and Budget, and the Water Resources Development Act of 1988 included the necessary authority allowing the private sector to use WES facilities for projects outside the United States.

Another action taken by the CERB was to institute themes for our meetings, and to choose meeting locations that would support the themes. At the Board's meeting in Savannah, Georgia, in November 1987, the theme was "Sea Level Rise." Following that meeting, the Board of Engineers for Rivers and Harbors looked at sea level rise (SLR) in more detail to develop ideas as to how the Corps needed to adjust based on what the CERB recommended in Savannah. The after-action list shows the Planning Division in the Directorate of Civil Works is about ready to finalize an Engineer Circular (EC) that will provide guidance to the field on what to do about SLR.

The Board also spent a lot of time on coastal engineering education. That effort came from one of LTG Heiberg's initiatives and had input from the civilian members of the Board. BG Kelly said that the main point is that this particular Board is really making a difference. Its activities and recommendations are affecting the way we now conduct business in the US Army Corps of Engineers (USACE), and how we will conduct future business.

MG James van Loben Sels welcomed the CERB to North Atlantic Division. He noted that he was a previous Board member. He said there remained great challenges facing the Corps and the public, and there were real-world issues on our coasts. We are looking at another set of problems in storm protection and coastal erosion, in fixing problems we thought we fixed before. He noted he was encouraged to see the interest in education from Corps staff because the experience level and talent we have on our staff is an increasing problem as we face retirements and competition in the work place for talented employees.

COL Joseph J. Thomas welcomed the CERB to Norfolk District. He thanked the City of Virginia Beach, the Erosion Council, and the Hampton Roads Maritime Association for their participation. He noted that Norfolk District is deeply involved in coastal issues and the cost-sharing environment has increased the need for long-range research and technology sharing in coastal engineering. The cost-share partners want to share the best information and take a larger role in the decision-making process as a basis for their continued participation.

COL Thomas said that although Districts are not tasked with a research mission, Norfolk District has taken advantage of opportunities to increase coastal engineering knowledge in areas such as navigation channel design, stability of bars constructed with dredged material, and beach nourishment. During the Norfolk Harbor deepening studies, the leading edge of available technology in ship hydrodynamics, offshore surveying methods, and sediment stability measurements was used. From those efforts, it was learned that there is a continuing need for further research in those and other areas. There is a need for field verification studies, improved design methods and formulae, and engineer manuals for use by Districts and other field operating agencies. He noted that the District has worked closely with CERC and other research organizations, and will continue to support this close relationship because of the mutual interest in developing sound coastal engineering procedures.

REVIEW OF COASTAL ENGINEERING RESEARCH BOARD BUSINESS

COL Dwayne G. Lee, Executive Secretary
Coastal Engineering Research Board
Commander and Director
US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

At the last CERB meeting in Oconomowoc, Wisconsin, we were directed to formalize the action item list, and this has been done. The list for the last Board meeting is on Page 21. The Board members have been given the status of action items from the Corpus Christi through Savannah Board meetings. The action item list will be updated prior to each meeting and provided to the Board as read-ahead material.

I am now going to cover the status of the action items from the last Board meeting. Item 1 is the charge to formalize the action item list. Item 2 concerns the education program for Corps coastal specialists proposed by Dr. James R. Houston, Chief, CERC, at the last meeting. LTG Heiberg had charged CERC with developing a plan after he reviewed the Board's recommendations on the need for an educational program for Corps specialists. The Board endorsed the plan presented by Dr. Houston and charged CERC with formalizing the proposed education program so it could be staffed in Headquarters (HQUSACE). In addition, CERC was charged with exploring the feasibility of expanding the program (Item 3).

CERC formalized the plan after the last Board meeting, and the plan was sent under the signature of the Acting President of the Board, BG Kelly, to the Director of Civil Works for staffing in HQUSACE. A short time later, BG Kelly was appointed Director of Civil Works. The plan was staffed by Planning Division, HQUSACE.

Comments on the plan came from the Training and Development Branch, Personnel Office, HQUSACE. The Training Branch recommended, before a program be considered, that it conduct both a thorough job analysis to determine skills needed by Corps specialists and a training needs survey to determine deficiencies in training. The Training Branch would then develop an education and training program to satisfy identified deficiencies.

Dr. Houston met with personnel from the Training Branch and reiterated the extensive groundwork by the Board to establish the need and composition of the plan. He noted the Working Group established by the Board conducted six regional meetings with coastal specialists to establish education needs. This was followed by two detailed education and training surveys that went to all coastal Districts and Divisions under the signature of LTG Hatch. The Board then reviewed the recommendations of the Working Group and results of the surveys. These results, coupled with the Board's

own observations of deficiencies in the Corps' coastal engineering expertise, led to the Board's recommendation to the Chief of Engineers that an education program be adopted.

The Training Branch directed Dr. Houston to Mr. Lloyd Duscha, Deputy Director, Engineering and Construction Directorate, and the proponent for education and training of engineers and scientists in the Corps, since a proponent outside the Personnel Office is needed to initiate a program. Dr. Houston met with Mr. Duscha and explained the plan in detail. After discussion, Mr. Duscha asked Dr. Houston to prepare paperwork to take the proposed program before the Corps Training Issues Committee that Mr. Duscha chairs. The proposed program was presented to the Training Issues Committee last week, and approval is pending.

We have explored the feasibility of expanding the program to participants from the private sector, state and local governments, foreign nationals, and military officers. Participants from the private sector and state and local governments can attend government courses on a cost reimbursable basis after all government personnel requests are met (i.e. they can complete classes that are not filled). The WES Graduate Institute currently has personnel from the private sector and local governments attending classes in Vicksburg under these ground rules. There may be problems with the Corps directing these individuals to particular universities, so if the program proves viable in the Corps after the pilot test at Texas A&M, we may recommend opening the program to any university willing to teach required courses of the program.

Foreign nationals could attend this program under the Exchange Visitor Program of the State Department. Approval would be required by the Assistant Secretary of the Army for Civil Works. Again, inclusion of foreign nationals could be instituted when the pilot effort proves the program viable and the program is opened to other universities. It is likely the program would prove popular to foreign nationals. CERC has received inquiries over the last year from countries such as Korea, Brazil, and Malaysia concerning education and training in coastal engineering.

The participation of the military officers in this program was an interesting concept raised by BG Vander Els. CPT(P) James Marino of CERC is one of the few military officers in the Army with an advanced degree in coastal engineering. He received a masters degree in coastal engineering from the University of Florida under an Army Educational Requirements Board assignment.

We conducted a survey of all Corps Districts and Divisions to determine if Commanders saw a need for officers with advanced degrees in coastal engineering. Page 22 is a fact sheet and documentation prepared by CPT(P) Marino on the results of the survey. The responses indicated eight out of nine coastal Divisions saw need

for uniformed coastal specialists. South Pacific Division (SPD), North Central Division (NCD), and North Atlantic Division (NAD) indicated it would be ideal to have one officer in each of their Districts so trained. New England Division (NED) responded that a graduate program for coastal engineers is "much more appropriate for our civilian work force." A major problem seems to be that field offices currently have far fewer officers assigned than they need. Many might like officers with advanced degrees in coastal engineering if they were fully staffed with officers to meet all their needs.

If the Board believes having military officers in the education program is warranted, the next step would be to recommend this action to the US Army Engineer School through LTG Hatch. The Engineer School would be the proponent of the program in the military personnel system of the Army if it concluded the program had a high priority versus other training and education needs in the Army. It is likely the process of establishing a program would be a lengthy one.

A panel at our last meeting addressed the topic of coastal Research and Development (R&D) on the Great Lakes. They discussed the recommendations of the Ann Arbor Workshop on Great Lakes Coastal Erosion Research Needs. NCD was tasked with prioritizing and coordinating research needs in the Great Lakes from a USACE perspective (Item 4). The Division has been in contact with Dr. Parsons of the University of Michigan, and has added NCD's support for the upcoming second workshop on research needs to help set priorities on future Great Lakes coastal engineering research. The Michigan Sea Grant College Program is acting as the sponsor for this effort. The next workshop will be held on 30 November after results of the Great Lakes field experiments of September 1988 become known. These were comprehensive experiments involving many participants including CERC, NCD, and several universities, and were similar in organization to the experiments conducted previously at Duck, North Carolina (Duck '85 and SUPERDUCK). CERC researchers have been invited and will participate in the workshop.

Another action item from our last meeting was to consider the possibility of establishing a Great Lakes Technical Information Center as a repository for Great Lakes coastal information (Item 5). NCD has identified the International Joint Commission as a logical repository, if a central location is desired. However, the various universities with Sea Grant affiliations in the Great Lakes region already collect coastal information. A great deal of duplication would result from a central location. Researchers would probably continue to use the local sources of information. The concept of a central repository will be explored further by NCD at the forthcoming Great Lakes Coastal Research Workshop.

As directed at our last meeting (Item 6), a technical information meeting was convened on 1 - 2 August between NCD (Buffalo and Detroit Districts), WES (CERC,

Hydraulics, and Environmental Laboratories), US Army Cold Regions Research and Engineering Laboratory (CRREL), Hydrologic Engineering Center (HEC), National Oceanic and Atmospheric Administration (NOAA's) Great Lakes Environmental Research Laboratory (GLERL), and the Environment Canada. The purpose of the meeting was to exchange information concerning a procedural approach to assess the capabilities of existing numerical models for the Great Lakes basin. The meeting concentrated on regulating Lake Ontario water levels. Possible improvements to the regulation plan were identified. WES was asked to undertake further hydraulic analyses of the adverse current problems in the St. Lawrence River. CRREL will develop and implement the Ice Forecasting System Model, including a real-time data system for the St. Lawrence River. HEC will develop improvements in statistical water supply determinations with applications in making the regulation plan's water supply indicator more sensitive to changes in conditions. They will also develop software for interacting with the St. Lawrence River ice model and Lake Ontario water supply forecasting model. GLERL/NOAA will develop a Large Lake Basin Model and water supply forecast.

There was a request at our last meeting to assess the state of instrumentation needs to support coastal engineering R&D (Item 7). CERC has supported, over the past 18 months, a study by the Marine Board of the National Research Council (NRC) to address this problem. Dr. William L. Wood of Purdue University, who was the Vice Chairman of the NRC study, will report on the preliminary findings tomorrow afternoon.

I reported at our last meeting that legislation was pending which would create a 2-year demonstration program for providing technical assistance, on a non-exclusive basis, to any United States firm which is competing for, or has been awarded, a contract for planning, design, or construction of a project outside the United States. The United States firm must provide funds to cover all costs of such assistance. That legislative language was included in the Water Resources Development Act of 1988 and now has been passed. This legislation may accommodate the need discussed at several Board meetings for CERC to aid United States firms in competition with foreign firms that have access to their national laboratories. I also reported that the Assistant Secretary of the Army for Civil Works had worked for initiation of the Construction Productivity Advancement Research Program, which provides for cost shared R&D between the Corps and non-Federal entities including state and local governments, universities, and the private sector. The legislation has authorized funding of $3.0 million for the current FY.

Finally, CERC ended a record year on 30 September with income up over 35 percent. The greatest increase came in reimbursable work which was up over 45 percent. The General Investigations funded Coastal Engineering R&D Program had its first increase this decade with funding up over 5 percent in FY 88. Contracting by

CERC was up almost 45 percent with high levels of contracting in the new Dredging Research Program.

Now I would like to turn the floor over to Mr. John Oliver from North Pacific Division and chairman of the Automated Coastal Engineering (ACES) pilot committee for a short update on ACES.

Mr. Oliver presented an update on the ACES program. He reported that there had been five workshops during the summer on the first ACES package of eight applications. Seven new applications were introduced into the basic ACES group during the last fiscal year. Work has continued on developing the basic hardware platform. Programs have been getting increasingly more complex. The ACES hardware group is recommending a 386 machine configuration that will cost from $13,000 to $20,000 per District. The Disk Operating System that is commonly used now will have to be modified to take full advantage of this machine. With the consensus of the CERB, the ACES group would like to recommend to coastal Districts that they consider purchasing this kind of equipment in their future program of equipment purchases. This would make their equipment compatible with software development that we have planned over the next several years.

Mr. Oliver said that they recommended concentrating on a single basic hardware platform for ACES. With concurrence of the Board, they would like to make a recommendation on that platform to the Districts.

DISCUSSION

Referring back to the training initiative, COL Lee said that approval had just been received the previous day, and that deliberations were now underway on just when to start the first session of that program. Tentatively, the program will start in the fall of 1990. There are two reasons for starting at that time. First, it will take some time to advertise the existence of the program to Corps Districts so that potential candidates are aware of the opportunity. Secondly, Texas A&M University would like a little more lead time to prepare to teach the courses included in the program.

BG Kelly asked for a review of the program. Dr. Houston said that under the current structure, the students would spend 9 months on campus at Texas A&M University taking all the basic courses needed in coastal engineering. They would then spend 3 months at CERC, including some time at the Field Research Facility, taking courses in physical and numerical modeling, and field measurements. They would also work on a project. Dr. Houston said that a minimum of six students would probably be required to make it a viable program. The maximum number would probably be a dozen. About six to eight students would be a reasonable expectation. Initially the program would probably be offered once every three years.

Dr. Mei said that although it is difficult to estimate the number of students in the beginning, the number of students could very well exceed six as the program goes on. He asked if there was any advantage to having the program every year. Dr. Houston said that in the current long-term training program of the Corps he did not anticipate enough students for offering the program every year, but as the program becomes established it might attract more students. The Corps has a certain number of spaces

in long-term training, and they are spread across a number of disciplines. Other disciplines could perhaps start similar programs.

Dr. Nummedal asked if the proposed training program would meet the needs of military personnel. COL Lee replied that no alteration of the program was proposed. However, the Army has a well-established procedure and process for determining the Army's needs for educating its officer corps, how academic programs are established, and how officers compete and are selected for those assignments. Whether or not this program will be identified as a potential program for training military personnel is something the Corps needs to take under careful consideration. The process will not be universally accepted, and the program will not meet unanimous approval. It will take a long time to achieve results, either positive or negative. BG Vander Els added that they did not want to tamper with some fundamental courses in the discipline, but the Army needs to know why they should be spending money to send uniformed personnel to study a particular discipline.

Dr. Oswald raised the question of other people who might be interested in the program, if Texas A&M advertised its availability. Dr. Houston said that it was probable that other students would be interested, and that there was an advantage to Texas A&M of being able to guarantee a specific program. A question was raised about other people attending the three-month session at CERC, and it was noted that was a possibility. It is possible that some Corps employees who already have advanced degrees may just want to attend the three-month session under a short-term training assignment.

BG Kelly noted that on the military side, the Corps does need military officers trained in coastal engineering so that we have some talent in that particular discipline. They will have to do some work to explain why, because he feels that they do need them.

Mr. McCann asked if the proposed program would be an add-on or would be competing with other programs for available long-term training spaces. Dr. Houston said it is part of the current long-term training program, but he noted that the major focus is to give people a strong fundamental technical background in coastal engineering, so it would probably complement a program like the Planning Associates.

ACTION ITEMS
FROM 49TH COASTAL ENGINEERING RESEARCH BOARD (CERB) MEETING

Item	Proposed Action Agent
1. Formalize action item list, maintain status of item, and provide to each CERB member as part of his read-ahead material.	CERC
2. Formalize the education proposal for USACE coastal engineers and submit to Corps of Engineers Civil Works for HQ staffing.	CERC
3. Explore feasibility of expanding USACE coastal engineers education course to private sector, university, foreign, and/or uniformed participants.	CERC
4. Prioritize and coordinate research needs of USACE in the Great Lakes from a USACE perspective.	NCD
5. Explore possibilities and merits of establishing a Great Lakes Technical Information Center as a repository for Great Lakes coastal information.	NCD
6. Convene a technical information meeting between NCD, WES, HEC, and the Great Lakes Environmental Research Laboratory to exchange information concerning a procedural approach to assess the capabilities of existing numerical models for the Great Lakes basin.	WES
7. Assess the state of instrumentation needs to support coastal engineering R&D and report back to CERB in November 1988.	CERC

FACT SHEET

USAEWES, CEWES-CV
CPT(P) Marino/2010
31 October 1988

SUBJECT: Education of Military Port/Coastal Engineers in USACE

PURPOSE: To determine the need for the education of active-duty military officers in port/coastal related disciplines for USACE.

FACTS:

1. Military port/coastal engineers played important roles in both the Pacific and European Theaters in WWII, in Korea, in Vietnam and in the Falkland Islands.

2. The number of officers holding graduate degrees or specialty training in the port/coastal engineering field cannot be simply determined from Headquarters, Department of the Army.

a. Discussions with members of the Professional Development Branch at TAPA disclosed that there is no code to identify these officers.

b. A manual search through each officer's file would have to be conducted to determine any graduate or specialty training in this field.

3. Scheduling of formal training in this field will not take place at TAPA until the US Army Engineer School proponent presents its requirements. TAPA is presently changing the Army Educational Requirements Board (AERB) to the Army Educational Requirements System (AERS). A significant change in the process is the constant mentoring that will be established between the student, TAPA, and the gaining activity.

4. The curricula of a typical graduate coastal engineering program and a water resources/hydrology program coincide for approximately one half of the total course load (Encl 1). It is feasible to take one additional semester in either specialty to obtain a second degree in either respective field.

5. Survey forms were sent to each Division (Encl 2). Of the 9 coastal Divisions, 8 have indicated a desire for port/coastal engineering trained military officers in their respective Districts (Encl 3). One Division (NED) can identify needs, but does not believe formal education in this field is appropriate for its officers.

6. Seventeen Districts desire to have one or more officers trained in the port/coastal engineering field (Encl 3).

7. These officers would be used in the Planning, Operations, Engineering, Resident, and Emergency Actions offices in the Districts (Encl 3).

8. There is no clear preference as to the choice of training desired, whether it be civil-schooling, WES Graduate Institute, or a short course (Encl 3).

9. Eight Divisions find a valid need for military officers to be trained in this field in both peace and war-time scenarios

Specific requirements include:

a. Emergency actions.
b. Hurricane damage and mitigation of coastal effects.
c. Dredging of ports and harbors in Third World scenarios.
d. Wartime contract administration services.
e. Logistics planning.
f. Theater of operations development planning.
g. Mobilization planning.
h. Infrastructure development.
i. Logistics-Over-The-Shore, port construction, and amphibious operations.
j. Liaison with the Navy and MTMC with respect to design and construction requirements.
k. The Port Readiness Program.
l. Navigation.
m. Rehabilitation of ports and channels.
n. Foreign Military Sales MILCON.

GRADUATE CURRICULA COMPARISON

PORT/COASTAL ENGINEERING (University of Florida)	WATER RESOURCES/HYDROLOGY (Texas A&M University)
MATCHING	
Principles of Engineering Analysis I	Statistics in Research I
Principles of Engineering Analysis II	Statistics in Research II
Open Channel Flow	Hydraulics of Open Channels
Intermediate Fluid Dynamics	Computational Fluid Dynamics
Research	Research
DIFFERING	
Port and Harbor Engineering	Hydrology
Ocean Waves I: Linear Theory	Hydraulic Engineering
Coastal Processes	Water Resources Development
Tidal Inlet Engineering	Water Resources Systems Engineering
Littoral Processes	Methods of Improvement for Construction Management.
Sediment Transport	
Selected Field and Lab Problems	
Coastal and Offshore Structures	

CEWES-CV-Z 4 August 1988

MEMORANDUM FOR: ALL USACE DISTRICT/DIVISION COMMANDERS

FROM: COMMANDER, USAE WATERWAYS EXPERIMENT STATION

SUBJECT: Graduate Education of Active-Duty Military in Coastal/Port Engineering

1. At the last USAE Coastal Engineering Research Board (CERB) meeting, the Director of Civil Works requested an assessment of the need for educating active-duty military officers in the field of coastal/port engineering. Since most coastal engineering needs of the Army are within the Corps, our initial assessment is being restricted to USACE. I would appreciate your response to the following questions and any comments you feel appropriate to add to the subject.

2. Questions:

a. What percentage of work, either in man-hours and/or dollars, is port or coastal related (to include dredging requirements), in your respective District/Division?

b. If you had a military officer with a coastal/port engineering degree, where would you utilize him - planning, engineering, con-ops or in a field/resident office?

c. Based on your workload, do you desire to have any of your officers trained in coastal/port engineering? If so, how many?

d. If you believe that training one or more of your officers in coastal/port engineering is beneficial, would you prefer that:

(1) He attend a fully funded civilian graduate program prior to arriving at the District/Division?

(2) He attend courses at the USAE Waterways Experiment Station's Graduate Institute, either prior to or during his District assignment?

(3) He attend a coastal engineering short course operated out of the Huntsville Division?

e. Based on your experience, what military requirements, both wartime and peacetime, do you see as possible uses for an officer with a coastal/port engineering background?

3. Your response by 31 August 1988 would be greatly appreciated so we can discuss this at the next CERB meeting in October. Responses may be sent via On-Tyme (CORPS.CEWES-CV-Z1) or hard copy to Commander, USAE Waterways Experiment Station, ATTN: CEWES-CV, P.O. Box 631, Vicksburg, MS 39181-0631. Point of contact for any questions or discussion related to this subject is CPT(P) James N. Marino, CEWES-CV, (601) 634-2010.

//signed//
DWAYNE G. LEE
Colonel, Corps of Engineers
Executive Secretary

DISTRICT/DIVISION RESPONSE MATRIX

QUESTIONS:

A: Percentage of work port or coastal related in District/Division?

B: Where would you utilize officer w/coastal degree - planning, engineering, con-ops, or in a field/resident office?

C: How many could you use?

D: Training preferred: 1-fully-funded; 2-WES; 3-short courses

E: Requirements, peacetime - wartime?

DIVISION/DISTRICT		A	B	C	D	E
NED		50%	P,E,CO	1	3	NO
NAD		35%	E,CO	1/DIST	3,2	YES
	NAP	65%	DEP DE	1	2,3	YES
	NAO	50%	P	1	N/A	NO
	NAB	**$	CO,E,P	1	3	YES
SAD		31%	P,E,CO		1,2	YES
	SAJ	43%	P,E	2	1,2,3	YES
	SAS	20%	E,O	1	2,3	YES
LMVD						
	LMN	50%	RO,P,E	1	1	YES
	LMM	4%	P,E	0	N/A	YES
SWD						
	SWT	1%	O	0	3	YES
	SWL	3%	CO	1	2,3	YES
	SWG	80%	DEP,P,CO	1	3,2	YES
SPD		21%	P,E,EA	2	1,2,3	YES
NPD		15%	P,E,CO	2	2,1,3	YES
NCD		20%	ALL	3	1,3	YES
POD		--	--	1	--	YES
ORD		0%	N/A	N/A	N/A	N/A
MRD		0%	N/A	0	N/A	YES
HND		N/A	E	0	N/A	YES
EUD		0%	N/A	0	N/A	--

P - Planning
E - Engineering
O - Operations
DEP DE - Deputy District Engineer
CO - Con-ops
RO - Resident Office
EA - Emergency Actions
DEP - Deputy
**$ - 80M

COASTAL ISSUES AND NEEDS IN THE COMMONWEALTH OF VIRGINIA

Honorable John W. Daniel, II
Secretary of Natural Resources
Commonwealth of Virginia
Richmond, Virginia

Historically, land use planning has been left to the discretion of local rather than state governments. The realization of the potential detrimental effects of uncontrolled growth on natural resources provides an impetus for state involvement in those matters. Because resource protection goals frequently are long-range and encompass large geographic areas, state involvement can help determine appropriate resource protection measures, provide technical and financial assistance, and remove some of the competitiveness from local land use decisions.

In an effort to address the adverse impact of shoreline development on the water quality and water resources of our coastal zone, the 1988 Virginia General Assembly enacted the Chesapeake Bay Preservation Act. The Act creates the Chesapeake Bay Local Assistance Department to provide technical assistance to localities in Tidewater Virginia to help them incorporate general water quality protection measures into their comprehensive plans, and zoning and subdivision ordinances.

The Department is governed by the Chesapeake Bay Local Assistance Board made up of representatives of each of Tidewater's nine planning Districts, and will help localities define Chesapeake Bay Preservation Areas and provide criteria for use by local governments in their planning, zoning, and subdivision activities. The criteria will incorporate such measures as performance standards, best management practices, and various planning and zoning concepts.

Along with the Preservation Act, the 1987 Chesapeake Bay Agreement stands as a testament to the leadership and desire to protect and preserve our coastal resources. The Agreement contains goals and commitments for protection of living resources; enhancement of water quality; management of the environmental consequences of population growth and development; development of public access to the Bay; and increased public information and participation.

The Agreement section which addresses population growth and development provides state and Federal agencies with a mandate -- and an opportunity -- to lead the way in developing, demonstrating, and practicing the best methods for minimizing the negative environmental impacts associated with development. By the year 2000, Virginia's population will be 6.6 million, a 17 percent increase over the 1985 population of 5.7 million. Greater demands will be placed on our land area, transportation networks, water sources, forests, waste disposal systems, game and wildlife, and recreational areas.

The Agreement commits the Bay states, the District of Columbia, Environmental Protection Agency, and the Federal Government to develop a set of policies and guidelines to reduce the impacts of development on water quality and living resources and to evaluate all state and Federal projects in light of their potential impacts on water quality and living resources. Likewise, the development of a toxins reduction strategy, and enhanced protection of wetlands, coastal sand dunes, and riverine forest buffers are mandated.

A major step in Virginia's effort to clean up the Bay was achieved with the passage of legislation banning phosphate laundry detergents. Virginia is also leading the nation in restrictions, approved by the 1987 General Assembly, on the use of marine paints containing tributyltin (TBT). TBT is a toxic pesticide which prevents barnacles and other organisms from growing on boat hulls, but according to studies, can harm or kill a variety of aquatic life, including oysters and other shellfish.

An important part of the Bay Agreement is the stipulation of the development of a Bay-wide wetlands protection policy. Since the enactment of the Virginia Wetlands Act, the destruction of our tidal wetlands has been reduced significantly, but some estimate the loss of Virginia's nontidal wetlands has been as high as 57,000 acres -- or seven percent of the total -- in the last 30 years. The 1989 Virginia General Assembly will consider nontidal wetlands legislation -- intended to discourage the avoidable elimination of wetlands -- which was carried over from its last session.

Measures to increase anadromous fish stocks are being developed. The decline of these species have been attributed to several causes including over-fishing, pollution, climatic conditions, and elimination of upstream spawning habitat sites. Currently, hundreds of miles of breeding grounds are blocked by a few dams.

The Agreement is an excellent example of intergovernmental cooperation and of the leadership, energy and dollars that we are investing in our coastal areas. It points out that no matter how careful we have been in the past or the role we play, we are going to have to do a better job of protecting our coastal resources.

DISCUSSION

Dr. Nummedal noted that most of Virginia's marshes are currently in balance between the current rate of sea level rise and the amount of sediment that comes in and accretes those marshes. He asked what would be in store for Virginia's marshes in the future if the rate of sea level increases. Mr. Daniel said that clearly some marshes are going to drown, but there is not a great deal that can be done about that particular fact. It is necessary to educate people with respect to the value of those resources, and to try to address those things that we do have some control over.

VIRGINIA'S PUBLIC BEACH PROGRAM: SUMMARY OF VIRGINIA COASTAL NEEDS AND THE USE OF SECTION 933 AUTHORITY FOR BEACH NOURISHMENT

Jack E. Frye
Division of Soil and Water Conservation
Department of Conservation and Historic Resources
Gloucester Point, Virginia

The Commonwealth of Virginia has been blessed with over 5,000 miles of tidal shoreline. Approximately 740 miles are sandy beach. The 23 locally controlled public beach sites account for 24 miles (3.2%) of the 740 miles of sandy beach.

Established in 1980, the Board on Conservation and Development of Public Beaches (Public Beach Board) administers a 50-50 matching grant fund to localities for public beach enhancement. The eight member Board is composed of 6 Governor appointees and ex-officio representatives from the Virginia Department of Conservation and Historic Resources and the Virginia Marine Resources Commission. The Board is instrumental in coordinating the Commonwealth's beach management and development program.

Sand Resource Inventory

Beginning in 1981, the Commonwealth began a research effort to delineate beach quality sand deposits in the lower Chesapeake Bay. Since then, the search area has been expanded to include the nearshore shelf adjacent to the City of Virginia Beach. The Sand Resource Inventory has identified over 150 million cu yds of beach quality material. Data collection takes into account the various environmental factors, both biological and physical, in evaluating a potential site.

Wave Data Collection Program

Little continuous wave data are available for the Lower Chesapeake Bay and Atlantic Coast of Virginia. An effort is underway to begin a continuous data collection program to provide the necessary data for improving coastal engineering and wave modeling efforts. Presently, the Commonwealth is funding this program with a combination of Federal Coastal Zone Management funds and state and local funds. The Commonwealth is interested in joining with the Corps of Engineers to become a part of the Field Wave Gauging Program to collect long-term, nearshore wave data.

Chesapeake Bay Shoreline Study

The Chesapeake Bay Shoreline Study is a cooperative project of the Commonwealth of Virginia and the Corps. The purpose of the project is to examine closely the effectiveness of gapped offshore breakwaters and the headland concept for shoreline erosion control. If successful, these structures may reduce the cost of shoreline erosion control while maintaining a more natural shoreline environment than that which results from continuous structures.

Federal Navigation Projects and Section 933 Opportunities

The Norfolk District Corps of Engineers is tasked with responsibility for maintaining the navigable channels for the Port of Hampton Roads and the nation's largest concentration of military installations. Federal navigation projects offer excellent opportunities for localities to receive large quantities of suitable sand. In addition, Section 933 of the Water Resources Development Act of 1986 provides the opportunity for 50-50 Federal cost-sharing for beach nourishment from Federal navigation dredging projects.

As part of the dredging of the Cape Henry Channel in 1989, 964,000 cu yds of sand will be placed along 4 miles of Virginia Beach under an approved Section 933 study. This will be the first Section 933 Federal cost-share project in the United States.

Planning is underway to dredge Virginia's Norfolk Harbor Channels to 55 ft in the early 1990's. This greater depth would provide an estimated 5 million cu yds of suitable beach sand. Section 933 studies are already underway on nine beaches in four localities.

Beneficial Dredged Material Usage

The Commonwealth is interested in working with the Corps of Engineers to improve the use of suitable dredged material for beach renourishment, feeder beaches, nearshore stockpiles, and offshore berms. The need for careful planning to provide adequate long-range disposal and maximum usage of suitable material is becoming increasingly evident.

DISCUSSION

BG Kelly requested comments from Mr. Davidson and Mr. Pellicciotto. Mr. Davidson said that the Corps had a draft EC giving policy guidelines on coastal systems analysis and regional shore protection efforts, which directs the Corps efforts toward analyzing the beneficial effects of a comprehensive nature. The EC states, "Our analysis will extend beyond the project site, provide a comprehensive view of shoreline bounded by natural limits to significant littoral transport and associated beach processes." Mr. Pellicciotto said that a lot of states are asking for beneficial use of dredged sand. The Corps is working very closely with the states to see, economically and environmentally, what to do with the sand. Upland sites for placement of dredged material are difficult to find. The Corps has organized a long-term management of dredged material committee to look into this. The Corps is looking at the beneficial use of dredged sand, and is working on solutions to try to help states and localities.

Dr. Mei asked Mr. Frye who receives the wave data that are collected. Mr. Frye said that right now the data are being collected by Old Dominion University and the Virginia Institute of Marine Science. Right now the data collection is in its early stages. The biggest issue is the development of hydrodynamic models, and some deep-water wave gages are needed to provide input to the models, and gages are needed at numerous nearshore sites for model calibration.

Dr. Nummedal asked if the sand in potential borrow sites is clean enough to be moved right onto the beaches or is there a significant amount of mud that could be an environmental problem. Mr. Frye said that the sand is usually very clean, but there are a few sites that have 3 to 6 percent silts and clays. In a very few cases there is some overburden of finer material that would not be suitable. He said some

of the deposits have a large area of surface expression so there would be very little turbidity in a direct beach nourishment project. The Virginia Institute of Marine Science is doing most of the analysis of borrow material.

BG Vander Els asked if a sinking fund had been established to fund this kind of project, and Mr. Frye said that had not been done. He said there had been some discussions about revolving funds for private-property shoreline development, similar to what the State of Maryland has, but that is still in the discussion stage.

Mr. Pfeiffer noted that the Corps has two ongoing studies of interest. One study that CERC and Mobile District have underway is concerned with placing dredged material on offshore berms, including feeder berms; the other study is a 3-year study being conducted by the Corps and the National Marine Fishery Service on the use of dredged material to create wetlands. The latter study is almost complete.

A question was asked about how potential offshore borrow sites were selected, and whether these sites included disposal areas previously used for dredged material. Mr. Frye indicated that some such sites were considered, and Corps data bases provided information on materials that were placed in those areas. There were also previous Corps studies on locating sources of sand. Studies conducted by the Virginia Institute of Marine Science used side-scan sonar to identify surface features, geophysical techniques to look at configurations of the subsurface, and coring in areas that looked promising. One deposit off Sandbridge, Virginia, for example, has a large quantity of readily accessible, beach-quality sand in about 35 ft of water.

REVIEW OF FEDERAL COASTAL PROJECTS IN VIRGINIA

Samuel E. McGee III
US Army Corps of Engineers
Norfolk District
Norfolk, Virginia

The passage of the Water Resources Development Act (WRDA) of 1986 has presented a great challenge to the Norfolk District and other Corps Districts to design and construct safe and economical navigation, shore protection and flood control projects. In order to meet this challenge, we have found it necessary to use the very leading edge of coastal and ocean technology and in some cases to actually advance the state of the art in these fields. The large amount of engineering and design work, while at times quite a burden, has also afforded us an unusual opportunity to work closely with WES, CERC, and other research oriented agencies in exploring and advancing new methods. Although the time and scope of this paper is too limited to cover all of these interesting and important cases, I will present a brief look at several of the cases which have coastal and ocean engineering relevance.

The largest single project in terms of engineering and scientific effort is the Norfolk Harbor and Channels Deepening project. We began work on the General Design Memorandum (GDM) in 1982 and upon completion in 1986 the GDM included the results of studies on offshore channel design, estuarine and offshore sedimentation, underwater highway tunnel protection, offshore construction methods, and the use of dredged material for beach nourishment for both ocean and bay beaches on the Virginia coast.

In the case of ocean channel design, we found the basic design criteria to be inadequate for assessing large ship response to the wave climate of the project area. The Maritime Administration's Computer Aided Operations Research Facility, in cooperation with their contractors and university research support, developed ship hydrodynamic models and computer simulation models to evaluate the design alternatives. These investigations, while achieving designs with a higher confidence level than the subjective procedures in the design manual, should be considered as a possible basis for further research in this field and most certainly should be considered for field verification studies and operational analysis. Because of other ongoing work, this type of follow-up study is difficult and often impossible to accomplish with the available District resources.

In order to evaluate life-cycle project costs and environmental impacts, it was necessary to determine estimated changes in sedimentation and shoaling, salinity, tidal range, and currents in the bay and estuarine areas of the project and for the Atlantic Ocean Channel. Much of this investigation was accomplished by WES using both physical and numerical modeling methods. The result of these studies and the confidence level in the results are considered to be very good for the areas covered by

the Chesapeake Bay physical model. The results for sedimentation predictions for the Atlantic Ocean Channel are more subjective due to the state of the available technology for offshore waters. The determination and prediction of shoaling and sedimentation in offshore channels is another area suitable for future coastal research and field verification studies. Such studies could be accomplished as a cooperative effort between the field agency (the District) and the research agency.

The design and construction of navigation channels located a substantial distance offshore, nearly 20 miles in the case of the Atlantic Ocean Channel, have presented real challenges in the field of bathymetric surveying and mapping. Norfolk District has developed and routinely uses electronic positioning systems that are accurate and reliable at these distances and in cooperation with the National Ocean Service has adopted tidal zoning methods essential for establishing repeatable bathymetric surveys. In addition to developing this offshore survey capability, Norfolk District has also added side-scan sonar capability and seismic (sub-bottom) profiling capability to the array of remote sensing tools available to our engineers and scientists. These tools are used not only for design but throughout the construction and monitoring of many of our projects.

Although not a coastal engineering issue in the usual sense, the Chesapeake Bay Bridge Tunnel, Thimble Shoal Tunnel tube presented us with an interesting engineering task. This tunnel tube was originally designed to use a 10 ft common earth fill cover. Because it has a limiting elevation of -63 ft mean low water and the basic project has a -55 ft plus overdepth elevation, the tunnel cover required a modified design. A large number of possible supplemental covers ranging from precast reinforced concrete to flexible concrete block matting were evaluated for such factors as stability and response to wave induced motion, ship induced motion, and anchor penetration and dragging. The result of these investigations was a recommendation to use a rock blanket approach due to ease of construction and maintenance and relative cost.

Because a significant portion of the dredged material in the Chesapeake Bay and Atlantic Ocean Channel is good quality sand that is suitable for beach nourishment, this alternative was extensively investigated during the GDM process. Of particular interest were the availability and performance characteristics of dredging equipment capable of such work in the wave climate of the project area. In response to this, an engineering report was prepared outlining the problems and needs associated with beach nourishment work and an evaluation of the available construction plant to meet those needs. This report indicates that much of the available plant is sensitive to waves, not just in terms of wave height but to the wave period as well. In this area, further research into dredging and transport methods as they relate to the coastal environment would be beneficial. It would be especially useful for District navigation channel designers to have an engineer manual with a compilation of pertinent data

and suitable design criteria for the design of beach fill projects using dredged material from adjacent navigation projects.

Both the Commonwealth of Virginia and Fort Story indicated a strong desire to use dredged material from the Norfolk Harbor Deepening project for nourishment of eroding shorelines. In response to this interest, Norfolk District directed the preparation of a series of coastal engineering reports for specific segments of the Atlantic Ocean and Chesapeake Bay shorelines. These reports used both available data and new field investigations to determine erosion patterns, erosion rates, littoral transport, and native beach material characteristics. Extensive geotechnical investigations of the channel sediments were also analyzed to determine suitable channel borrow areas for each beach that was investigated. Engineering reports were prepared for Sandbridge Beach, Virginia Beach, Fort Story (Cape Henry), East Ocean View Beach, and West Ocean View Beach (Willoughby Spit). These reports have enabled the local sponsors to better evaluate the options and, subsequent to the enactment of the WRDA of 1986 and in accordance with Section 933 of that Act, to pursue the concept of cost shared beach nourishment in connection with the deepening project.

Detailed coastal engineering evaluation of potential beach nourishment sites can be a costly and time consuming endeavor. Large dredging and nourishment projects of 500,000 cu yds or greater can generally support and justify the expense and time necessary for a thorough engineering and geotechnical analysis. A need exists, however, for a simpler "cookbook" approach for the evaluation of beach nourishment for smaller-scale projects and, in particular, for Operations and Maintenance (O&M) projects of less than 100,000 cu yds. It would be most helpful for Districts to have a means for evaluating small projects to determine the suitability of the material, the expected performance and stability of the beach nourishment, and, of course, the cost effectiveness of the endeavor.

During the field trip portion of the program you will have the opportunity to see first hand the details of the Virginia Beach Hurricane Protection Project, the status of several Section 933 beach nourishment investigations, the Rudee Inlet Project and how that material has been used to combat erosion, and the recent successful use of dredged material from the Lynnhaven Inlet Project to rebuild nearly a mile of totally eroded beach. The details of these projects will be discussed at their respective stops during the field trip.

In closing, it is appropriate to again acknowledge the successful collaboration over the past few years between Norfolk District and the research oriented agencies and to look forward to the many new opportunities for continued progress in the increasingly important area of coastal and ocean engineering and research.

Numerous specific technical reports on the topics mentioned above and related topics are available directly from the National Technical Information Service (NTIS) or by request from Norfolk District.

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DISCUSSION

Channel design difficulties were discussed in more detail. The Corps' Channel Design Manual gives a number of subjective things that have to be considered, but does not tell a design engineer how to add up those factors. The factors include the pitch, yaw, roll, heave and sway motions of the vessel, and the squat and trim of the vessel underway. These factors are not directly additive. They are looking at dredging a fairly narrow channel in fairly deep water; this could be a 60-ft channel in water that is 50 to 52 ft deep. If all the factors are added up, depending on wave conditions selected for design, you could get a 75-ft depth requirement for all-year, all-weather operation. Choosing different depths between 60 and 75 ft would allow operation for different percentages of the time. The problem is how to make that determination. The technical information on just how a particular ship responds in deep water to a particular wave climate is not all that good. When ships had smaller drafts, once they cleared a bay the water was deep enough for navigation. With deeper-draft ships, the channel has to extend some distance across the shelf, maybe up to 100 miles in the Gulf of Mexico. This requires providing a dredged channel and dredging in conditions that the Corps has not dredged in before.

Studies of ship motion were discussed. Some fairly common commercial vessels are being looked at. They were mainly concerned with ship response, and looked at hydrodynamics with respect to the alignment of the channel. The best channel alignment from the standpoint of bathymetry is not the best in terms of sea state, because it exposes the beam of the ship to northeast wave patterns which induce, or can induce, a fairly large rolling motion. Because they are dealing with bulk carriers with a fairly wide beam, this has the effect of a substantial increase in channel depth requirements. This turned out to probably be the key design criteria in their case.

BG Kelly asked about the status of the Norfolk Deepening Project. The District has completed almost all of the dredging of the first element that was agreed to with the Commonwealth of Virginia. Mr. McGee reported dredging was completed in the Norfolk Harbor channel and the Thimble Shoal channel, and was almost complete in the channel to Newport News. The state and the shipping agencies were planning to

have the channels in operational use the following month. The material from the Norfolk Harbor channel and the channel to Newport News was placed in the Craney Island disposal area. The material from the Thimble Shoal channel was all taken to the Dam Neck ocean disposal site.

PANEL

LONG-RANGE OUTLOOK FOR COASTAL ENGINEERING IN THE CORPS

BG Patrick J. Kelly, Moderator
President, Coastal Engineering Research Board
Director of Civil Works
US Army Corps of Engineers

Mr. James D. Davidson
Deputy Chief, Planning Division
Directorate of Civil Works

Mr. John A. McPherson
Assistant Chief, Engineering Division
Directorate of Engineering and Construction

Mr. John J. Parez
Operations and Readiness Division
Directorate of Civil Works

Mr. Ted A. Pellicciotto
Assistant Chief, Dredging Division
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BG Kelly noted that for FY 89 the coastal engineering basic research program would have a 5 percent growth. Basic dollars for R&D, discounting for inflation, have decreased over the years. So, for the first time in FY 89, the R&D has a real term growth. When LTG Hatch was CERB President, he reviewed that declining R&D budget, and was hopeful that he could do something about that. Last spring's testimony for the FY 89 budget did, in fact, convince Congress to put more money in the basic coastal engineering R&D budget. BG Kelly said today's discussion of the CERB meeting would be where we need to put that money, and that has a big input into that whole process. He said that the Corps had a Research and Development Committee which sets priorities for R&D needs in dollars. He noted that he wore two hats, as President of the CERB and as Director of Civil Works. He said he would be wearing both hats as he listened to the presentations.

Mr. Davidson said we define "engineering" as used in the title of this Board, CERB, in the broadest possible terms. Planning is one facet in the continuum of engineering activities that range from planning, to design, to construction, to operation and maintenance. Our involvement with the activities of the Board (and all coastal matters) is by definition up front.

Factors which will influence planning in the next five years include:

a. By the year 2000, 85 percent of the US population will live within 50 miles of one of the coasts, including the Great Lakes,

b. Sea level will continue to rise, although the rate is open to some debate,

c. The economy of imports and exports will govern the development of our ports,

d. Ocean dumping will be restricted for environmental reasons, and

e. The Federal interest in navigation, flood control, and other purposes will be dictated by the state of the economy.

The Corps' traditional missions of flood control, navigation, and shore protection have had a new look since the passage of the Water Resources Development Act (WRDA) of 1986. Changes in cost sharing have made our partnerships with the local sponsors a more complicated process.

The Corps has been concerned with two kinds of coastal projects: navigation and shore protection. As we learn more about the coastal processes we are broadening our view of the coast as a complicated interactive system. In our navigation projects we must be concerned with more than type, size, and number of vessels which can safely and economically transit an inlet or harbor entrance; shore protection projects must be concerned with storm effects of surge, inundation, and wave forces. We must fully recognize the interaction of these two basic types of projects so that our total multipurpose objectives can be realized.

The potential future damages resulting from sea level rise (SLR) must be present worthed; effects that may not be realized for maybe 50 years means that projects planned to accommodate a future SLR cannot be justified for construction today. However, we must plan our projects so that a future SLR can be accommodated.

There are 251 feasibility reports at the Washington level (most of which were authorized by PL 99-662); of these, 70 involve projects in the coastal region with a total value of over $3.3 billion. Increasing population and development pressures in the coastal regions will likely increase the demand for coastal projects in the years ahead.

Our greatest challenge will be how to plan and implement coastal projects at a time of increased local cost sharing and shrinking Federal resources. Initiative '88 makes a start in finding ways to accomplish our planning more efficiently. Complicated interactive coastal problems need to be looked at comprehensively, not piecemeal. Multipurpose projects will be the rule rather than the exception. The Coast of California Storm and Tidal Wave Study and the Coast of Florida Erosion and Storm Effects Study are a type of study which can integrate the various problems; we expect more of this type of study in the future.

Mr. McPherson said coastal engineering is a relatively young discipline. In recent years development of new techniques and expansion of the knowledge horizons appears to be accelerating. This presentation addresses areas of recent and continuing development including wave theory and dynamic interaction of waves and their environment; sediment motion and its movement along shore, onshore and offshore; effects of structures on coastal processes and their reaction to coastal processes; dredging and dredge material disposal; the art of modeling erodible sacrificial sand structures; and the art of modeling ship movements for various channel configurations. Continuing development in these and other related areas in the future will be shaped

by changing needs and mission responsibilities perceived by present and future Corps leadership. Our attempt here is to report where we are presently going in the above areas and speculate on future development in the face of increasing development along our coasts and the probability of increasing relative SLR and climate change. The consequences of present trends and future development on Corps navigation, flood control and shore protection missions may also be hypothesized.

Mr. Parez said the Operations and Maintenance (O&M) mission of the Corps has a continuing relationship with coastal engineering. There are almost 900 projects in the "Channel and Harbor" category that have been constructed and are now operated and maintained by the Corps. They consume about $500 million of the total O&M budget of $1.4 billion. There is an ongoing need for coastal engineering in maintaining the channels and structures associated with these projects. This need is addressed on an individual project basis by means of the engineering and design requirements. Generically, coastal engineering in the O&M program has had a number of initiatives, including Repair, Evaluation, Maintenance and Rehabilitation (REMR), Monitoring Completed Coastal Projects (MCCP), Dredging Research Program (DRP), LIDAR helicopter bathymetry, CODAR remote sensing, Dolosse demonstration, etc.

The inventory of coastal projects is not getting smaller. Projects are getting older and dollars are getting scarcer. Maintenance requirements will continue into the future, but dollars will not necessarily keep pace. Resources need to be allocated to the highest priority needs. Coastal engineering can help alleviate the funding problem through innovative, and hopefully, less expensive means of repair.

In making Mr. Charles Hummer's presentation, Mr. Pellicciotto said that at the 44th meeting of the CERB in Sausalito, California, the Chief of Engineers, LTG Heiberg, charged the Board to recommend ways that R&D could generate significant payoffs for the Corps. One area identified for such an approach was to integrate the needs of the Corps dredging program into future R&D, with an emphasis on integrating coastal engineering into this effort. A review of subsequent Board meetings clearly shows both the Coastal Engineering Research Center (CERC) and the Dredging Division responded both with speed and substance to meeting this challenge. In preparing for this presentation, Mr. Hummer reviewed the proceedings of the intervening meetings and found that a major portion of each meeting addressed the successes the Corps has made in integrating coastal and the dredging functions. In his view, a large part of both the timeliness and substance of the response is due to the focus which the Corps has placed on the dredging program in the form of a single emphasis management structure dedicated to all forms and phases of the dredging programs. In each CERB meeting, the Chief of the Dredging Division played a major role in the presentations. We can look at this success in attacking a new initiative in some exciting new programs, with pride and satisfaction.

Probably the most notable initiative adopted as a result of LTG Heiberg's charge is the DRP. The Board has been fully informed of the direction and substance of that program from the outset. The DRP has a year of operational experience and is beginning to produce discrete reports which will serve to focus and define the work effort as the program matures. He noted that of the 26 original work units in the program, 8 are directly related to research into coastal engineering, with a number of the other requiring the expertise of coastal engineers. The management of the program rests with the CERC, although the work is spread among other Corps labs, and in one instance to one of our coastal Districts. The results to date are encouraging and confirm the vision of LTG Heiberg in identifying the synergism of one of the Corps major programs, dredging, and that of coastal engineering.

Dredging as a major mission of the Corps has been a continuing subject before the CERB. The Dredging Division has become a technical monitor for each of the coastal engineering research programs, thereby maximizing both the focus and synergism of the two programs. Emphasis and redirection of some of the ongoing work units are reflected in this closer liaison. The research community has become more involved and participatory in the dredging management and operational aspects which account for the largest part of both the new construction dredging and maintenance dredging programs. He said we are seeing some major products which will have payoffs both for the research programs as well as a major and predominant mission of the Corps.

He gave a status report on initiatives related to dredging.

Dredging Research Program

As mentioned earlier, the DRP has one full year of operation and preliminary results are very encouraging. The second year is funded at the requested level and we are optimistic that a year from now we will have some definitive results to report. We have five technical monitors and three advisors to oversee the program. The Chief, Dredging Division, serves as Chief Technical Monitor. In addition, we have established a Field Review Group, with subject assignments, to insure continuing field input into the evaluation of work products and the direction of the program.

Underwater Berms

Mobile Harbor: The construction of underwater berms and subsequent monitoring is progressing well. The berm concept was largely the brainchild of Mr. Hummer's predecessor, Mr. Bill Murden who first brought it to the attention of the Board at the 45th meeting held in Alaska. The Mobile Harbor berms are the largest initiative in this area. The feeder berm which has an extensive monitoring program, has shown no movement prior to the September-October storms. We are awaiting post-storm surveys, which are now scheduled for December. In 1989, monitoring the berms is being conducted as part of the DRP. Continuing hydrographic or bathymetric surveys are anticipated, some 5 are planned in 1989. Real-time continuous current and wave data will also continue. In the case of the stable berm at Mobile, the test section is now

complete. This stable berm will ultimately involve over 19 million cu yds of dredged material from the Mobile Harbor Improvement Project authorized by the WRDA of 1986. Initial results are encouraging as they relate to the enhancement of fisheries resources. One post-construction survey is complete. Sub-bottom profiling, side-scan sonar, and conventional acoustic hydrographic survey were all accomplished. The fully processed data is not yet available, but preliminary analysis indicated that we were successful in constructing an intact designed bottom feature.

New York: The construction of beach feeder berms at Gilgo Beach and Lido Beach have shown some preliminary success. In July 1987, some 410,000 cu yds of sand was placed parallel to the beach in 16 ft of water at both locations. In the case of the Gilgo Beach berm, the berm had an average elevation of 5 ft with some mounding up to 9 ft. Successive surveys in October 1987 indicated some of the top of the berm had been eroded with a loss of 10,000 cu yds, in December 1987, nearly 280,000 cu yds had been lost from the mound, with an additional loss of 3,000 cu yds one month later. The December surveys showed a mound only 1 to 2 ft high. Studies will continue to monitor the mound and try to determine the fate of the material. There was no data available on the Lido Beach berm when this presentation was prepared.

Galveston: Construction of the berm at South Padre Island is scheduled to begin this month. Approximately 450,000 cu yds will be used to construct this berm. Again, the initial features and reaction over time will be monitored.

Beneficial Uses of Dredged Material Workshops

The Dredging Division, WES, and the Galveston District joined forces in conducting the fifth workshop on beneficial uses of dredged material. The workshop was held last April and was a resounding success.

Mr. Pellicciotto said he was pleased to report the coastal engineering/dredging cooperative efforts initiated under the auspices of the CERB have been very fruitful and will continue into the future. The Dredging Division of the Civil Works Directorate will continue to provide the focus on the dredging program and the interface with the coastal research programs. Much of what is done in the future will be a direct result of the comprehensive programs started in the last three years. There are, however, several identified coastal R&D work units the Dredging Division particularly endorses; namely, the simulation of coastal processes in shallow tidal inlets and sediment transport consequences of such inlets. A number of shallow draft projects in the southeastern part of the nation experience continuing rapid shoaling. These projects are marginal in terms of obtaining annual maintenance funds on the basis of the levels of commercial traffic. None the less, they have important local and regional economic impacts. A better understanding of the physics and processes could solve both design and mitigating structural questions. Similarly, downstream erosion of beaches continues to be a major problem. Research initiatives in these areas could ameliorate

the continued competition for maintenance dredging funds and assist in the beneficial disposal of the sands removed from the inlets. He recommends favorable consideration by the Board on both of these initiatives.

DISCUSSION

BG Vander Els asked what the panel viewed as the appropriate role of HQUSACE and the CERB in leading the formulation and propounding changes in the social desirability and political acceptability of coastal engineering projects. Mr. Davidson referred to a previous statement by Mr. Frye that social acceptability should be one of the primary considerations on Section 933 projects. Perceived environmental costs are part of the social acceptability. Perhaps the Board may look closer at the trade-off between economic costs and environmental costs of dredged material placement. The Corps goes through that trade-off process on every harbor project we undertake. BG Kelly asked if the Planning Division was revising plan formulation approaches and directives in looking at those criteria. It was generally agreed that formulation criteria will continue to be based on net economic benefits, and it is uncertain right now as to how to define a lot of benefits in quantitative economic terms that we can deal with according to our codes and standards.

Dr. Nummedal asked if there was any specific effort as part of the MCCP Program to directly document how money spent on that program has beneficial impact on future construction, and to use that information in future testimony for congressional budget authorizations. Mr. Parez said that they try to emphasize that in testimony to Congress, and believe a strong research effort is needed to support the O&M program. Dr. Nummedal said that Congress appears to be in the mood to support research, and had just approved a long-term, five-year budget request for the National Science Foundation (NSF).

BG Kelly asked about the Corps' commitment on monitoring; what projects are the Corps supposed to be monitoring, what projects should the local sponsor monitor, and is there a document to codify the program. He also asked how much O&M funding in FY 89 is devoted to monitoring coastal projects; and do we have a system, laid out in an EC that takes feedback from the monitoring program and provides design information to the Districts. Mr. Lockhart said that the Corps had changed the management approach for the MCCP Program. A panel of field representatives attends the program review. Beach erosion control projects that are not part of O&M have been eliminated, and the focus has changed to navigation projects. Mr. Lockhart said there was no document to codify that, and BG Kelly said we need to do that. Mr. Lockhart said that they had done that indirectly in a letter asking for project nominations. Funding for the MCCP Program in FY 89 is $1.6 million. The Corps has started to produce some reports from the program. There are plans for one of the R&D work units to evaluate data from the MCCP Program and develop procedures for improving design or operational procedures. It was noted that there is not a formalized feedback system. BG Kelly said that further work needs to be done on laying out MCCP, and perhaps at the next CERB meeting we need to report on what we have done to clarify that area.

Dr. Nummedal noted that his understanding was that MCCP funding could only be used after the project had been completed, but many investigators have expressed a desire to start the monitoring during construction. He thought it would be helpful if monitoring was allowed to start during construction.

Dr. Mei asked that the CERB be given a status report on the DRP. He also asked what the final decisions had been in selecting the main tasks of the program, and what the rationale was for the decisions. Mr. McNair noted that a bulletin had been issued in August 1988 that lays out some of the research program and goes over some of the selecting criteria.

BG Kelly noted that the CERB could have a special meeting devoted to review the DRP in Washington, DC, for a half-day or a day. Dr. Mei noted the DRP was a

major program in coastal engineering research when compared to NSF or Sea Grant funding in that area.

Prof. Reid asked what particular area in the DRP Program might produce some breakthroughs. Mr. McNair noted that a possible area was sediment transport as it deals with placement of material in open-water disposal areas. The DRP will be looking at boundary layer mechanics and instruments to measure, confirm, and verify our approaches to our hypothesis. We will be looking at methods for predicting the fate of the material both in the short term, immediately after placement, and in the long term, which could be months or years after placement. We are developing monitoring techniques for monitoring open-water sites, and data sets to use in adjusting our numerical models and procedures.

Prof. Reid asked if the R&D would include ways of improving the monitoring of sediments. Mr. Pellicciotto said that one big aspect of the program is the techniques and the equipment to be used for monitoring. Production meters are being tested right now to determine how much material is really going into the disposal sites. Mr. Pfeiffer added that another area where the Corps anticipates savings is in the knowledge of the material itself. Multi-million dollar claims have often stemmed from that, when material to be dredged has not been identified properly. Better equipment and more efficient dredging is another area of potential savings. An unmanned monitoring and reporting system is another area being looked at.

Dr. Mei asked if there were plans to get the dredging industry more involved in the DRP. Mr. Pellicciotto said that when they have their bi-annual meeting they include the dredging industry. It is a joint Corps/National Dredging Association Meeting featuring various guest speakers from HQUSACE and the field. The dredging industry is asked for their input on the types of equipment and techniques that are needed. Some contractors deal in dredging on a different scale such as dredging for aggregates, and they have a desire to make use of some of the dredged material. We are talking to the National Aggregate Association. He thinks that the dredging industry will have some good roles in the program.

BG Kelly noted that we had 20-year hindcast modeling for the east and west coasts, and 30-year hindcast for the Great Lakes. He asked if there was a reason we did not have 30-year hindcasts for east and west coasts. Mr. Lockhart said that the periods of record were originally for 20 years. The Great Lakes was done first, and then the east and west coasts. We then went back to the Great Lakes and updated those to 30 years, and now we are planning to update the east and west coasts since we have more data. A 30-year record will give a good prediction for a 60-year event and a fair idea for a 100-year frequency projection.

BG Kelly asked about discussions on modeling. He said he would like the CERB to look at the whole area of modeling because the trends clearly are that we probably will get more and more involved in mathematical modeling to describe our processes. He said the Board would like some advice on when they might need to address that. He asked if the new supercomputer would facilitate addressing and moving from 2- to 3-dimensional models. Dr. Houston pointed out that the different CERB meetings concentrate on different topics, for example the next CERB meeting is concentrating on shoreline erosion and restoration, and that might be an appropriate forum to discuss shoreline change modeling. COL Lee said the new supercomputer would provide more assured and cheaper access to a supercomputer, and will make 3-D modeling a more realistic alternative to consider. Dr. Oswald said that the supercomputer is a tool to aid us; but we really have to develop the 3-D models.

Dr. Oswald added it's very clear that some of the basic research that must go on is developing a clear understanding of the whole dynamics, from source to propagation and losses. We are doing engineering solutions for which we do not fully understand the boundary conditions, and we are doing it with empirical data; and yet we miss the opportunity to continue to collect that data and we continue to use the same engineering models without adequate understanding of what we are doing. He said he viewed the supercomputer, our investment in R&D developed models that will run on that, and the correlation of those with real data, as being the key to the future. The fact we do not have it now means we do not have solutions to problems which 20 years from now we will have to go back and refix again because we did not fully understand them now.

INTRODUCTION AND REVIEW OF COASTAL R&D PROGRAMS

Dr. James R. Houston
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US Army Engineer Waterways Experiment Station
Vicksburg, Mississippi

I am going to discuss the Corps' research program in coastal engineering as a framework for this afternoon's detailed discussions of long-range coastal engineering R&D. Many of you may not be familiar with this program. Knowledge of the program is important since productive discussion of long-term R&D requires understanding of resources expected to be available to address long-term problems.

The mission of the Coastal Engineering Research Center (CERC) is R&D in coastal engineering. Part of CERC's mission is to solve particular problems identified by Corps field offices. This work is funded on a cost reimbursable basis by the field offices. Another part of CERC's mission is to address more general problems through applied research funded directly from the Headquarters, Corps of Engineers. In both cases, the R&D is very applied and related specifically to the missions of the Corps of Engineers. Congress has indicated that basic research is a mission of the National Science Foundation (NSF) and not the Corps and thus the Corps' R&D is to be applied R&D and specifically mission related.

There are a variety of R&D programs in the general area of coastal engineering. CERC manages the General Investigations (GI) funded Coastal Engineering R&D Program, Field Data Collection Program, Monitoring Completed Coastal Projects Program, Dredging Research Program (DRP), and reimbursable work for Corps field offices. In addition, CERC performs work in programs managed by other Corps labs. All of these programs have specific goals established by the field and Headquarters.

The R&D Program of the Corps is user driven. There are yearly reviews of the Coastal Engineering R&D Program by a Field Review Group of personnel from coastal Districts; Technical Monitors that represent the major functional Divisions of Headquarters, Corps of Engineers; and the civilian members of the CERB. These reviewers are polled on priorities of work efforts in the Coastal Engineering R&D Program. The Technical Monitors base final work priorities on the reviewer recommendations and their own national perspective of needs. Thus, CERC implements a program defined and prioritized by the field and Headquarters.

CERC's mix of work has changed dramatically over recent years as the Corps' work load has changed. In the early 1970's, 90 percent of CERC's budget was in the GI funded Coastal Engineering R&D Program. This year less than 25 percent of CERC's budget came from this Program. CERC's R&D Program has changed from one concerned with general coastal problems to one concerned primarily with specific problems in the Corps. This trend will apparently continue into the future, although declines in the GI funded R&D Program may have been halted through the efforts of

LTG Hatch and the Directorate of Research and Development. There were funding declines in actual dollars every year of this decade for the program until it bottomed out in FY 87.

Research in the Corps has advanced in recent years through new research initiatives. For example, the Repair, Evaluation, Maintenance, and Rehabilitation Program was a major six-year program to address the problems of aging infrastructure in the Corps. CERC performed considerable research on rehabilitation of Corps coastal structures under this Program. The DRP is a major new finite length program to reduce the cost of dredging operations in the Corps through R&D. Many specific problems in the Corps have generated R&D funding that advances coastal engineering. For example, the Dolosse Project is a major project to advance understanding of problems related to concrete armor units on breakwaters. This project was funded as a part of a rehabilitation project for the damaged Crescent City, California, breakwater. CERC made stress, strain, and movement measurements over two winter seasons on actual dolosse armor units placed as a part of the rehabilitation project.

A major new initiative of the Corps promises to greatly advance construction technology in the Nation. The Construction Productivity Advancement Research (CPAR) Program is a new program in FY 89 to advance construction productivity in the United States through partnership between non-Federal entities (including state and local governments, universities, and corporations) and the Corps. Efforts in this Program will be cost shared between the participants. Ideas which advance construction technology in coastal engineering and have potential to advance the competitiveness of the US construction industry in the world would be candidates for funding under this Program. Since many programs of the NSF emphasize the teamwork of academia and the private sector, CPAR offers the opportunity for the Corps, private sector, and academia to join forces to increase the competitiveness of the United States in world markets.

Looking into the future, it appears the Nation will be faced with a wide variety of coastal related problems. Much of the funding available to address these problems will be funding provided to address specific aspects of the problems. Funding to consider more general problems is expected to be limited and may decline in inflation adjusted dollars over the long term. New programs such as the DRP and CPAR offer considerable potential to advance the field of coastal engineering.

DISCUSSION

BG Vander Els said the presentation indicated that coastal engineering R&D is very dependent for its health on the Civil Works Program. He noted that many coastal projects are in question because of the dimension, for example, of recreation which is currently politically unacceptable. Part of the political unacceptability relies on the economic feasibility. The methodology for that economic feasibility was not etched in stone. Perhaps we should consider a sub-working group of the civilian side of the

CERB to at least study and analyze how our current economic feasibility and methodology may be deficient. They might look at land use policies at various levels of the political structure.

BG Kelly said those were comments we would probably be addressing as we go from one administration to another. Different administrations advocate different areas of emphasis, and one does indeed see change. The Reagan administration advocated "high payoff items" which were basically navigation, flood control, and storm-damage prevention. That does not mean the Corps does not have the authority or capability to address other project purposes. He said that land use is an area that the CERB probably needs to take a look at.

Dr Mei noted that funding for coastal field data collection (CFDC) has remained a fairly constant percentage of CERC's overall budget, while the funding for GI has steadily decreased. He asked if some of the CFDC money could be converted to GI funding. Dr. Houston noted that the Corps has strongly supported increasing the research funding, but Congress and OMB make the decisions on the final budget. The CFDC funding is a different kind of funding than the GI funding. They require separate justification and testimony. We do try to integrate the two programs. However, if we take money from one program, it cannot be transferred in-house to the other program.

Mr. Pfeiffer said that the proposed Corps budgets for the next three or four years have increases for the CFDC Program to expand the program to an all-coast wave data program. He noted that Congress finds it easy to cut research budgets because there is no strong constituency supporting the programs. He feels that there is a constituency for the new CPAR Program.

Dr. Oswald said that in the 1980's there was a coupling of the research program to the customers needs so that it is not now an isolated research program. The customers also are recognizing the capability of CERC.

BG Kelly noted that besides CPAR, there is existing authorization that allows us to cost share with public entities. We could easily cost-share research with the states that would have advocates for the research. He thinks that this is a new area that we should explore. He thinks it has a lot of merit, and we should look in that particular direction.

Mr. Pfeiffer said that the State of Alaska has already come forward, and is having discussions with Cold Regions Research and Engineering Laboratory and other Corps labs. They would be pleased to provide details to the Commonwealth of Virginia if they have an interest.

PANEL

FUTURE DIRECTIONS IN COASTAL R&D HYDRODYNAMICS PANEL

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US Army Engineer Waterways Experiment Station
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Dr. Edward B. Thornton
Naval Postgraduate School
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Dr. Hans Burcharth
University of Aalborg Denmark

Dr. John D. Wang
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Dr. Vincent spoke on critical research needs in the area of wind-wave prediction. Most often, wave height, period, and direction characteristics are the important parameters that determine whether a particular engineering solution is practical or economically feasible. The current capability to predict wave parameters was reviewed, and it is concluded that, at best, a skill score of 20 - 30 percent seems supportable. Such errors can translate into a 100 percent or higher misestimate in armor weight.

The ability to model waves numerically has been significantly enhanced by the enormous increase in computing power. Unfortunately, a primary problem is a lack of definitive, scientific quality data with which to pin down such critical constraints as the rate of wave growth with fetch or time, the response of the waves to turning winds, and the effect of different bottom materials. Consequently, research into the physics of the basic processes are hampered because it is not possible to distinguish between basic processes. The problem is complex because the wave field typically evolves over large areas of ocean over a long time period. In coastal areas the problems are then complicated by irregular bathymetry and variations in bottom materials.

The outlook for improvements for the general ocean model problem in the short term is not particularly good because of the absence of synoptic scale data over the oceans at sufficient density to rigorously check the models. For the past decade, satellite oceanography was thought to be the path for improvement, but it would appear that it will be more than a decade before a major impact will be felt. For the coastal wave problem the prognosis is better. A combination of in situ buoys coupled with wind input from the National Weather Service NEXRAD radar system should provide significantly improved input for coastal forecast and hindcast models not available for the general ocean problem.

Dr. Thornton reviewed critical research needs in the area of wave and nearshore dynamics. Waves are usually an important design parameter for coastal engineering projects, and are often determined by transforming deep-water wave data, either measured or hindcasted. Improvements are needed in 1) the measurement and analysis techniques to improve directional resolution (<5 deg.); 2) the transformation models to efficiently include spectral refraction-diffraction; and 3) the transformation model(s) need to be verified, which has never been done adequately.

Nearshore dynamics includes the prediction of wave and current processes, which are the input to the prediction of littoral drift and morphological changes. Our knowledge of nearshore dynamics has been accelerated by the success of large-scale field experiments such as Nearshore Sediment Transport Study (NSTS) (over planar beaches) and to a lesser extent the DUCK experiments (over complicated bathymetry). There is a need to improve our knowledge of dynamical processes over barred and more complicated three-dimensional bathymetry. It is suggested a comprehensive field measurement program be conducted, and the Field Research Facility at Duck, North Carolina, is an excellent site. The experiment should include an intensive processes study combined with a longer monitoring program. Emphasis should be given to obtaining a better understanding of rip currents, vertical mean flow structure, swash, and breaking wave processes. Greater resources (instrumentation) than previous experiments are required to obtain adequate vertical and horizontal spatical resolution. Coordination with other agencies and collaboration with academic institutions would be necessary.

Dr. Burcharth discussed wave structure interaction needs in breakwater research. He said most breakwaters and many sea walls and groins are rubble-mound structures with armor layers made of randomly placed rocks or concrete units. Many serious failures and consequent loss of money have been seen in recent years despite decades of breakwater research. Appearing now are unexpected demands for costly repairs and maintenance. Clearly the design procedures used so far are too often inadequate and need to be improved significantly through research. Basically both loads and structural response are stochastic in nature which means that uncertainty related to important parameters must be evaluated and the design must be based on exceedence risk criteria. This calls for a tremendous amount of parametric studies with repeated tests. Traditionally, only the hydraulic stability of breakwaters has been studied in hydraulic models simply by visual observation of the movements/displacements of the blocks as a function of the sea state. However, breakwaters often fail due to breakage of the armor units at sea states much milder than those causing hydraulic instability. Thus, an improved design procedure must include evaluation of both hydraulic stability and mechanical integrity. In this respect, it will be necessary through research to establish relationships between sea states and stresses in structural members for a number of typical breakwater configurations. Both model studies with instrumented armor units

and field studies are needed. Early deterioration of concrete is often due to inadequate mix specifications or to inadequate production procedures. Optimum prescriptions for concrete are closely related not only to availability of raw materials but also to the shape and size of the concrete armor units which again are related to the stability of the breakwater. This illustrates the need for development of an "integrated design procedure" where all these major aspects are taken into account. Surely, this will also make it easier to make an optimum choice between the many existing types of armor units; but more important it will form the basis for the development of new and better units requiring less repair and maintenance expenditure.

Numerical modeling of breakwaters is in progress but is confined partly because it is based on deterministic calculations of armor unit/layer response and partly because no good description of the kinematics of the incoming breaking waves exists. Thus, research related to the kinematics of breaking waves is also important for further developments of coastal structures.

Dr. Wang discussed long-range research needs in storm surge and circulation modeling. He said the objective of storm-surge modeling is primarily to determine hydrodynamic loads, whereas circulation modeling describes the transport and mixing of a waterborne substance.

Research needed to improve storm-surge modeling include: studies of the surface wind-wave-current boundary layer in shallow water, rigorous treatment of the physics of flooding and drying, develop better performing absorbing lateral cross-shore boundary conditions to improve numerical predictions and reduce computational effort, determine effects of curvilinear grids on accuracy, and evaluate three-dimensional effects on current fields. Circulation modeling can greatly benefit from research on: transport in the surface wind-wave-current boundary layer, bottom boundary layer dynamics, residual currents and parameterizations of turbulence in stratified flows. In both modeling areas, efforts to improve numerical techniques should continue with development of irregular grid methods and high accuracy schemes. For these purposes, it is desirable to create a super computer facility for model development and applications.

Modeling must be supported by data. There is a strong need for synoptic prototype flux observations, e.g. regional coastal monitoring networks of tracer movement. As measurement technology becomes more sophisticated and expensive, there is need for an instrument pool, e.g., acoustic doppler current profilers, network of "tracerometers".

DISCUSSION

Dr. Mei said all the speakers pointed out very important, pressing needs in coastal engineering research that he believes can only be accomplished by the joint effort of researchers at CERC and outside the Corps. He said that in addition to looking for

more funding to strengthen CERC's GI program, we need to find ways to stimulate outside researchers to work on problems that are important to the Corps and the coastal engineering profession in general. An example is the wave forecasting/ hindcasting task, described by Dr. Vincent, which is of fundamental importance to coastal geophysicists and engineers as a whole. That sort of task requires large participation from both within and without the Corps. Dr. Vincent said we are trying to develop good working relationships with NASA and the Weather Service to develop within the United States a wave forecasting/hindcasting group that would encompass people in universities and government agencies. This area has not received much attention, and it is difficult to find very much strength remaining in universities. There are a lot of programs that should be strengthened and a lot of researchers that should be supported to improve an area that has very significant economic impact. The people involved in this area are working together informally. There are problems in trying to formalize it because of institutional loyalties and rivalries.

Dr. Mei said all problem areas, are of interest, including wave-current interactions, circulations, and storm surges, and all researchers recognize the importance and the incompleteness of the present status. The problem is a lack of research funding. CERC can serve an important function, together with the leadership of the Corps, to stimulate more support from the NSF, or perhaps through the Army Research Office (ARO), and also by collaborating with activities such as the Office of Naval Research (ONR), to make coastal engineering research a much more viable activity.

Dr. Thornton said about three years ago there were only 3 ONR contractors on nearshore processes compared to 25 or more investigators 10 or 15 years ago. Things are improving, but without research funding, the investigators will get out of the coastal engineering business, leaving no new engineers trained in the field. The real long-term concern is the loss of the cadre needed in the future.

Dr. Oswald said funding has declined over the last three years for ARO individual investigator programs. There is very little new money. There have been a number of actions, such as the University Research Initiative at the direction of the Office of the Secretary of Defense. Several centers of excellence were funded, and that took money out of the ARO program. Also, because ARO has been functioning under the Army Material Command (AMC), they tended to take an AMC role. He said he would continue to raise the issue of support to the total Army, including the Corps. Their ability to respond is going to be totally dependent on available new money. He said he would take this on as a charge, to obtain support from ARO. BG Kelly noted that three years ago the Corps looked at other agencies for possible research funding, and approached ONR without success. He suggested we might get together with ONR about similar interests and cooperative research. Dr. Oswald said he would look into both ONR and ARO funding possibilities.

Dr. Nummedal said he would make a short presentation later about the NSF structure of science and technology centers, and also the engineering research centers, which are set up to facilitate cooperation between multiple universities, universities and industry, or, as a third option, universities, government agencies, and industry. There is the potential to address many of the concerns just addressed within of some such cooperative venture. In spite of funding adversities, there are investigators who have succeeded in making enormous advances in our understanding of coastal engineering and coastal dynamics. We are presently looking at questions that were not even thought of as questions 20 years ago. Concepts that were theoretically proposed 30 to 40 years ago were not known to be important processes until 10 or 15 years ago.

Dr. Thornton said right now there is big interest in 3-D aspects of problems because they are important in sediment transport, particularly with suspended sediments. A number of models have evolved recently that do not have data with which to test them. A lot will depend on instrumentation that needs to be developed; right now instrumentation is lagging behind.

Dr. Nummedal referred to a remark by Dr. Wang on an instrument facility and asked if he viewed that as a pool of equipment at a particular geographic area that people can tap into, or a cooperative venture similar to the Universities National Oceanographic Laboratories System (UNOLS). Dr. Wang said he thought the comparison with UNOLS was good. The emphasis is on having a pool not only of instruments, but people who know how to use those instruments because techniques

are getting more and more complicated. The instruments themselves are expensive and he noted that a lot of sophisticated instrumentation is not being used full time at the owning institutions.

Prof. Reid said he thought the use of remote sensing for assessing phenomena should be explored further. Satellite imagery is used to assess surface currents in deeper water. He said the effects of stratification should also be addressed.

Dr. Oswald made reference to model scouring, and asked how the interface between water and sand was treated. He asked if it was a sharp interface, or if there was a gradiant in which there was sediment in suspension. He referred to transport problems, and said the state of the interface would be important because it provides the first vehicle from which transport begins. Dr. Thornton said that the permeability would be an important aspect and was sure consideration of the gradient was included.

Dr. Kraus noted there were a number of large field experiments in the late '70's and early '80's. They included the NSTS, conducted over a period of five years in the United States; and the Nearshore Environment Research Center (NERC) project in Japan, also over a period of five years. He noted that NSTS had field experimentation as its major effort, while the NERC study was an integrated project of field studies, numerical modeling, and laboratory modeling with a primary goal of developing numerical predictive models. NSTS was directed towards nearshore hydrodynamics and did have better, more comprehensive basic research results in the field work. Dr. Kraus added that the last three years of the NERC project were concentrated on engineering projects such as detached breakwaters, jetties, and groins. He feels CERC should continue the emphasis on field experimentation applied to engineering projects.

Mr. Jarrett referred back to Dr. Wang's presentation and said he agreed with the emphasis on small storm surges, and the impact of the smaller storms on the coast is important in regard to the Section 933 Program, in terms of what damage reduction will be realized. He said generally, the beach fill that will be obtained from navigation projects is going to be relatively small, so we need to concentrate on the impacts of that type of fill on storm damage reduction.

BG Kelly asked if that was being addressed in an EC. Mr. Lockhart said they were working toward that, but did not have guidance at that time.

PANEL

FUTURE DIRECTIONS IN COASTAL R&D SEDIMENT TRANSPORT PANEL

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Dr. Kraus began the session by saying that CERC serves as the applied research arm of the US Army Corps of Engineers and the Federal Government in the area of coastal sediment transport. Calls for assistance or information on problems related to coastal sediment transport and nearshore morphology change are received daily from Corps District offices, Government agencies, private industry, and universities. These problems cover a broad range, including shore protection, navigation channel maintenance at inlets and entrances, sediment shoaling in harbors, and prediction of the fate of disposed dredged material. Most projects in support of Corps field elements are completed at CERC within the relatively short time of one or two years, but often even shorter duration "fast track" studies must be completed over the course of a few weeks to a few months. Field elements must also be provided with tools to solve these problems in-house.

Field elements and technical monitors at the Office, Chief of Engineers (OCE), thus tend to advocate and support research that provides immediate products to the user, i.e., activities that are low-risk and yield tangible results. There are indeed numerous such products and incremental improvements to be made in existing techniques, and these can be readily implemented in the field through the recent proliferation of advanced desktop computers. The question that arises is how, in this climate of urgency and emphasis on fast payoffs, can a long-term research program in sediment transport research be conducted? This question is particularly worthy of consideration, if it is believed, as I believe, that most of the 'easy' problems in sediment transport processes have been solved. If we are to make any kind of leap forward, a continued and coherent long-term research program is required.

There are precedents for the support of high-risk applied research at CERC, such as the DUCK85 and SUPERDUCK field data collection projects. These projects provided data to satisfy specific requirements of research work units, enabled development and testing of field instrumentation and measurement techniques, and were a vehicle for training of CERC and Corps District personnel. It should be recognized that such applied research activities, possibly of high-risk nature and which may produce results needed by the coastal research program itself and not necessarily by field elements, are essential in order to break past barriers hindering progress in coastal sediment transport. Breakthroughs are necessary for the development of truly improved products to serve CERC's clients as well as to expand the knowledge of the CERC research staff.

Fortunately, the conduct and direction of long-term research programs can be guided by the needs of CERC activities which respond to field elements. Numerical modeling of shoreline and beach morphology change is an example. Newly developed models, for which CERC has been a world leader, have in recent years been used in mission-support projects on all coasts of the United States. Improvement of existing models is required and is demanded by the field as the level of sophistication of designers, planners, and the public increases. In this example, areas in which continuous and long-term research is needed include: cross-shore distribution of longshore sediment transport; generalization of transport predictive relations to include the effects of irregular waves, tidal flows, wind-generated currents, and long-period wave motion; threshold for sediment movement and the limiting depth for significant sediment movement; and transport phenomena at structures, including scour, bypassing, and transmission.

Other examples of long-term research programs can be given in the areas of physical modeling, sediment shoaling and scour around structures, inlet processes, beach nourishment, and deeper water projects such as treated by the DRP. In all these areas, a core long-term research program in coastal sediment transport must be maintained which serves as a source of relevant, correct, and advanced knowledge in support of CERC's clients.

Dr. Madsen stressed the importance of establishing a rational approach to sediment transport in the coastal environment as one that proceeds from 1) simple, yet physically realistic predictive model formulations; through 2) carefully controlled laboratory experiments; to 3) the ultimate verification/testing of the predictive model through field application. The premise of this presentation is that a rational approach to coastal sediment transport is called for if the state of the art is to be significantly improved.

Initiation of sediment movement under waves is used as an example of the success of a rational approach, as defined here, and points out that some level of understanding of and ability to predict the characteristics of turbulent bottom boundary

layer flows is a prerequisite for a rational approach to coastal sediment transport problems. For this reason, the state of the art of predicting turbulent wave and wave-current bottom boundary layer flows is briefly reviewed, before turning attention to the response of movable bottom sediments to the turbulent flow above.

Available experimental results on wave-generated bottom bedforms (ripples) and sediment transport rates are critically reviewed. For the geometry of bottom bedforms, evidence of the influence of scale effects is presented, while the quantitative accuracy of experimentally determined transport rates, and, therefore, also the predictive relationships derived from these, is questioned. In particular, it is pointed out that experimental evidence suggests a net transport of sediment in the direction opposite the direction of wave advance for nonlinear waves propagating over a rippled bed, a feature not predicted by any existing quantitative sediment transport relationship for wave-dominated coastal waters.

A long-term research program on the rational formulation of sediment transport in near-coastal waters is outlined including necessary supporting experimental laboratory investigations. It is concluded that long-term stable funding sources for predictive model developments, and carefully planned and conducted laboratory and field investigations must replace the previously fragmented approach, if real advances in the state of the art of predicting sediment transport processes in the coastal zone are to be made.

Dr. Wright said over the past decade, rigorous models have been developed for predicting the transport of sediments in coastal, estuarine, and harbor environments. However, the accuracy of these models in predicting real transport modes and rates remains seriously limited by deficiencies in our knowledge of the workings of natural, as opposed to idealized or laboratory, transport systems. In order for modelers to be provided with realistic sets of assumptions, boundary conditions and estimates of critical coefficients (e.g. drag coefficients, threshold criteria for sediment entrainment), field-based experimental research is needed over the next decade in three major areas: (1) dynamics of coastal and estuarine benthic boundary layers; (2) dynamics of cohesive sediment transport; and (3) processes responsible for across-isobath sediment transport on natural shorefaces.

(1) Benthic Boundary Layer Dynamics

In shallow environments, boundary layer structure and quantities such as bed shear stresses and drag coefficients can vary appreciably due to spatial and temporal variations in bed roughness, sediment transport, stratification, wave-current interactions, and flow accelerations. Field experiments are required to evaluate the relative contributions of these effects.

(2) Cohesive Sediment Dynamics

The physical, chemical, biological, and geological processes which erode, transport and deposit fine-grained cohesive sediments are poorly understood. Comprehensive field

studies are needed to test the existing body of theory on cohesive sediment transport and to advance theory.

(3) Cross-Shore Transport Processes

Simple, laboratory-derived models which account for onshore/offshore sand transport solely in terms of shoaling waves are inadequate for describing processes on natural shorefaces. Field data indicate that the direction and rate of transport may be dominated by other factors, including wind-generated net flows, wave groupiness and long (infragravity) waves, and wave-current interactions. Our field data base must be greatly expanded before reliable predictive models can be constructed.

Dr. Weggel said coastal sediment transport problems can be approached from several different aspects: the "microscopic" or "scientific" approach which seeks to develop a basic understanding of the physics of sediment transport including mathematical description of fluid flow and the fluid's interaction with sediment particles, and the "macroscopic" or "engineering" approach which seeks to predict scour and deposition patterns and sediment transport rates in order to design engineering works. (Obviously, some engineers have been working on the "microscopic" approach just as there have been scientists working on the "macroscopic" approach.) The situation is not unlike the relationship between fluid mechanics and hydraulics during the early years of this century. In an analogy to fluid mechanics and hydraulics, the two approaches are destined to merge since a better understanding of the mechanics of sediment transport must lead to better predictions of sediment movement and dispersal for engineering applications. It is the essence of engineering, "getting the job done," that does not allow engineers to wait for science to provide them with a complete understanding of the sediment transport phenomenon; on the other hand, it is inevitable that science will eventually provide many of the answers needed by engineers.

Historically, the scientific view has been concerned with problems such as: initiation of sediment motion under waves, wave boundary layers, boundary shear stresses, development of and evolution of bedforms, sediment entrainment into flows, and sediment concentration distributions within the water column together with sediment transport. The engineering view has been concerned with the gross and net quantities of sediment movement, the net direction of transport, friction factors resulting from bedforms, and how sediment is redistributed over an area in response to changing wave and flow conditions.

The advent of the computer and our ability to numerically model many of the phenomena governing sediment transport will provide the methods for making engineering predictions in the future; in fact, we are already doing just that. Engineering problems amenable to solution by computers include: predicting longshore transport rates and the distribution of that transport across the surf zone; shore-normal sediment transport and the response of beach profiles to changing wave

conditions; synthetic generation of wave and longshore transport data to predict shoreline evolution and to simulate the operations of sand bypassing systems; coupled longshore and shore-normal transport simulations; and the patterns of sedimentation and scour in the vicinity of tidal inlets.

DISCUSSION

Prof. Reid said that both Dr. Madsen and Dr. Wright had emphasized the importance of the boundary layer between what is truly a fluid and what is compacted sediment. We need to understand the physics of the moving material between the fluid and solid which is neither fluid nor solid. He asked how this was handled in the models. Dr. Wright replied there is currently no theory covering cohesive sediment dynamics. One of the most promising approaches is called Mixing Theory, and is being used at Old Dominion University where it is considered in terms of subcontinual of fluids and solids. These kinds of approaches are promising. A marriage between the empirical information and the theory is still a long ways off.

Dr. Madsen said the stratification effect has been incorporated in some models using atmospheric boundary layer results to parameterize it. However, no one has studied sediment transport data to determine if these coefficients really apply. Experiments measuring sediment in suspension and the effect of having sediment in suspension actually give contradictory results. When the sediment is heavy enough to give a significant gradient in density, stratification is an important effect. Prof. Reid said he also had horizontal gradients in mind, which control the true dynamics of the moving fluid.

Dr. Nummedal said some thought should be given to exactly how to set priorities for particular research tasks that are of maximum benefit to the Corps of Engineers and its missions. He said recommendations should be kept in mind by CERC principal investigators submitting proposals to the next program review. In reference to the onshore/offshore sediment exchange between the beach and feeder berms, he asked Dr. Wright what parameters were most needed for site selection. Also, if a feeder berm is in place, what instrumentation is needed, and what do we need to determine from the monitoring program?

Dr. Wright replied the forces dominating onshore and offshore transport are needed in order to adequately model the behavior of a feeder berm. It is necessary to deploy a tripod designed to measure responses under storm conditions, to include a profiling array of current measurements, simultaneously with suspended sediment arrays. After we determine a location, and the berm is in place, if we simply want to know whether the berm is moving onshore or offshore, we could take periodic surveys with high resolution side-scan sonar. If we need to know when it is moving onshore and moving offshore, then we need more advanced measurements, perhaps using high-resolution sonar altimeters over a long period of time. The technology is feasible and accessible.

Dr. Mei said there is much we do not know about the dynamics of cohesive sediments. He said the Dutch have a program on this which involves not only field studies in the Dutch estuaries, but also efforts of physical chemists who are looking into the microscopic behavior of cohesive sediments. This kind of integrated research seems to be necessary, and he knows of smaller scale efforts in Japan and France as well. He asked how much effort in the DRP was devoted to cohesive sediment dynamics. Mr. McNair said there was a group of work units in the DRP which addressed that particular question. Dr. Kraus said the FY 89 funding on that research was $190,000, with most of the work being done in the Hydraulics Lab at WES and some work at universities. Mr. McAnally of the Hydraulics Lab has been at Delft to look at the Dutch work. Another problem is the mixture of cohesive and clastic materials which is common, for example, in New England. When the material is deposited at offshore sites, the material's electrolytic properties change because the fluid is changing, and that is a time-dependent problem. He said they were working with the Dredged Activity Monitoring System (DAMOS) out of New England Division,

which has several years of environmental data, and we have joined with them to extend that into the physical study of cohesive sediment.

Dr. Nummedal referred back to Dr. Weggel's earlier presentation, and said people with the appropriate economic background need to look at some examples of Corps projects and put some actual dollar values on the research. BG Kelly said he had given Dr. Oswald that task, and said that Mr. Davidson might help. He said we need to find the National Economic Development approach, and he thinks that has a lot of merit.

BG Kelly asked how much of the dredged material is mud. It was indicated that this was about 40 percent. There was some discussion of mud not being useable material. Mr. Pfeiffer noted that they have routinely said that 90 percent of the material is clean.

REPORT OF THE COMMITTEE ON COASTAL ENGINEERING MEASUREMENT SYSTEMS

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West Lafayette, Indiana

In June 1986, a nine person committee was appointed by the National Research Council's Commission on Engineering and Technical Systems, Marine Board, to undertake a two-year study of the present state and future needs of coastal measurement systems. The committee was composed of Warren W. Denner (chairman), Science Applications International Corporation; William L. Wood (vice-chairman), Purdue University; David G. Aubrey, Woods Hole Oceanographic Institution; Odgen Beeman, Ogden Beeman and Associates, Inc.; Eugene H. Harlow, Soros Associates; Edward B. Thornton, Naval Postgraduate School; Robert O. Reid, Texas A&M University; Nolan C. Rhodes, Port of Corpus Christi Authority; and Richard W. Sternberg, University of Washington. The committee was charged with the tasks of: assessing the needs for coastal data and measurement systems; determining the availability and suitability of existing instrumentation and measurement systems; and developing a set of recommendations regarding instrumentation and measurement system development. The committee was also responsible for providing guidance on development priorities.

In general, the committee agreed that there is a pressing need for development of instruments and measurement systems. To stimulate this development there is a perceived need for resource commitment at the national level. Presently, the user community is too small to attract much industry interest in developmental technology. Although the annual expenditure on instrument and measurement systems development is relatively small, the economic impact of data potentially obtainable from these systems is vast. The committee also recognized that development of instruments and measurement systems is, at present, carried out on a small scale and is usually driven by individual research needs. Therefore, availability and suitability of existing systems is often unknown to much of the potential user community. There is need for better coordination at the national level and for a forum to provide information, collaboration, and interaction on coastal measurement systems development.

The committee agreed to a number of findings regarding specific development of coastal instruments and measurement systems. The committee also found that some existing conceptual and mathematical models need theoretical improvement and rigorous field testing (in an interactive fashion), while better physically based models are derived and field tested. All of these findings are presently under review prior to publication of the final report.

Mr. Jarrett said that in addition to the need for data, we need to emphasize the accuracy of it, or at least an identification of where the data comes from. He thinks that the wide variability we get, in some of the empirical equations and relationships that we work with from day to day, results from the type of information fed into the relationships. He said that in addition to the instrumentation, there is a need for standarization of the methods used to collect the data. Dr. Wood noted that there is a section in the report on data. One emphasis is on data standards for certain categories of data that are going to have universal use. He said that perhaps a national facility could be used as a calibration type of facility so that we could have an intercomparison when new instruments and techniques come on line.

Mr. Powell said that they have recently reorganized cooperation between the Corps, the Bureau of Reclamation, and the Tennessee Valley Authority on instrumentation. He also mentioned the need for more field verification for the numerical models.

BG Kelly mentioned that one possible way of making instrumentation available to those needing it was to extend COASTNET to various non-Corps activities. He feels CERC needs to take the lead. Dr. Houston mentioned the possibility of using ARPANET, that CERC is not on right now, but that a lot of universities have access to it. However, it is not a secure network. He said that there could be advantages both ways because there are instruments that CERC would like to borrow. Dr. Wood mentioned that they had tried to cover the international framework as well as the United States, and had sent out a survey to all the labs they identified worldwide.

Mr. Pfeiffer mentioned instrumentation being developed at Delft to measure sediment transport. He also mentioned the new directional wave gage being worked on at CERC and the helicopter LIDAR bathometer being developed jointly with the Canadians. Dr. Oswald suggested that the CERB might write a letter to the Director of the National Bureau of Standards requesting help in developing appropriate instrumentation. BG Kelly asked about PIANC, and Mr. Calhoun replied that he was not aware of any particular working group on instrumentation. BG Kelly suggested that we should look at PIANC because it included all of the leading countries in coastal engineering.

FACILITIES

Dr. Bernard Le Me'haute'
Ocean Engineering Division
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University of Miami
Miami, Florida

The purpose of this presentation is an attempt to answer some of the questions raised by Dr. Robert W. Whalin, Technical Director, WES, in his address to the CERB in 1985 concerning the possible extension of CERC facilities and experimental R&D.

The speaker feels that experimental hydraulics in general and in coastal engineering, in particular, has been neglected during the last two decades. The reasons for this neglect are given. One is the development of mathematical modeling. However, it is to be realized that the accuracy of mathematical modeling is limited by the gaps and uncertainties in the functional relationships which are used in these models, and that these gaps can only be filled by basic experimental research. The pros and cons of computers vs. scale models are presented.

The fundamental problems requiring experimental research in coastal engineering are reviewed, with emphasis on the most pressing problems encountered on the US coastline.

Ideas for feasibility studies for unique experimental facilities are proposed. These facilities should preferably not duplicate other exisiting, other foreign or US laboratories. New technological developments allow pioneering research unattained by past experimenters. The financial aspects of investing in experimental facilities and their staffing is presented.

Existing US policies and practice are critically reviewed and the role of CERC and US leadership in coastal engineering is stressed. The importance of reassessing CERC as an international center of excellence in pioneering experimental research in the Corps of Engineers is emphasized as the most practical and only solution in the US context, provided it acts as a catalyst for academic involvement and it helps the private sector as well.

The pros and cons of alternate solutions are discussed. The dictate of research needs by the District engineers is also discussed in relation to researcher's initiatives in experimental investigations.

DISCUSSION

Dr. Nummedal asked if the problem really wasn't a proliferation of private small-scale initiatives instead of industry making an effort to themselves sponsor one major lab. Dr. Le Me'haute' said that the private sector has limited its investment because a world-class facility will not pay off. Only the Federal government can afford this because it's a matter of size. The Federal government can make a longer-term investment.

Dr. Nummedal asked if there was a fundamental difference in foreign labs, supported by their governments, and CERC which is under the Department of Defense (DOD), that makes it difficult to structure our laboratory. Dr. Le Me'haute' said the private sector has been helped by development money which has come from the DOD, and he thinks it should be an asset rather than a liability. Dr. Oswald noted that the Water Resources Development Act of 1988 makes the facilities available to the private sector.

Dr. Mei said he shared the opinion that we need a long-range commitment to research in coastal engineering. However, he said he does not foresee any lab becoming a national laboratory for a long time. Dr. Le Me'haute' said he was presenting his view as a scientist, which he feels is shared by many of his colleagues, that we should have a coastal engineering laboratory; not only first-class, but the best in the world. He realizes that this is a difficult task. He feels that we need to have vision beyond an economic return.

Dr. Houston pointed out that our facilities are constructed through a revolving or sinking fund in the Corps which has to be paid back. It has to be paid back with inflation included, i.e., based on the current replacement cost. At WES, the economic return is important, just like in private industry. That puts a lot of constraints on what we can afford. COL Lee added that there is only one building at WES that is not funded from the revolving fund; all the rest of the facility and fixed plant at WES is under the revolving fund. The supercomputer is an exception because it is an Army supercomputer located at WES. Mr. Pfeiffer said there is no way we could build a $27 million facility out of revolving fund money.

NEEDS OF PRACTICING COASTAL ENGINEERS

Dr. David R. Basco
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Director, the Coastal Engineering Institute
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The results of research and development conducted by the Coastal Engineering Research Center (CERC) for the Chief of Engineers and the Corps' District Offices are used by most consulting engineering firms practicing coastal engineering in this country and around the world. The symbol of this is the Shore Protection Manual (SPM, 84) that has become the bible and most worn reference on the bookshelves of professional engineers.

We ask the question: What are the long-range needs (research, etc.) in coastal engineering of engineers in private practice? The answers may be different than those of the academic community, research scientists and research oriented engineers. But they may be no less important since professional engineers must apply these same research results in the planning, design, construction, and maintenance phases of coastal projects. Therefore, we feel that input from a representative sample of professional engineers is appropriate for this 50th meeting of the Coastal Engineering Research Board (CERB) with the theme "Long-Range Research Needs in Coastal Engineering."

To learn of these needs, we developed a questionnaire that included 50 questions in the following categories:

PART I Background Information
- A. Basic (Company) data
- B. Consulting practice specialty areas in coastal engineering
- C. Additional civil engineering activities, etc.

PART II Design and Consulting Service
- A. Sources and availability of data
- B. Scientific and engineering principles used in practice
- C. Principles of balanced design
- D. Engineering services

PART III Perceptions of Coastal Problems

The questionnaire was mailed to approximately 40 companies in the Hampton Roads area that were definitely known or expected to be engaged in civil/coastal activities.

As a follow-up, a workshop was held to cover a list of topics that followed the general outline of the questionnaire. The purpose was to provide information to the consulting firms, to develop the questions and responses further, and to give those participating some idea of the results.

The "needs" of this sample of private practitioners, as developed from the questionnaire and workshop, will be presented in detail at the CERB meeting. Also available will be the sample questionnaire. No results are presently available at this time (October 7, 1988).

A full written report is in Appendix B.

DISCUSSION

Dr. Mei noted that Dr. Basco had singled out construction technology and maintenance, including damage control, as two items that need to be emphasized in research. He said that is true, in addition to developing numerical models, physical understanding, or even updating the Shore Protection Manual. These efforts are probably of direct relevance to setting up design criteria. He thinks CERC could play a unique role in how to effect construction techniques, construction procedures, and construction management. He asked if there were any groups or teams that carry out that sort of task. Dr. Basco made reference to the new CPAR Program. He also said it is necessary to get the engineers and scientists out to where there is really construction going on. Dr. Mei added that most of us do research that improves the design criteria, but to start up an innovative construction technology program is probably at least as important as setting up good design criteria as a part of technology transfer.

Dr. Nummedal referred back to comments Dr. Basco has made regarding seawalls. He agreed with the need for a study of seawalls because a lot of statements have been made without any foundation in facts. He asked about the local examples used and Dr. Basco discussed the data that was shown. Dr. Nummedal noted that Dr. Kraus of CERC was compiling a book of papers looking at the data available on the effect of seawalls.

FUTURE DIRECTIONS IN COASTAL STRUCTURE DESIGN CRITERIA

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All structural engineering design must result in one of the following situations:

a. The structure is over designed.

b. The structure is optimally designed.

c. The structure is under designed.

In the case of coastal engineering, structures that are under designed incur large costs in maintenance and rehabilitation as wave action inflicts damage to the structure. A recent example is the Corps' Crescent City breakwater rehabilitation estimated to cost about $3 to $4 million. Structures that are over designed for the environmental conditions incur additional costs in initial construction. However, the uncertainties in coastal structure design criteria make it difficult to judge whether a structure is over-designed or optimally designed.

The fundamental goal of coastal structures research is to provide engineering guidance for optimal design so that Federal dollars can be saved in construction, maintenance, and rehabilitation, and local cost-shared dollars can be saved in construction. Pursuit of this goal requires a projection of future trends in coastal structures which then allows development of proper design criteria to accommodate these trends.

Future Trends in Coastal Structures

Trend #1. Less new construction of large projects requiring coastal structures. The Nation's coastal infrastructure is largely in place, however, there are exceptions to this trend involving military construction and protection of selected coastal development.

Trend #2. More rehabilitation of existing structures because of deterioration, flawed design criteria, or conditions in excess of the design event.

Trend #3. New, large projects will be built in developing third world countries. Possible Corps mission may occur through the CPAR Program in cooperation with US firms bidding on construction projects, or through support of military operations.

Trend #4. Evolution of structural types that are more easily constructed, less expensive to maintain, and able to be altered if monitoring indicates the project is not performing as intended.

Trend #5. Evolution of structural types which are not presently in common use such as reef breakwaters, berm breakwaters, and tandem breakwaters.

Trend #6. Decreasing manpower to perform design and project management tasks in the Federal Government.

Future Trends in Design Criteria

Future trends in structural design criteria must be in response to the above-stated future trends in structures, as well as being driven by the goal of achieving optimal design. The following are several projected trends in design criteria.

Trend #1. Criteria must be developed using irregular wave parameters to more realistically represent the environmental forces.

Trend #2. Risk analysis must enter into the design process.

Trend #3. Design optimization must occur in order to reduce both initial and follow-on costs.

Trend #4. Design criteria must be easy to use and well documented if manpower declines in the skilled engineering professions.

Trend #5. Criteria need to be developed that includes the impacts when two or more different types of structures are used together on a project.

Trend #6. Design criteria need to be developed for those types of structures that are not presently used extensively, but which may be a preferred alternative in the future.

Trend #7. Criteria focussing specifically on the problems inherent in rehabilitation need to be developed and expanded in order to assure a dependable, functioning structure requiring less repair and maintenance.

Although the above projected trends in coastal structures and structural design criteria are not startling, there still remains the difficult challenge of providing the optimal design path for the engineer. So long as there is a national need for structural solutions to coastal problems, the Corps will have need for effective design criteria; and until optimal design criteria are available, there remains great potential for cost savings.

DISCUSSION

Dr. Nummedal asked how we could transfer the field experience of the existing pool of more senior engineers to the new, essentially computer-trained people coming out of universities. Dr. Hughes said when new people join CERC, perhaps consideration should be given to sending them to a District and putting them under the auspices of a senior level coastal person who could pass on a lot of their experience and knowledge. We also might consider bringing in some senior field people to teach an applications-oriented course of study. Dr. Nummedal indicated that company recruiters ask university faculty the question, "How come geologists graduating today are not having the kind of field experience that they were used to seeing in people coming out of school?" They are considering some of the same remedies. BG Kelly said universities should consider co-op programs as a good medium.

Mr. Domurat said that one difficulty is the location of the office itself, in being able to hire people. He said Los Angeles District (SPL) has initiated an exchange program between CERC and SPL. He thinks it's critical to have a young engineers' training program in the Districts. It is a program that rotates people through all the different disciplines in the Corps. He thinks it is important for young engineers and scientists coming into CERC to go to a District for a certain period of time. If they are going to work on R&D for Districts, they need to come in and realize what those

problems are and spend some time to get a better feel for what's really happening in the field. BG Kelly indicated that WES might look at that. Dr. Oswald endorsed the idea of a cooperative exchange arrangement for new R&D people. He thinks though, that we have a lot of experts, with a lot of experience, who are reaching retirement. We may miss an opportunity. He thinks we should implement a program where we interview to try and capture some of the lessons learned; the experience factor in some of the mistakes that were made and where something didn't work, where it did work, and what were the correct actions. We might do well to capture these on tape. It is a body of knowledge that you don't want to miss.

Dr. Hughes said that there was an oral history of Southern California projects put out by SPD. Several senior people gave a discussion and remembrance of the coastal works. Dr. Oswald said that was what he was referring to, only to try to capture it in various categories.

Mr. Powell said he had seen a draft letter stating an intention of eliminating the General Design Memorandum (GDM), and that would mean that people involved with tech transfer are going to have to facilitate a much faster and a better design. In the feasibility stage of a project, we do not need all of the detail, but we need to know what the shape is and how much it is going to cost. It will take a lot of help from the research community, particularly as they enter into project studies and are assisting in that area. BG Kelly said they are looking at combining the feasibility report, which is the result of the planning process, with the GDM, which is the initiation of the design process, because there is a lot of duplication.

BG Kelly said that we have to better define our cost estimates. We do not spend adequate time in defining cost estimates down to the feature level, and we end up with many more busted cost estimates than we should have. The Corps, particularly the Directorate of Engineering and Construction, needs to start putting together detailed cost data for different types of structures so that the Districts can go back to that reservoir of history and be able to define better their costs. The new Engineer Circular coming out will require looking at costs all the way down to the subfeature level. Dr. Hughes said that the intention was to include that in the design optimization loop. It is necessary to consider the trade-off between risk and cost, and cost data would be needed there.

Dr. Oswald said that what they were talking about was establishing a computer data-base system. This would need to be broken down by structure type and region. People needing the data could access the data base. He said he believed it was a HQUSACE function to maintain and gather the data, but the R&D people could work with HQUSACE in developing the software program. BG Kelly referred this to Mr. McPherson as an action item.

Mr. Lockhart noted that more effort will need to be put into developing accurate O&M costs. Costs cannot just be transferred from one site to another. Until we have greater experience, we will need to do more model tests to develop costs.

THE NATIONAL SCIENCE FOUNDATION (NSF) RESEARCH CENTERS PROGRAM

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Program Status and Funding

Since 1985 NSF has provided financial support for Engineering Research Centers (ERC's). In the FY 89 proposed budget NSF is asking for additional funding to expand this program with a series of new Science and Technology Centers (STC's). NSF asked for $150 million, Congress appropriated $25 million. In making this dramatic cut relative to the requested amount, Congress expressed support in principle for the STC's but argued that the concept was not yet well enough developed to authorize the full amount requested. NSF will resubmit a request for increased STC funding for FY 90, and expect to issue a new call for proposals in January or February of '89.

Regardless of the short-term fate of STC and ERC funding, it is apparent from data on NSF's long-term research support that the funding of STC's and other group activities has shown a slow but steady increase. Most of this support has come at the expense of such ill-fated programs as institutional support rather than support for individual researchers. In FY 88 the total NSF support for centers and groups amounted to $290 million.

NSF Director's Testimony to Congress, 23 March, 1988

Mr. Erich Block, Director of NSF, made the following remarks about STC and ERC centers in his remarks to Congress during this year's budget hearings.

The budget was formulated based on a rate of growth which would double the Foundation's budget over the next five years. This request reflects the administration's desire to increase the rate of non-defense R&D growth, which, at present, is falling significantly behind that of some of our major industrial competitors. NSF's budget request is formulated around three themes: (1) education and human resources, (2) disciplinary research and supporting facilities and (3) research centers and groups. The principal arguments for enhanced funding in category 3 are that we must foster broader interdisciplinary investigations and build stronger links between universities and industry. The following quote from Mr. Block's testimony articulates some of the key arguments for research centers.

> "We have noted a gradual transition in the nature of scientific inquiry in the last decade. Technologies such as satellite communication and large-scale computing enable scientists to work with data sets of great size and complexity. These and other tools have opened completely new avenues of experimentation and illustrate the gradual shift to greater interdisciplinary collaboration as well as the need for large-scale facilities

and sophisticated instrumentation. Such collaborative centers and large-scale facilities must be assured a stable funding environment if they are to direct their energies to producing high-quality science. It is simply not cost-effective to "power-down" productive, large-scale activities simply because of short-term vagaries in the funding cycle.

In this regard, I would point out that once again we have submitted a draft 5-year authorization bill. It reflects the realization that long-range planning must be accompanied by long-range commitment."

I may add here that the Congress this fall did approve a 5-year authorization bill aimed at doubling NSF support over the next 5 years.

NSF sponsorship of research centers is based on the premise that this structure enhances increased communication between the universities and industry. Such structured linkage is especially important in the United States, where we have a basic research system built around universities. This structure provides the strength of close ties between research and teaching but also has the inherent weakness of sometimes isolating universities from economic reality. The center concept is designed to overcome this problem.

The NSF Engineering Research Centers, established in 1985, have succeeded in fostering such collaboration, and each NSF dollar has been more that matched by industrial contributions. Also, these centers have stimulated governmental interagency cooperation. For example, the Plant Science Centers (FY 88 start-up) are jointly supported by NSF and the Departments of Agriculture and Energy. It would appear that these centers could provide a model for a potential research center including components of the WES and appropriate universities.

Some concern has been expressed by many of our scientific colleagues about the potential diversion of funds from disciplinary programs of NSF to these new centers. For that reason let me finish this discussion with one more quote from Mr. Block's Congressional testimony.

"The traditional organization of research in our universities into disciplinary departments has been tremendously productive. It is still the best single way of doing science. But it is not the only way. Research groups crossing disciplinary lines, and interdisciplinary centers tied closely to industry for more effective knowledge transfer provide healthy diversity."

NSF Areas of "Emerging Research"

NSF funds high-quality research in essentially all areas of science and technology, but the following topics have been highlighted in the FY 89 budget hearings.

Superconductivity
Chaos Theory
Biotechnology
Antarctic Research
Computer-aided Design and Robotics
Research on Global Change

I have underlined the last two categories listed above because these themes clearly cover many of the research topics we have discussed at past and present CERB meetings. NSF encourages studies which focus on the planet Earth as a complex system of interacting processes, both natural and man-induced. Clearly such coastal engineering concerns as sea level rise, changing frequencies and paths of major storms, earthquake zones, tsunami effects, etc., fall into this category. Equally relevant is research leading to increased efficiency in computer-aided design of coastal structures.

Structure of Engineering Research and Science Technology Centers

"The goal of the engineering Centers program is to develop fundamental knowledge in engineering fields that will enhance the international competitiveness of US industry and prepare engineers to contribute through better engineering practice. Engineering education and research must be firmly linked at the Centers."

Such centers are to be located at academic institutions because of the required strong link between research and education. Cooperation between several institutions is encouraged. Strong commitment from industry is required before NSF center funding is considered. Such commitment is made in the form of industrial contributions of money, equipment and people.

The STC's will differ from the ERC's in their overall objectives, but the structure is likely to be very similar. Quoting from the NSF announcement, the STC's should "exploit opportunities in science and technology where the complexity of the research problem requires the advantages of scale, duration and/or equipment and facilities that can only be provided by a research center. Thus an STC should be a mechanism for accomplishing significant results on a particular topic more effectively and in a more timely manner than its participants could achieve as individual investigators." The reason that I was asked to present this summary to the Board today is that the Department of Geology and Geophysics at Louisiana State University (LSU) has just this year participated in a major proposal effort for an STC, and funding of this initiative right now looks very promising. The proposed STC would aim to develop an overall "Process Model for Sedimentary Basins." The Center is based on computer networking of scientists in divers geographic locations. The educational institutions involved are Cornell, Columbia, MIT, Woods Hole and LSU. A number of industrial companies are involved as well, including Schlumberger, AMOCO, ARCO, IBM, Landmark Computer Graphics and Petroleum Information Co., and others. The flexibility of the computer networking is such that when students graduate and move

they may continue to participate in Center activities at their new work place. Likewise, the potential is great for inclusion of other universities, governmental laboratories and industrial companies as the Center evolves.

This is not the place to describe in detail the structure and objective of this Basin Research STC, except to point out that we believe, and so, clearly, does NSF, that a new structure of research centers based on networking rather than assembly of all the appropriate experts in the some building of bricks and mortar is the way that large-scale mission-oriented research will be accomplished during the next decades.

Recommendation

The need for large-scale laboratory facilities and the multidisciplinary nature of most coastal engineering problems would seem to warrant the establishment of an integrative "center." I would recommend that the Corps establish an ad hoc committee to evaluate whether an ERC or STC, consisting of selected components of the WES and some universities, might be an avenue for the establishment of a coastal engineering research center.

DISCUSSION

It was noted that the commitment and participation of private industry is a very important part of the NSF Centers. Dr. Mei asked if the strong possibility of industry support could be foreseen, given the climate of oil industry activity. Dr. Nummedal indicated that he sees indications that the interest is out there, and it is not limited to the petroleum industry. Dr. Mei indicated that the type of approaches that CERC may receive, e.g., to use facilities for model testing, may not be enough to form a strong component to justify creation of NSF Centers. Dr. Nummedal noted options available for collaboration between industry, government agencies, universities, and NSF, and recommended an ad hoc committee to evaluate those options.

Dr. Oswald noted that dialogue is reduced using computer-netted R&D, and asked how that would be overcome with this particular center concept. Dr. Nummedal said that he had given that some thought, and that dialogue on the telephone or via computer link-ups seems to be the main component. He said that we are, in effect, already establishing very close working relationships with colleagues that have a similar goal, yet complementary expertise, regardless of the geographic location. He sees the networking concept as a logical extension.

Dr. Basco asked about the NSF Ocean Engineering Research Center at Texas A&M. Prof. Reid said that center was designated as an Offshore Technology Center, and primarily addresses the needs of construction in deep water offshore. It was noted that it does not include coastal engineering. The Center is a consortium between Texas A&M, the University of Texas, and private industry. BG Kelly said we might look at that as an after-action item.

PUBLIC COMMENT

Mr. James W. Holton of Waterway Survey and Engineering, Ltd. said outstanding benefits of Corps R&D for the practicing engineer have been the SPM and the products of the Dredged Material Research Program. However, improvements to design criteria are still needed. He agreed with the need to monitor completed coastal projects. He suggested monitoring some of the private projects, some of which are not necessarily designed according to SPM criteria, as well as monitoring public-funded projects. He emphasized the need to get research results out to the public for use in the private sector. He said we need project monitoring plans so that monitoring is properly conducted and does not lead to the wrong conclusions. He also said that data collection needs to be well planned and controlled. He noted that practicing engineers have a major legal liability, and cannot predicate a design based on what one person has published in a paper. If the criteria come from a document such as the SPM, then it can be defended. It is highly important to take what is in published papers and consolidate it in periodic revisions to the SPM. When we have a high degree of confidence in research data, we need to incorporate it into design documents for practicing engineers. He thinks there is an urgent need for a comprehensive guideline for beach monitoring, spelling out the various areas that need to be monitored, the ones that are essential and the ones that would be nice to have. He thinks monitoring could be cost-shared as a cooperative research effort, and we could realize a high return for a modest cost. He also spoke favorably about the new Dredging Research Program. BG Kelly asked Mr. McPherson to make special note of the comments centering around monitoring completed projects.

Mr. Powell said that the O&M manual for cost-shared coastal projects is about due to be published. It includes monitoring. He noted there would be a Corps Tidal Hydraulics Committee meeting the following week, and that the agenda would include dredging.

Dr. Burcharth made reference to economic optimization and the use of probabilistic design. He said we have the methods in hand, but we need to have the functional relationships between the parameters before we can actually quantify things. Stability formulas do not take into account many parameters. He feels that within the next five years, much more will be known about coastal structures.

Dr. Wang noted that we don't have the necessary data to evaluate numerical models. He said he had detected ambivalence about the models. He said he thinks we need to establish some criteria for evaluating the performance of the models. He said he recently chaired a committee under the Tidal Hydraulics Committee of American Society of Civil Engineers, and they have a report out addressing some of the problems. BG Kelly said we would try, at each CERB meeting, to pick out a given numerical model and integrate that into the program of the meeting. We would talk about the model, where it stands, how we are coming, and problems thereof.

Mr. Johnson made an announcement regarding the 30 November meeting which would be held under the auspices of the University of Michigan. The meeting would be on Great Lakes coastal erosion, and would review progress since last year's workshop, including discussion of the Great Lakes '88 experiment, and to develop a coordinated plan to attack the identified primary research needs for the next decade. A workshop held under the auspices of the International Joint Commission in October addressed data needs and research needs relevant to the effects of Great Lakes' water level fluctuations onshore erosion processes. The Canadians claim, with respect to their cohesive bluffs, that there is very little you can do in the way of lake level regulation to alter the erosion processes. He said there is considerable need for a better understanding of downcutting rates of the nearshore zone in these cohesive bluff processes, because it would appear that would determine your long-term recession rates of your bluffs. BG Kelly asked if the Canadians would be willing to cost share the research because it is a mutual concern. Mr. Johnson said he was sure that they would.

Mr. Vann commented that field data acquisition is one of the more expensive aspects of research. He said they found by standardizing the method in which they gather data, they gather very little single purpose data. They use the same data to

develop shoaling rates, to assess movements of sediments, and also use it during the budget process in out-years. They use the same data to define what's going on in the environment itself as far as physical movements. They reuse the data successfully because they gather it in a prescribed manner, and that saves money.

LTC Franco said when the people in the field have a problem they go to the researchers. He suggested that the researchers know what projects the field is working on over a long period of time, and they should come to the field with some proposals to try out or apply some of their techniques or postulates. Come in early in the predesign stage, do some of the analysis, and go ahead and follow through with the construction. Projects are cost shared. He feels that cost-sharing partners would be willing to cost share the monitoring. He said they might find opportunities to apply some of the models or approaches in the real world, and then provide data back to the researchers.

Mr. Frye mentioned that the Section 933 policy is new and evolving, and that it holds a lot of promise. In regard to cost sharing, he thought that there were many opportunities in Virginia. He feels the state and the Corps are working as a team, and that is going to continue and increase. He hopes that there will be a public awareness that this is a team approach.

JOINT LOGISTICS-OVER-THE-SHORE BRIEFING

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The CERC has become active, in recent times, in providing the Department of the Army with a research and development capability in the area of coastal processes and phenomena as related to Joint Logistics-Over-The-Shore (LOTS) Operations.

Providing a steady and reliable stream of logistical support to any theater of operations is crucial. The Army considers its support structure as one of its potential centers of gravity or key functions. If the center of gravity is defeated or collapses, all could be lost. As 90 percent of our logistic support comes via sealift, it is essential that there is a viable means to discharge and throughput those supplies. Many Third World regions, such as parts of Southwest Asia and Central America, provide us with little or limited existing port access. In those regions with ample port facilities, such as Northern Europe, we can be denied access through various acts of war. Therefore, it is essential that we are able to throughput cargo over an unimproved stretch of coastline by conducting LOTS operations.

LOTS is just one of many Sustainment Engineering missions for the Corps of Engineers. Predominant players in a Joint LOTS operation are the US Army Transportation Corps, US Navy, US Army Corps of Engineers, and the US Army Quartermaster Corps. Each arm has specific and detailed missions.

CERC conducted a Joint LOTS Technology Transfer Workshop (TTW) to determine the engineering problems from the field operators and to insure that there would be no duplication of effort in the engineering research and development community in terms of solving those problems. Seventy-seven individuals from 27 different Department of Defense agencies participated in the workshop. Nine key points were identified by the participants, as follows:

a. Need for adequate dredging support.
b. Priority of study to Southwest Asia, North Pacific, Central America, NATO.
c. Need for a Sea-State database and planning model.
d. Enhanced material handling and lighterage design.
e. Ship motion compensation systems.
f. Sea-State attenuation.
g. Soil stabilization.
h. Rapidly deployable port.
i. Use of remote-sensing for real-time and long-range planning.

One predominant factor which affected LOTS operation was the Sea State. It was shown that all logistical throughput ceased when the ceiling of Sea State 2 (3 ft waves, 12.7 knot winds) was reached.

The CERC staff took these identified problems and established two research and development program goals. These goals were:

a. Determine the optimum means for LOTS site selection.

b. Maximize throughput a selected LOTS site.

Specific work units were then developed to meet these goals. These work units include efforts in 1) developing a Sea-State database, 2) developing a database for predicting currents and water level fluctuation, 3) developing a real-time forecasting model, 4) developing a model for the evaluation of coastal environments, 5) development of a LOTS simulation planning model to maximize throughput, and 6) the development of a rapidly deployable breakwater system. All of these packages are key to global use. These work units are all funded in the FY 88-94 budgets.

Additionally, CERC recognizes the need for engineering research and development in the dredging arena. This problem is amplified in the more remote or less developed regions of the world. CERC has proposed a work unit to solve some of these problems, but is presently unfunded. CERC hopes to glean ideas from some of the technology developed in the Civil Works-funded DRP for later use in a military-funded program.

DISCUSSION

BG Kelly noted that Wilmington District needed a portable breakwater, and the military needed a portable breakwater, and there should be a lot of synergy. Mr. Jarrett commented that Wilmington District's involvement with the floating breakwater was through the Navy. The Navy had a similar program called COTS (Continuing Off-loading Transport System). The Navy was looking at the use of sloping float breakwaters as a means of providing protection for off-loading. He was not sure if LOTS was involved with that kind of transport and breakwater development, but they could look at what the Navy and Wilmington District have done. The Navy had proposed using existing barges, but the District found they were not structurally sound. The District would be interested in pursuing the development of specialized equipment if they could get the money. Mr. Pellicciotto commented on the rapidly deployable dredge. He noted that the Dredging Division feel there are some good design concepts to pursue. BG Kelly asked if TRADOC had a Required Operation Capabilities for that. COL Lee said to the best of his knowledge they did not. He added that the Corps has a wartime responsibility for dredging in the theater of operations. BG Kelly said that the process for the research must go through TRADOC to establish the requirements, then the Army Material Command is tasked to do the research, which could be delegated back to the Corps. He said this has a lot of merit, and we need to pick up on it, and Mr. Pellicciotto was going to have to do that. Dr. Oswald said they needed to work with General Ross who is responsible for logistics, and is the proponent for this kind of R&D.

Dr. Mei said that given the scope of long-range research needs which are important not only to the Corps' civil works, but also to military applications, he would like to see us broaden the outlook on the philosophy of doing research in addition to technology transfer. He thinks CERC cannot only do the most up to date research, but can also become a catalyst to enhance the advancement of coastal engineering by promoting better collaboration with the private sector, with other government agencies, and with universities. He feels that this can be done on two different fronts. One is constantly examining the optimum use of funds available to CERC, the other is expanding the participation and the search for new funding support. He referred to the prior discussions of funding support from NSF, the Office of Naval Research, and the Army Research Office. He noted that CERC has a larger block of funding for coastal research than other sources, and that can be more easily justified if CERC can act as a catalyst to get expanded funding for the coastal engineering community.

Dr Mei noted that the DRP is the largest integrated research program that really touches upon all aspects of coastal engineering. He suggested more CERB involvement in that program.

Dr. Nummedal said we need a stronger effort at setting priorities. He thought that the presentations by Drs. Kraus and Hughes specifically set priorities. Dr. Kraus had listed a series of items within the general field of sediment transport, and Dr. Nummedal thought that this kind of list should be discussed internally at CERC to further establish what the priorities should be. He thinks at the Spring Program Review, an identification could be made as each work unit is reviewed as to whether that work unit is viewed as part of the long-term or basic research objectives of CERC, or whether it is a more applied, short-term, problem-solving type issue. That was done to some extent last Spring, but maybe that could be further strengthened.

Dr. Nummedal said that technology transfer between CERC and the Districts is clearly a very important role, as has been pointed out at this and all prior CERB meetings. He thinks that they all agree that it is an essential component, and that a number of programs within CERC right now are making technology transfer more efficient. He is particularly pleased with the initiative taking by CERC investigators to invite engineers involved in specific project designs to come to CERC, and work with CERC engineers and scientists, so that they have been parties to the creation of the final report. He thinks that kind of close cooperation is extremely useful and stimulating. He said that he wholeheartedly endorses rotational assignments of younger engineers and scientists.

Dr. Nummedal said he agrees entirely with Dr. Mei that CERC should be a catalyst to stimulate further funding support from agencies such as NSF and ONR. He stressed it is important when CERC is doing that, they not be perceived as competitors

with academic institutions for NSF and ONR funds. He said that if they were perceived as competitors, it could hinder increased funding for coastal engineering. He said that establishing some sort of center, as he had alluded to earlier, might establish CERC's role.

Dr. Nummedal referred to the point made earlier in the meeting by Dr. Le Me'haute' about getting funding for large-scale programs, and made reference to such things as the super collider and the deep-sea drilling project. He said we need to look at the development that preceded the actual acquisition of funds for those kinds of programs. Over the years, it has been very clear that none of them have been funded without a fairly long-term establishment of consensus in the scientific community as to what the priorities really are. Years of journal papers and presentations at meetings that basically focus on a common set of problems of great scientific significance mean that Congress hears nearly unanimous support when a proposal for funding is considered. We may have failed in this regard, or may have not attempted to unify the coastal scientific community into articulating what some of the key priorities should be. He thinks that is an absolutely essential prerequisite before we can expect any agency to put more funding into this kind of endeavor. He thinks that there are various mechanisms available to do this.

Dr. Nummedal said that, both in getting funding and attracting young engineers and scientists to work on coastal problems, it is extremely important to articulate some vision as to where the discipline is going. We spend a lot of time discussing particular projects, but that is not the exciting, intellectually stimulating question that will attract a number of bright young scientists and engineers to work in coastal engineering. We need to express things in terms of the intellectual excitement that this discipline has in it. There were a number of presentations at this meeting that contained elements of such visions for the future, but we need to get that out to the community.

Dr. Nummedal noted that CPT Marino's presentation was the first one he has heard on military applications, and CERC should clearly be involved in that area. He thinks there are opportunities in this area, and some overlap with civil works applications, and he hopes to hear presentations at future meetings on military needs in coastal engineering.

Dr. Nummedal recommended that the Corps establish an ad hoc committee to look into the establishment of a science and technology center structure for coastal science. He also recommended that the Corps establish a committee of qualified economists, including non-Corps members, to reevaluate the procedure we use to calculate benefit-cost ratios. He said that some of the procedures used are antiquated, and in light of provisions in the Water Resources Development Act of 1986, this will be a very opportune time to totally reevaluate that procedure. That is something that goes beyond the expertise of the present Board. As a final recommendation, he supported

BG Kelly's suggestion for a data base where we have actual cost history of past Corps' projects.

Prof. Reid noted the earlier comments concerning CERC acting as a catalyst for coastal research. He said that the academic community should be made aware of specific needs so that individuals having an interest might explore those areas and seek funding. He also addressed the role of modeling, which is very important in both structural design and shore processes, and briefly stated his perception of that role. He said one must have a marriage between field programs, laboratory modeling programs, and mathematical models. His perception of mathematical models is that they are a way of taking measurements and extending them in space and time. There are, in particular, certain predictive models. But most of our models, when used in consort with laboratory measurements, are really interpolators in a very broad sense, and he thinks we should keep that in mind. The models are no better than the data fed into them. He reiterated the earlier statement by BG Kelly that the Board should consider the topic at future meetings.

BG Kelly tasked the Board, in their written comments to him, to provide their ideas and opinions on the various topics presented. He said that he would like their own perspective on the long-range research needs, and what they feel should be the priorities. He said that their thoughts would help him and Dr. Oswald as they set priorities. There is a fixed amount of money, and they want to apply it where it has the best impact. It does not all have to go to practical applications. It has been pointed out at several CERB meetings that we cannot address the practical solutions until we understand the basic processes, and they go hand-in-hand.

FUTURE CERB MEETINGS

BG Kelly said that at future CERB meetings he would like, as appropriate, a discussion of models as they relate to the themes of the meetings. He asked COL Lee, Executive Secretary of the Board, to present the proposed locations and themes for the future meetings.

COL Lee said the next meeting was set for Wilmington, North Carolina, in May 1989, and the thought was to incorporate into the agenda of that meeting a discussion on shoreline modeling efforts, both numerical and physical. This would include the state of the art, or where we are in CERC in modeling those types of processes, as well as some specific examples of models we have ongoing relative to that shoreline modeling process.

The fall meeting in 1989 is scheduled for Los Angeles. The tentative theme is Pacific Coastal and Navigation Challenges. That would be an opportunity to look at harbor models, circulation models, continue the dialogue that we would start in Wilmington on our state of the art, and use the Los Angeles-Long Beach Harbor numerical model as a case study.

COL Lee also suggested putting together a briefing at WES for members of the HQUSACE staff to discuss the whole area of hydraulic and coastal modeling. He suggested sometime after the first of the year. Dr. Oswald said he would like that to include the correlation between past model efforts and actual results.

The Board agreed with the plan to incorporate discussions on the models in future meetings. BG Kelly asked Dr. Houston to consider which models would be appropriate at each of the future Board meetings.

BG Kelly asked for consideration of a special Board meeting in the January-February time frame to discuss the DRP. That was concurred in by the Board members. He then requested suggestions for the locations and themes of the spring and fall meetings in 1990.

Dr. Houston said the proposed location for the spring meeting in 1990 was Fort Lauderdale, Florida, and the theme would be Coastal Inlets. The proposed location for the fall meeting in 1990 was New Orleans, and the theme would be Coastal Flood Protection. The Board members agreed to those themes and locations.

CLOSING REMARKS

BG Kelly appreciated the participation and the perspective on the topic of Long-Range Research Needs from the outside community as well as from the Headquarters staff, WES, and CERC. He thought there was a common theme of interaction between CERC, universities, private sector, and other Federal agencies, with CERC being the catalyst. BG Kelly reiterated his need for input to set priorities.

BG Kelly thanked the Board members; the North Atlantic Division; the Norfolk District, especially COL Thomas, his Deputy LTC Frost, Mr. Ron Vann, who acted as a central coordinator to pull the meeting together, Mr. Sam McGee, who put together an excellent field trip, Ms. Marsha Weatherly, who assisted in the adminstration of the meeting, and all the other District employees involved. He thanked his Headquarters staff, especially Mr. John Housley who is his point of contact; the WES staff, especially COL Lee, Dr. Houston, Mr. Charles Calhoun, and Ms. Sharon Hanks, the CERB administrative assistant.

BG Kelly complimented the Commonwealth of Virginia for their participation and support, particularly the Secretary of Natural Resources, the Honorable John W. Daniel, II, and Mr. Jack Frye, who gave us Section 933 guidance and input. He thanked the City of Virginia Beach, especially the Honorable Meyera Oberndorf, Mayor, Messrs. Bob Matthias, and Carl Thoren; the Virginia Beach Erosion Council, including Dewey Simmons, its president, and Woody Holton, who provided public comment; and the Hampton Roads Maritime Association, especially Mr. Jack Mace. He also thanked Fort Story and LTC Hicok, the battalion commander who arranged and conducted the presentation on LOTS during the field trip.

(The 50th meeting of the CERB was adjourned.)

APPENDIX A
BIOGRAPHIES OF SPEAKERS/AUTHORS

DR. DAVID R. BASCO

Dr. Basco was a faculty member at Texas A&M University from 1969 to 1986 and has recently joined Old Dominion University as Professor of Civil Engineering and Director of the newly created Coastal Engineering Institute. He obtained his B.S. and M.S. degrees in civil engineering from the University of Wisconsin in 1960 and 1962, respectively, and his Ph.D. degree in civil engineering from Lehigh University in 1970. In 1975-76, Dr. Basco was a visiting research professor at the Delft Technical University, The Netherlands, and also an NSF Faculty Fellow at the International Institute of Hydraulic Engineering in Delft. In 1982, Dr. Basco spent his sabbatical leave at the Technical University of Denmark, Lyngby, Denmark, as a visiting research professor. His current research interests are in water-wave mechanics and coastal hydrodynamics, including wave breaking and dynamics of surf zones. He is also doing research in fundamental aspects of computational hydraulics and in dredging engineering. Dr. Basco's professional experience has been as an engineer with the US Bureau of Reclamation, Allis-Chalmers Manufacturing Company, the US Army Corps of Engineers Waterways Experiment Station, the US Geological Survey, and in private consulting practice as President of E_2O Consultants, Inc. He has been an active member of the ASCE, where he presently serves as Associate Editor for the Waterway Port Coastal and Ocean Engineering Journal. He has authored over 60 conference and journal papers and technical reports.

DR. HANS F. BURCHARTH

Dr. Burcharth received his M.S. degree in civil engineering from the Danish Engineering Academy in Copenhagen in 1961. In 1969, after eight years as owner of a consulting engineering company and part-time lecturer and researcher at the Danish Engineering Academy and University of Copenhagen, he became Professor and head of the Laboratory of Hydrodynamics, Port and Coastal Engineering in Aalborg, Denmark. Since 1979 he has been Professor of Marine Civil Engineering and head of the Department of Civil Engineering at the University of Aalborg. Dr. Burcharth is the chairman of the Danish Governmental Committee for funding civil engineering basic research. He is President of the Danish Society of Hydraulic Engineering and a member of the Danish Academy of Technical Sciences. He is Secretary of the PIANC PTC II Working Group on Rubble-Mound Breakwaters. His research has focused on statistical analysis of turbulence, wave grouping, material science, and breakwater technology. He is internationally utilized as an expert and consultant in breakwater engineering.

JOHN W. DANIEL, II

Mr. Daniel, Secretary of Natural Resources, a newly-created cabinet post, has served in state government in various capacities for the past twelve years. The Natural Resources Secretariat was created by the 1986 General Assembly at the request of Governor Baliles. Mr. Daniel served as Deputy Secretary of Commerce and Resources before the reorganization that took effect on 1 July 1986. A Richmond native and a graduate of the T. C. Williams School of Law of the University of Richmond, Mr. Daniel served for five years as a staff attorney in the Division of Legislative Services for the Commonwealth of Virginia and for four years as Special Assistant to the Attorney General. Interest areas have included mining and energy, conservation and natural resources, and environmental matters. Mr. Daniel served in the United States Army Reserve from 1972-78. He is a member of the Virginia State Bar Association, Board of Directors of the Kanawha Recreation Association, the Virginia Association of Retarded Citizens, and the Greater Richmond Area Association of Retarded Citizens. Mr. Daniel is married to the former Helen (Pat) Garland Ferguson, and they have two children.

JAMES D. DAVIDSON

Mr. Davidson is the Deputy Chief, Planning Division, Directorate of Civil Works in HQUSACE, Washington, DC. He has the responsibility for assisting the Chief of Planning in the water resources planning for navigation, flood control, shore protection, and other purposes nationwide. Mr. Davidson previously served as a branch chief in the Planning Division, HQUSACE, a staff member of the Board of Engineers for Rivers and Harbors (including a 1-1/2 year detail with the US Senate Environment and Public Works Committee), a member of the Planning Division, South Pacific Division. He began his career with the Corps in the Huntington District in 1962. Mr. Davidson graduated from the University of Kentucky in 1959, did graduate studies in Water Resources at the University of Illinois, and attended the Planning Associates program. He is a registered professional engineer and land surveyor in Kentucky, and has received the Meritorious Civilian Service Award.

JACK E. FRYE

Mr. Frye is a native Virginian. He received his B.S. degree in geology from Virginia Tech and his M.S. degree in oceanography from Old Dominion University. From 1978 through 1980, he taught Marine Geology and Physical Oceanography at the Florida Institute of Technology in Jensen Beach. Since 1981, Mr. Frye has been with the Virginia Department of Conservation and Historic Resources, Division of Soil and

Water Conservation. From 1981 until October 1986, he served as an environmental engineer, providing erosion control advice to private property owners on tidal waters. In October 1986, he was promoted to Shoreline Programs Manager. He is administrator and advisor to the Board on Conservation and Development of Public Beaches, manages the Shoreline Erosion Advisory Service, and develops and coordinates State shore erosion research efforts and projects with the Virginia Institute of Marine Science, Old Dominion University, other State agencies, and the Federal Government.

DR. JAMES R. HOUSTON

Dr. Houston is Chief of the Coastal Engineering Research Center of the US Army Engineer Waterways Experiment Station (WES). He has worked at WES since 1970 on numerous coastal engineering studies dealing with explosion waves, harbor resonance, tsunamis, sediment transport, wave propagation, and numerical hydrodynamics. He is a recipient of the Department of the Army Research and Development Achievement Award. Dr. Houston received a B.S. degree in physics from the University of California at Berkeley, an M.S. degree in physics from the University of Chicago, an M.S. degree in coastal and oceanographic engineering, and a Ph.D. in engineering mechanics from the University of Florida.

DR. STEVEN A. HUGHES

Dr Hughes is a research hydraulic engineer in the Wave Dynamics Division, Coastal Engineering Research Center (CERC), US Army Engineer Waterways Experiment Station. He joined CERC in 1981 and has been involved in the Shore Protection Manual revision, numerical modeling of shallow-water waves, wave coherence, wave height distributions, remote sensing, image analysis, and instructing in workshops and the Coastal Engineering Short Course. Since stepping aside as Chief of the Coastal Processes Branch, his primary interests have been coastal scouring, movable-bed modeling and wave phenomena. He received a B.S. degree in aerospace engineering (1972) from Iowa State University of Science and Technology, an M.S. degree in coastal and oceanographic engineering (1978), and a Ph.D. degree in civil engineering (1981) from the University of Florida. He is a registered professional engineer in the State of Mississippi.

DR. NICHOLAS C. KRAUS

Dr. Kraus is a senior research scientist in the Research Division, Coastal Engineering Research Center (CERC), US Army Engineer Waterways Experiment Station. He joined CERC in September 1984 and is presently involved with numerical modeling

of beach evolution; fundamentals of sand transport, including windblown sand; and finite amplitude wave theory. Previously he was a senior research engineer at the Nearshore Environment Research Center in Tokyo, Japan. Dr. Kraus received a B.S. degree in physics from the State University of New York at Stony Brook and a Ph.D. degree in physics from the University of Minnesota. He is a member of the American Society of Civil Engineers, Japan Society of Civil Engineers, American Geophysical Union, and Society of Economic Paleontologists and Mineralogists.

DR. BERNARD LE MEHAUTE

Dr. Le Mehaute was born and educated in France, and obtained his Ph.D. degree in hydrodynamics at the University of Grenoble in 1947. He was the first recipient of the International Coastal Engineering Award of the American Society of Civil Engineers in 1979 and served on the Coastal Engineering Research Board for 6 years (to July 1988). He is now a Professor of Applied Marine Physics at the Rosenstiel School of Marine and Atmospheric Science.

DR. OLE S. MADSEN

Dr. Madsen graduated in January 1964 with a Masters degree in civil engineering from the Technical University of Denmark with a specialty in coastal engineering. After service in the Danish Army, he came to the United States in 1966 where is received his Doctor of Science degree in hydrodynamics from the Civil Engineering Department of the Massachusetts Institute of Technology (MIT) in October 1969. Following a two-year period as oceanographer/mathematician with the US Army Coastal Engineering Research Center in Washington, DC, he returned in January 1972 to MIT where he is presently Professor of Civil Engineering at Ralph M. Parsons Laboratory.

CPT(P) JAMES N. MARINO

CPT(P) Marino has been at the Coastal Engineering Research Center (CERC) since January 1987 after receiving a Master of Engineering degree in Coastal and Oceanographic Engineering from the University of Florida, in December 1986. At CERC, his duties include the management and coordination of the Joint Logistics-Over-The-Shore program and conducting research and engineering analysis on tidal inlets, coastal feeder berms and dredging. He, also, serves as the Military Research, Development, Test & Evaluation Coordinator at CERC. CPT(P) Marino received his commission and B.S. degree in engineering from the United States Military Academy at West Point, NY, in 1978. He is a registered professional engineer in Virginia and

Florida. He previously served as Commander of the 814th Engineer Company in the Federal Republic of Germany.

SAMUEL E. MCGEE III

Mr. McGee graduated in 1978 with a Bachelor of Science degree in civil engineering from Old Dominion University in Norfolk, Virginia. At Old Dominion University he was elected to membership in Chi Epsilon National Civil Engineering Honor Society. Prior to entering the field of engineering, he served as an aviator in the US Army including two 1-year assignments in Vietnam. He has served for the past 10 years as a civil engineer with Norfolk District, US Army Corps of Engineers, principally in the field of navigation project engineering and design. His most recent significant project assignment was the preparation of the General Design Memorandum for the Norfolk Harbor and Channels Deepening Project.

JOHN A. McPHERSON

Mr. McPherson currently serves as the Special Assistant for Civil Works to the Chief of Engineering Division, Directorate of Engineering and Construction, Headquarters, US Army Corps of Engineers, Washington, DC. As Assistant Chief, Engineering Division, Mr. McPherson is responsible for supervising and managing all engineering design activities relating to the Civil Works construction mission of the Corps of Engineers. Prior to this assignment, he served 3-1/2 years as Chief, Technical Engineering Branch, Engineering Division, Ohio River Division, Cincinnati, Ohio. Mr. McPherson graduated in 1961 with a degree in civil engineering from Michigan State University, East Lansing, Michigan. He is a registered professional engineer in the Commonwealth of Pennsylvania.

DR. DAG NUMMEDAL

Dr. Nummedal has served as a full professor of geology at Louisiana State University (LSU) since 1984, and was an assistant and associate professor from 1978-1984. He is presently a member of NASA's Planetary Geology and Geophysics Advisory Committee, and was a member of NASA's Planetary Geology Working Group, the National Academy of Science's Committee on Engineering Implications of Changes in Mean Sea Levels, and Chairman of the Coastal Sedimentation Research Group of the Society of Economic Paleontologists and Mineralogists.

Dr. Nummedal joined the faculty at LSU after serving as a research scientists and assistant director in the Coastal Research Division, Department of Geology, University of South Carolina. He also served as a consulting geologist in residence, Oxy-Cities

Service Oil and Gas Company, Exploration Research Laboratory (1985); visiting scientist, US Geological Survey, Center for Astrogeology (1981); visiting assistant professor, Institute of Marine Science, the University of Texas at Austin (1980); and guest investigator, Viking Lander Imaging Flight Team, Jet Propulsion Laboratory (1976).

A native of Drammen, Norway, Dr. Nummedal received his B.A. in 1965, and M.S. in 1967 from the University of Oslo, Norway, and his Ph.D. in 1974 from the University of Illinois, Champaign-Urbana. He is a member of numerous profession organization including the Geological Society of America, the American Sedimentologists, and the American Shore and Beach Preservation Association.

Dr. Nummedal is the author or co-author of over fifty professional papers, and numerous technical reports. He has presented a large number of lectures, and has served as a short course instructor including the Corps of Engineers course on Applications of Engineering Geology to Coastal Projects.

JOHN J. PAREZ

Mr. Parez graduated from Marquette University with a degree in civil engineering in 1971. Upon graduation, he began working in the Chicago District Corps of Engineers in the rotational training program. After completing the training program, he worked in the Operations Division until 1979. From 1979 to 1986, he worked in the Operations and Maintenance Branch of North Central Division. From 1986 to the present time, Mr. Parez has worked in the Corps Headquarters as Chief, Management and Budget Section of the Operations Branch.

TED A. PELLICCIOTTO

Mr. Pellicciotto is a graduate of the Missouri School of Mines and the University of Missouri, earning degrees in Mining Engineering, Civil Engineering, and a Master's in Construction and Management. He has been employed by the Illinois Division of Highways in the construction and operation of state and Federal highways. He was a design and construction engineer for the Pittsburgh Plate Glass Company, where he was responsible for the turn-key operation of major chemical processing systems. He began his Corps career in 1965 with the Norfolk District Construction Branch, transferring to the Corps Headquarters in 1970, where he held positions in construction, operations, and maintenance of water resource projects and emergency management. His present position is with the Civil Works Dredging Division serving as Deputy Chief of the Division.

DR. EDWARD B. THORNTON

Dr. Thornton has been Professor of Oceanography at the Naval Postgraduate School, Monterey, California, since 1969, where he teaches courses in Coastal Oceanography, Wave Theory, and Signal Processing. Dr. Thornton graduated with a Ph.D. from the University of Florida in Coastal and Oceanographic Engineering in 1969. He is a member of American Geophysical Union and ASCE for which he served on the Awards and Coastal Engineering Technical Subcommittees. He presently serves on the National Research Council Committee on Coastal Engineering Measurement Techniques. Dr. Thornton has considerable consulting experience in coastal engineering. His research has focused on field measurement and modeling of nearshore wave, current and sediment processes, areas in which he has published numerous articles.

DR. C. LINWOOD VINCENT

Dr. Vincent is currently Senior Scientist and Program Manager for the four Coastal Engineering Research Programs at the Coastal Engineering Research Center (CERC), Waterways Experiment Station (WES). His positions in the past include Chief, Coastal Branch, Wave Dynamics Division, Hydraulics Laboratory, WES; Chief, Coastal Oceanography Branch, Research Division, CERC, Ft. Belvoir, VA; and Senior Scientist, Research Division, CERC, WES. Dr. Vincent's research interests include ocean wave mechanics, air-sea interaction, spectral wave modeling, and wave climatology. He has also worked in the area of tidal inlet processes. Dr. Vincent has received an Army Research and Development Achievement Award and The American Society of Civil Engineers Walter L. Huber Prize for his wave research. Dr. Vincent has a B.A. in mathematics, a M.S. and Ph.D. in environmental sciences (earth sciences) from the University of Virginia.

DR. JOHN D. WANG

Dr. Wang received his M.S. degree in civil engineering from the Technical University of Denmark, and a Ph.D. degree from the Massachusetts Institute of Technology. He is currently a professor of Applied Marine Physics and Ocean Engineering at the University of Miami. His research interests are in the field of numerical modeling of coastal processes including tides, wind and density driven currents, waves, and substance transport.

DR. J. RICHARD WEGGEL

Dr. Weggel was born in Philadelphia, Pennsylvania, where he attended the Philadelphia Public Schools, graduating from Frankford High School in June 1959. He received his B.S. degree in civil engineering from the Drexel Institute of Technology in June 1964. Following graduation, he taught static mechanics at Drexel. He obtained his M.S. degree in 1966 and his Ph.D. degree in 1968 in civil engineering (hydraulics and water resources) from the University of Illinois at Urbana-Champaign. Dr. Weggel was Assistant Professor of Civil Engineering at the University of Illinois from September 1968 until February 1971, when he joined CERC in Ft. Belvoir, Virginia, as a hydraulic engineer working on what was to become the Shore Protection Manual. In March 1973, he became Special Assistant to the Commander and Director of CERC, and in July 1977, he became Chief, Evaluation Branch, Engineering Division, CERC. During his tenure at CERC, he contributed to the Shore Protection Manual and served as a consultant to Corps of Engineer Districts and Divisions on coastal engineering problems. In June 1983, he joined the faculty of the Department of Civil Engineering at Drexel University as an Associate Professor. In September 1988, he was promoted to the rank of Professor and became Head, Department of Civil and Architectural Engineering.

DR. WILLIAM L. WOOD

Dr. Wood is Director of the Great Lakes Coastal Research Laboratory and a Professor of Ocean Science and Engineering at Purdue University. He received his B.S. degree in mathematics and physics from Michigan State University and his Ph.D. in geophysics from Michigan State University. Dr. Wood's research is focused on coastal hydrodynamics, sediment transport, boundary layer processes, and large lake dynamics. Dr. Wood is a member of a number of professional and honor societies and currently serves on the National Research Council's (NRC's) Committee on Coastal Engineering Measurement and chairs the NRC's Committee on Coastal Erosion Zone Management. Author of numerous professional publications, Dr. Wood is currently completing a book in the series Living With America's Coastlines: Lake Michigan's Coast.

DR. L. DONELSON WRIGHT

Dr. Wright was born in the United States in 1940. He obtained his Ph.D. degree from the Coastal Studies Institute, Louisiana State University (LSU), in 1970; his M.A. degree from the University of Sydney (Australia) in 1967; his B.A. from the University of Miami in 1965. Since 1982, Dr. Wright has been Professor of Marine Science, Virginia Institute of Marine Science, College of William and Mary. He was formerly

Associate Professor and Head of the Coastal Studies Unit, University of Sydney, from 1974-1982, and Associate Professor, Coastal Studies Institute, LSU, from 1970-1974. Dr. Wright's research specializations include: coastal and shoreface morphodynamics; benthic boundary layer processes; nearshore and estuarine oceanography; sediment transport processes; river mouth deltaic, and estuarine sedimentation.

APPENDIX B
RESEARCH AND OTHER NEEDS OF PRACTICING ENGINEERS

RESEARCH AND OTHER NEEDS
OF
PRACTICING COASTAL ENGINEERS

by

Dr. David R. Basco, P.E.
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Introduction

The results of research and development conducted by the Coastal Engineering Research Center (CERC) for the Chief of Engineers and the Corps' District Offices are also used by most consulting engineering firms practicing coastal engineering in this country and around the world. The symbol of this is the Shore Protection Manual (SPM, 1984) that has become the most worn reference on the bookshelves of professional engineers.

We ask the question: what are the long-range needs (research, etc.) in coastal engineering of engineers in private practice? The answers may be different than those of the academic community, research scientists and research oriented engineers. But they are no less important since professional engineers must apply these same research results in the planning, design, construction and maintenance phases of coastal projects. Therefore, input from a representative sample of practicing engineers is appropriate for the 50th meeting of the CERB with the theme: "Long-Range Research Needs in Coastal Engineering".

The local coastal/civil engineering community is spread throughout the Hampton Roads area (the cities of Norfolk, Virginia Beach, Chesapeake, Portsmouth, Suffolk, Hampton, Newport News, etc.) and engages in a variety of activities (shoreline protection, port and harbor design, dredging engineering, etc.) dictated by the numerous tidal waters that dominate the region. To learn of their needs we developed a Questionnaire (Appendix I) with 50 questions in the following categories:

Part I - Background Information
- Basic (company) data
- Specialty consulting practice areas
- Additional civil engineering activities

Part II -Design and Consulting Services
- Sources and availability of data
- Scientific and engineering principles used in practice
- Principles of balanced design
- Engineering Services

Part III-Perceptions of Coastal Problems

The Questionnaire was mailed to 22 firms (including one person offices) known to have previously dealt with coastal problems[1]. Only 55% responded which was disappointing.

As a follow-up, a Workshop was held to cover the list of topics within the Questionnaire. The purpose was to provide information to the consulting firms, to develop the questions and responses further and to give those participating some idea of the results. Eleven engineers attended the Workshop (See Agenda, Appendix II).

The results from this relatively small sample of the coastal engineering community are presented below in the form of general observations and recommendations which combine the (1) needs and apparent lack of knowledge as evidenced by Questionnaire answers; (2) oral statements at the Workshop; and (3) the personal interpretations of these findings by the writer. It is possible to summarize these results into four categories:

(1) Construction Technology and Methods;
(2) Damage, Balanced Design and Economics;
(3) Seawalls and Beaches;
(4) Project Monitoring and Case Studies; and

each is discussed in some detail below with no particular order of importance. Misinterpretations of the findings are the sole responsibility of the writer.

Construction Technology and Methods

Little is written on the methods and techniques to construct coastal designs. Coastal engineering as a profession beginning after the 2nd World War, has properly focused its research efforts on understanding nature, its forces and their implications for sizing structures and the impact of the structures on the environment. Almost no coordinated effort has been made in a systematic study of ways to build the resulting designs at the coast - and more importantly - ways to improve construction methods to save overall construction costs. Construction details are left totally up to marine contractors who have generally been able to use their own experience and/or their own ingenuity to produce results. There is little or no knowledge by designers about construction technology and methods and vice versa. Since over 90% of costs for engineered projects are spent on materials, machines and labor for construction, it would seem prudent to seek ways to reduce costs of construction. Savings of only a few percent through improved construction techniques and methods can mean savings of millions of dollars on large projects. It was the general consensus that the CERC and the construction oriented research arms of the Corps should begin a long term effort to improve general knowledge about technology and methods of marine construction in the United States[2]

When asked about their specific knowledge of techniques, range of methods, and ways to improve construction technology, the following replies were received:

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[1] It was also sent to 24 civil engineering firms not recognized in the coastal area and this was confirmed since none responded.

[2] The Construction Productivity Advancement Research (CPAR) initiative of the WRD Act of 1988 is a small step in the right direction.

"There is not much information available"
"Need documentation of constructed projects by engineers"
"...more widespread dissemination of available techniques"
"...(my knowledge) of available construction methods is very poor"
"...need improved ways to access nearshore beach sands for beach renourishment"
"Need short courses, seminars and widespread dissemination of available techniques"
"(the key is)...how to get contractors to share their experience without giving away a competitive edge"

The Corps together with the universities, consultants and marine contractors must work together so that not only is current technology and methods well documented, but that improved methods are found and shared with all groups.

Damage, Balanced Design and Economics

Because of the exceedance probability distributions for the two key design variables (wave heights and water levels), *all* constructed designs are likely to receive some damage from *excessive* energy levels over the course of their design life. Damage plays a critical role in coastal design and damage is to be expected, recognized as such when occurring and included in all coastal engineering cost analyses as a maintenance expense for repair.

For rubble structures with protective armor layer, excessive wave energy versus damage percentage curves and tables have been developed (e.g. SPM, 1984, Vol II, Table 7-9, p. 7-211) along with a methodology to combine with probability of exceedance curves to calculate damage repair costs for maintenance purposes. As design wave energy levels increase for rarer storm events, initial construction costs increase, maintenance and repair costs decrease and total costs (initial plus maintenance) take on a classic U-shaped curve. The minimum total cost is the result of a "balanced design" philosophy that recognizes damage and resulting maintenance expense as a integral part of all coastal designs. A crude analogy is the annual street, road and highway maintenance and repair expenditures at all government levels as a result of heavy traffic and winter/summer - freeze/thaw cycles.

Coastal structures are thus expected to receive some damage due to energy levels exceeding those used in design, can be destroyed if the rare storms strike, but only (rarely) *fail* to perform their design function when the above takes place at energy levels *below* those used in design. All those associated with coastal related projects would be wise to clearly define the use of the words damage, destroy and failure as related to functional performance of a given design.

Most of the engineers surveyed have never used the calculation procedures presented in the SPM to estimate maintenance costs and total costs for rubble armored structures. However, most all do include some other empirical method, or practical experience for maintenance costs in the processes. It was recommended that efforts be made to examine real projects designed by the SPM methodology to learn of any general trends or guidelines for the minimum cost, probability of exceedance (i.e., recurrence intervals) values. This information would be for more useful than the guidelines now in the SPM.

Similar damage curves for other shore protection alternatives (hardfacing and soft defense, beach types) are also clearly needed if the same balanced design philosophy is to be useful to study total costs of all alternatives. Although extremely difficult to define, some generally expected trends may still be attainable for

use by the design engineer. The most immediate effect of sea level rise will be increased maintenance costs.

It was also generally felt that the media, general public, and many coastal scientists (oceanographers, geologists, biologists, etc.) are not aware of this fact of life of the coastal engineered environment. They called upon the Corps to help educate and tell the complete story about coastal designs. Damage must not be equated with failure and we have only ourselves to blame for the public's misconception in this regard.

Another misconception is that regarding the Federal governments role in solving coastal problems. The limited range of benefits permissible under NED guidelines and resulting *Federal* B/C ratios for "...federal interests" are almost never discussed in these terms. The general public, media and local interests (financial) for coastal projects almost all believe that the Corps is the only solution and theirs the only B/C ratio possible. If the intent of the WRD Act of 1986 is the eventual solution of more coastal problems by full "local" funding, then the Corps can play a big part by helping to educate all involved in this regard. A good place to begin would be a case study report of an example with complete, documented cost information when a project "fully funded by the locals" proved less costly in the long run.

There is no secret why this area is of interest and importance, for it would mean more work for the private sector to help solve coastal problems in the U.S.. Simply put, a major, long-range need of practicing coastal engineers in the U.S. is more work! But it may also mean more economic, quicker solutions to local coastal related problems.

Seawalls and Beaches

Various allegations on the adverse effects of seawalls on beaches are claimed as common knowledge and attributed to "coastal scientists". Often, Dr. Orrin Pilkey, professor of geology at Duke University is quoted as saying "...seawalls actually increase erosion and destroy the beach" (e.g., Pilkey, The Virginia Pilot and Ledger Star, 01/03/87).

Professor Dean (1986) studied the nine allegedly adverse effects of seawalls on adjacent beaches and found only three that could be supported by factual evidence from laboratory and field experience or theoretical grounds. The American Society of Civil Engineers recent International Symposium, COASTAL SEDIMENTS 87 (May 12-14, New Orleans) addressed this topic in two sessions and a special panel discussion. In one paper, based upon a literature survey of over 70 technical papers and reports, Kraus (1987, p. 955) concluded that little quantitative, factually proven information is available.

On a shoreline with an historic, long term erosional trend, it can be scientifically demonstrated that the offshore bathymetry, and resulting wave energy variation along the coastline is primarily responsible for a net imbalance in longshore sediment transport resulting in shoreline recession. To fail to consider longshore variations in the *offshore* boundary conditions is to miss the most dominant factor in the process. Shorelines with no development, but dune lines relatively fixed by roads and other artifacts of man retreat at the same rate relative to a *fixed* dune position as nearby, developed coastlines with seawalls and bulkheads. Only after the seawall is built, is it relatively easy for the general public to discern the shrinking beach width over time. To place the blame on the seawall for a local, long term erosional trend is a false, misconception that serves no useful purpose to solve coastal problems. To this writer's knowledge, there is no scientific evidence to support the claim that a beach width shrinks faster in front of a seawall on a shoreline with a proven, long term erosional trend. There is no factual evidence to support the often quoted claim that "seawalls destroy beaches".

In the Questionnaire we asked the following questions and received the response summarized beneath each:

43. How would you classify your knowledge on the effects of seawalls (bulkheads, etc) on adjacent beaches?

    [roughly split between adequate and inadequate.-]

44. Do you believe that "seawalls destroy beaches"?

    [roughly split between yes and no]

45. On a shoreline with a proven, long term erosional trend, and considering average yearly conditions, does the beach width shrink faster in front of a fixed dune or fixed seawall (bulkhead) position?

    -two/thirds said shrinks faster in front of seawall -

    -most of remainder said "don't know" -

    one said same rate, in front of both -

46. Does the US Army Corps of Engineers do an adequate job of helping the general public understand how seawalls and beaches interest?

    - 85% said no -

    - one response said "People like Orrin Pilkey are a lot more PR sensitive and vocal".

47. How can the Corps of Engineers do a better job to inform the public on the matter of seawalls and beaches, including the exposure of false and misleading information?

    - most votes for use of television

    - almost equal number for booklets, pamphlets, newspaper interviews, etc -

    - a few were in favor of the development of a video cassette -

    - none said "do nothing"

48. Does the Corps of Engineers do an adequate job of explaining the benefits of coastal projects long after built?

    - over 90% said no.

From the above, we have concluded that the Corps must invest in long-term research to ascertain beyond any shadow of a doubt, how seawalls interact with beaches. And, they must help to reeducate the public and the scientific and engineering community regarding those misconceptions that have arisen. To do and/or say nothing gives the impression that all the negative, incorrect and false statements are correct which can only lead to more costly and perhaps incorrect solutions to some coastal problems in the future. As one professional engineer wrote on his Questionnaire:

> "The public sees coastal problems as environmental issues - not engineering. They also see the Corps trying to hurt the environment in their coastal plans. This is very bad as it does nothing to enhance engineering and technical knowledge of the coast".

Prototype Monitoring

Finally, it was determined that practicing coastal engineers would be benefitted by more prototype monitoring and technical guidelines on how a *complete* monitoring program should be conducted. This was especially true for determining how beaches perform after renourishment. One key variable seldom measured is the local wave climate near the completed project. One may pose the question: what scale of coastal engineered project is deemed significant enough, to warrant the expense of a nearshore, directional wave gage installation *before, during* and *after* construction to aid in design and to monitor performance? The profession needs an inexpensive, shore-connected, directional, wave gaging system with fully operational microprocessing software to routinely measure wave climates within 2000 ft of the coast.

The results of the prototype monitoring efforts should then become part of case studies useful as clearly explained examples of what has worked and what has not in coastal engineering. Reports, books and even videos disseminating these results on a large scale would be desirable.

Summary

The results of a Questionnaire and Workshop for practicing coastal engineers have produced the following key recommendations to the Coastal Engineering Research Board of the US Army, Corps of Engineers:

1. A long term effort should begin to improve both general knowledge, and construction technology and methods for coastal engineered projects. Even small savings on large scale projects can mean millions of dollars in lowered construction costs to justify the research expenditures.

2. The role of damage in the balanced-design philosophy of coastal engineered projects must be understood so that damage is not equated with failure. Generalized damage versus excessive energy levels for all shore protection alternatives (hardfacing, rubble and soft systems) should be developed so that rational methods to estimate maintenance costs associated with each alternative can be utilized.

3. The CERC must continue to invest in long-term research to determine, beyond any shadow of a doubt, what the truth is about how seawalls interact with beaches. When facts are brought to light to dispel previous misconceptions, the Corps must help to re-educate the general public regarding the truth.

4. The CERC must continue to develop an inexpensive system for the routine measurement of wave climate in coastal waters. Prototype monitoring efforts are incomplete without local wave data. It is recommended that a few complete case studies be documented of what has worked and what does not - particularly in shore protection.

The professional engineers participating in this effort strongly supported the idea of a future American Society of Civil Engineers sponsored specialty conference for practicing coastal engineers with emphasis on design, construction and maintenance of coastal projects. It should include a review of the duties and responsibilities of all registered professional engineers in all the "coastal states" of the United States. They felt that many recent ASCE specialty conferences in the coastal area were more beneficial to scientists and research-

academicians, then to practicing coastal engineers.

As the Corps' Coastal Engineering Research Center evolves and plans its future research directions with advice from the CERB, it would be the hope of the practicing professional engineers (and the writer) that greater future resources are allocated to the more applied end of the research-development spectrum to aid practicing coastal engineers.

APPENDIX C
RECOMMENDATION LETTERS

TEXAS A&M UNIVERSITY
COLLEGE OF GEOSCIENCES
COLLEGE STATION, TEXAS 77843-3146

Reply to
Department of
OCEANOGRAPHY

December 19, 1988

Re: Nov '88
CERB meeting

Brigadier General Patrick J. Kelly
Director of Civil Works
U.S. Army Corps of Engineers
20 Massachusetts Avenue, N.W.
Washington, D.C. 20314-1000

Dear General Kelly:

The following are my comments pertinent to the theme of the November 1988 CERB meeting- Long Range Research Needs in Coastal Engineering. These comments: (a) reflect my perception of the needs for a broad national effort for effectively dealing with coastal problems; and (b) identify those specific needs which I consider to be of highest priority to the Corps of Engineers' mission in shore protection and navigation.

In my view, the research needs in coastal engineering fall in one of three general categories:

(1) Improvement of our understanding of fundamental hydrodynamic processes in the coastal domain including wave dynamics, wave-current interaction, fluid-sediment interaction, and fluid-structure interaction;

(2) Adequate data on nearshore water level variations, surface waves, currents, winds, sediment transport, morphological changes, structural behavior, and the measurement system technology to acquire such data on a continuing basis, as well as special experiments required to address certain aspects of item (1);

(3) Improvement of technology in the design and construction of protective structures, and in the cost effectiveness of dredging and sediment by-passing operations.

Item (3) clearly impacts directly on the primary mission of the Corps of Engineers in the coastal zone, but (1) and (2) must be addressed if significant advances are to be made in the Corps' ability to carry out its mission effectively.

Implicit in (1) is the development of predictive capabilities in respect to near shore wave modification, littoral currents, sediment erosion/accretion/transport, and structural stability in the presence of fluid dynamic forces. Such predictive capability should ultimately be manifested in the form of mathematical models, whether they be simply a formula parameterizing some process or an iterrelationship between variables which allows one to describe the space and time evolution of a process. In any event one cannot have an adequate model without adequate understanding of the physics and adequate data by which to drive and verify it. Moreover the task of addressing what constitutes adequate data is dependent not only on the ultimate use to which it is to be put in design or operations but also is dependent on understanding of processes, whose quantitative and conceptual aspects are embodied in the adopted model. Thus the need for and the adequacy of models really impacts on all three areas.

The above research needs are sufficiently broad in both scope and demands on the available resources of any single agency that a truly coordinated national effort among government agencies and the private sector is inevitable. Examples of overlap in common interests on the part of government agencies exists in the subject of surface waves. NOAA, ONR and CERC all have a vital interest in the Surface Waves Dynamics Experiment (SWADE). The proposed deployment by NDBC/NOAA of a grid of buoys on the continental shelf and slope off Chesapeake Bay in 1990 could give much needed deep water data on waves and winds for experiments at CERC facilities at Duck, N.C. This data could also be vital for verification of the phase I WIS predictions of wave spectra in that area. ONR's interests are in fundamental understanding of wave-wave interaction over a broad spectrum in the effort to properly interpret satellite derived data and hopefully this will encourage a renewed push to get NROSS type capability for wave and wind sensors back in their planning. Sattelite derived global winds, sea level and other surface data are definitely in the plan of the international WOCE program, whose participants include United States (NSF), France, the United Kingdom, West Germany and Japan.

Much of our understanding of fundamentals of wave processes and sediment dynamics has come out of studies by individual investigators via funding by NSF and ONR.

This is also true of the development of models of such processes. These efforts are vital and must be encouraged by stressing the needs in this area at the level of the National Research Council through its Marine Board. By this mechanism the voice of the scientific and engineering community might be heard on Capitol Hill but only as documentation to support some collective interagency plan.

Much of the developments in structure technology over the last few decades has come from overseas. Hopefully the new CPAR program discussed by Dr. Houston will spur some renewed thrust by the U.S. in this area, assuming that it does not come about at the cost of diminishing other efforts to strengthen our coastal studies programs.

The topic of Coastal Engineering Measurement systems was recently addressed by a special ad hoc panel for this purpose under the aegis of the Marine Board of the National Research Council. Bill Wood summarized the charge to and conclusions of this panel at our November CERB meeting. While this topic addresses directly category (2) above, the panel dealt with its charge from the broader perspective of the overall research needs in coastal engineering. In particular it identified the needs in the development of measurement systems for properly quantifiying those processes vital in dealing with sediment suspension and transport, as well as fluid structure interaction, and placed high priority on acquisition of adequately resolved information on deep water directional wave spectra and the near shore data required to verify the use of new generation models of wave transformation. The presentations of our recent CERB meeting confirms on the whole many of the conclusions of the Marine Board panel but have raised some additional issues with respect to the realities of funding and in particular the decline of support within the Corps dedicated to addressing the fundamental questions of category (1) in favor of more emphasis on the practical problems of catagory (3).

My view is that a suitable mix of ongoing R&D on coastal problems in all three catagories is essential within the coastal engineering community as a whole. While the highest priorities within the Corps of Engineers must continue to be given to programs which directly address increasing the cost effectiveness of construction, operations and maintenance embodied in its mission, its research arm, CERC, must be given greater capability in taking on a leadership role in R&D for the community, which its

name implies. If it is to serve a meaningful role as catylist and focus for coastal engineering research and service on a national (and hopefully international level), increased funding for basic research, wave data acquisition/ archiving, and upgrading of its facilities and manpower for this purpose must be factored into a long range plan. While individual investigators at universities must continue to rely heavily on separate funding for basic research through NSF, ONR and possibly other government agencies, such funding could be enhanced through collaborative programs in which the facilities such as at Duck, N.C. serve as a focus for comprehensive field studies which could lead to major break throughs in our understanding of the coastal zone. In short we need more 'Super Duck Experiments' on a continuing basis and the cost no doubt shared among agencies. To do this effectively requires selling at Congressional level a collaborative program among agencies and the community, with attendant influx of new funds. Large collaborative programs which are as important as this to the coastal communities can be sold.

It is difficult to assign priorities to specific needs related to the Corps mission in the coastal zone. The list is long and I am not sure that my perception of all the needs is all-inclusive. However based on what I sense as vital I would put at the top of such a list:

- Continued acquisition of wave data (including directional spectra) in the coastal and offshore regions for adequately quantifying wave climatology in different coastal regions and for verification of nearshore transformation models;

- Acquisition and analysis of changes in bottom profiles under different wave conditions, sediment types, (cohesive and noncohesive) and shore or navigational structures;

- Development in the technology for monitoring sediment transport and verifying models thereof;

- Development in the technology and/or operational techniques for improving the efficiency of dredging operations for different sediment types;

- Development of the instrumentation required for monitoring the stresses and motions within rubble mound structures under a range of wave conditions; and

- Continued studies which can give meaningful cost benefit information relevant to coastal projects.

In closing I am enclosing for your information a news brief about the NSF funded Engineering Research Center for Offshore Technology of the University of Texas and Texas A&M University. The principal thrust of this center will focus on oil recovery in deep water and hence does not really overlap with the role of CERC whose focus is on coastal engineering. However the Offshore Technology Center and its participating energy companies could serve the coastal engineering community in providing additional offshore wave data and related information.

Sincerely,

Bob Reid

Robert O. Reid
Professor of Oceanography
and Member of CERB

mfr/ROR

Information Copies to:

Col. D. G. Lee, Ex. Sec.
Dr. J. R. Houston
Dr. C. C. Mei
Dr. Dag Nummendal
Dr. Wm. Wood

Enclosure

Offshore technology center is launched

The National Science Foundation has awarded Texas A&M University and the University of Texas at Austin a grant to develop new technologies for the extraction of oil and gas from deep offshore wells. The program is expected to draw $28 million in funding over the next five years.

NSF officials announced in August the establishment of the Engineering Research Center for Offshore Technology to be based at Texas A&M. The center, a joint venture between Texas A&M and UT Austin, will bring together researchers from both schools as well as industry personnel from energy companies to study novel approaches for oil recovery at depths greater than 4,000 feet. In addition, the center will work to establish a fundamental engineering and technology base to ensure U.S. leadership in offshore energy activities.

Currently, the technology does not exist to produce oil and gas at such depths depite estimates of sizable offshore reserves. For example, experts say that the Gulf of Mexico alone has two fields that may contain reserves equal to the 24 billion barrels of oil orginally discovered in Saudi Arabia.

"We believe the NSF decision to award this grant here in Texas is a tribute to the capabilities of the University of Texas and Texas A&M University," Texas A&M President William Mobley said. "This is an outstanding example of how collaboration between and among higher institutions of higher learning in the state can lead to a very significant and positive impact."

According to officials, NSF will contribute about $1.5 million to the center this year, and additional federal funding could reach $16 million during the next five years. The level of support will depend on future federal budgets as well as on the sucess of research at the center, officials said.

The center also has drawn support from 22 companies that have pledged to contribute $5 million in cash, equipment and researchers.

Texas A&M will contribute $5.5 million, including $5 million for a research building at the Texas A&M University Research Park. The facility will house a 100-foot by 100-foot wave tank with a 12-foot depth. The tank also will have a 49-foot-deep pit with an adjustable floor for tests on oil platform computer models.

UT Austin will contribute $1 million in new equipment, 25,000 square feet of laboratory space in Austin and time on the school's supercomputer at Balcones Research Center.

John E. Flipse, Cain Professor of Offshore Technology and associate deputy chancellor of The Texas A&M University System, will direct the center. UT Austin's Richard Miksad, chairman of the Aerospace Engineering and Engineering Mechanics Department and Rohlic Regents Professor of Civil Engineering, will be associate director.

"The prospects of this venture are very great — not only for higher education, but also for the economic health and development of Texas and the Southwest," said William Livingston, UT's vice president and dean of graduate studies. "It is far-sighted and laudable that the National Science Foundation has decided to lend its very significant support to what we believe will be a very significant research center."

Officials said terms of the federal grant require the center to be in operation within two years.

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November 28, 1988

BG Patrick Kelly
President, CERB
c/o Mrs. Sharon Hanks, CERB
Vicksberg, Miss.

Dear General Kelly,

It is a great pleasure to have taken part in the 50th CERB meeting at Virginia Beach. All Corps and external experts have thoughfully contributed to present a balanced view of the theme: Future Needs of Coastal Engineering Research. Painstaking preparations by Dr. Houston, Colonel Lee and their staff have again scored a resounding success.

As you requested, I attach my own list of priorities, on a separate sheet.

While different people have different priorities, I am sure that among all our lists one can find many topics that are common. It is therefore evident that the needs and challenges are both great.

To exp dite the progress it is necessary that a concerted effort on the national scale be launched. Above all, active participation must be solicited by three concerned parties: I). Field engineers and planners of the Corps districts. They are the implementors of coastal design and the antennas of the needs of coastal communities. They can provide the most pertinent information for the immediate research needs which affect the design practise and construction techniques. II). CERC 's research staff. They are directly responsible for the call of the district and have great responsibilities to tranform the current state of the art in coastal sciences to immediate engineering applications. III) The research communities at large, in academia, industries and government agencies, whose have been doing and can do works of long range significance to coastal engineering.

The Corps can be most proud of the achievements of groups I and II. As others and I on CERB have advocated before, the Corps can do more to bring the existing capabilities in, and enhance the participation by, group III. This is not to say that people in group III have been idle so far. On the contrary, they have contributed much in the past twenty years. But the lack of a strong and direct collaborations with the Corps in the form of long-term contracts means that not enough of the outside capabilities is utilized towards basic solutions of long-standing coastal engineering problems. This may at least slow down the trafer of knowledge. As one example, useful studies outside must appear in the literature first before CERC can use them. Two years pass by in this way. More unfortunately, many difficult problems in coastal sediment transport have not seen much advance in the past twenty years, in contrast to spectacular developments in many other fields including offshore engineering. How is today's technique of beach nourishment different from those

of bygone days? Are we not spending more and more money each year doing things the same way? We need the Shore Protection Manual; we also need research that can greatly improve that manual.

To enable significant advances which bring long range benifits, I wish to reiterate the suggestion that CERC and the Corps become once more the national agency not only for conducting research by its own staff, but also promoting research, both basic and applied, elsewhere in this country. This requires a vision and a plan of not just seeking new funds to expand the facilities and capabilities of CERC which are already considerable for its mission, but to help ignite the activities outside. In the long run I prefer not to build CERC into a national super lab with all kinds of expensive equipments, which would further drain the available resources, but to have it follow the example of the National Institute of Health.

As I recall when General Heiberg called for creative thinking about privatization , somewhere in our discussion was that new sources which may derive from privatization should partly directed to contract more basic research for which CERC is less responsible. This item seems to have been vaporized in recent CERB meetings. In Norway, France and Taiwan, there are laws which direct some of the taxes by oil or shipping companies to support research institutes, such as the Norwegian Marine Center at the University of Trøndheim, the Institut Français du Petrole, and the Harbor Research Institute in Taichung. It would be great to plan at the beginning of privatization on how to deploy some the new income to contract research. Advocated here by someone from academia, is this idea a conflict of interest?. From a long range point of view, I think not.

With best regards,

Sincerely yours

Chiang C. Mei
Professor of Civil Engineering
Room 48-411, Tel. (617) 253-2994

encl

Important research topics in coastal engineering

C. C. Mei

I. Research to improve design

1. Wave and current dynamics nearshore. Better understanding of the nonlinear mechanism with emphasis on shallow water. Numerical modelling of nonlinear and breaking waves. Experimental modelling.

2. Forces of large-amplitude waves on seawalls and breakwaters, piles... Wave-overtopping, shock pressure. Theory and experiments.

3. Transport of noncohesive sediments. Basic understanding of turbulence involving sedimnts. Theoretical modelling.

4. Cohesive sediemts: Physical chemistry, rheology, effects of salinity. Transition to turbulence. Transport of fluid mud in suspension by tides or by wind waves. Effects of interfacial shear. Bulk transport by pressure gradient. Experiments in laboratories. Field measurements. Theoretical modeling.

5. Experiments and theoretical modelling of long waves in harbor due to short wind waves.

6. Forcast of wind waves with emphasis on transformation in shallow wave. Connection with deep ocean wave-forceasting models.

7. Interaction of coastal structures with soil foundations in waves.

II. Remoting sensing

1. Develop new technology for sensing waves, currents and bathymetry in shallow waters by satellite and by sonar.

IV. Research in coastal construction technology

1. Innovative designs (in addition to testing of existing designs) of coastal structures. Seawalls, dolloses and breakwaters.

2. Modern management of coastal projects. Construction scheduling, procedure, and planning.

III. Dredging

1 Innovation of techniques for measurements and of tools for dredging. Transport, dumping and reuse of dredged materials.

2. Environmental effects.