DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

REPLY TO
ATTENTION OF

CEWES-CC-S (1110-2-1403b) 20 July 1998

MEMORANDUM FOR Commander, U.S. Army Engineer District, Mobile, ATTN: CESAM-PD-EC (Dr. Susan Rees), P.O. Box 2288, Mobile, AL 36628-0001

SUBJECT: Transmittal of Report Review

1. Enclosed is a revision of a February 1998 draft Memorandum For Record of a Dauphin Island report by Dr. Scott L. Douglass and Ms. Tina Sanchez. The revisions reflect discussion you and Mr. J. Patrick Langan had with Mr. Edward B. Hands on 7 July 1998.

2. If you have any questions or comments, please contact Mr. Hands at 601/634-2088.

FOR THE DIRECTOR:

Encl

JAMES R. HOUSTON, PhD
Director
Coastal and Hydraulics Laboratory

DEPARTMENT OF THE ARMY
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3909 HALLS FERRY ROAD
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REPLY TO ATTENTION OF

CEWES-CC (70)

17 July 1998

MEMORANDUM FOR RECORD

SUBJECT: Review of the Report "The Influence of the Mobile Pass Ebb-Tidal Shoal Elevations on Dauphin Island's Beach Erosion," written by Dr. Scott L. Douglass and Ms. Tina Sanchez, dated 20 December 1997

1. This review was prepared by the staff of the U.S. Army Engineer Waterway Experiment Station, Coastal and Hydraulics Laboratory, at the request of the U.S. Army Engineer District, Mobile (Dr. Susan Rees and Mr. J. Patrick Langan).

2. The report was prepared for the Alabama Department of Environmental Management (ADEM). Mr. Brad Gane, Chief, ADEM Coastal Programs, submitted the subject report to Dr. Susan Rees with a cover letter dated 12 January 1998.

3. The purpose of the report is to "investigate the linkage between the removal of sand from the littoral system on the outer bar and the beaches of the east end of Dauphin Island." In his cover letter, Dr. Gane suggested a meeting of ADEM, the U.S. Army Corps of Engineers, and Dr. Douglass to discuss the subject would be beneficial. This review was prepared for that meeting.

4. The report attributes the erosion observed along the easternmost mile of Dauphin Island to northwestward migration of Sand/Pelican Island and to a dredging-related lowering of bottom elevation over shoals near the lighthouse on the Mobile ebb-tidal delta. A similar argument was published by G. M. Lamb (1987) "Erosion downdrift from tidal passes in Alabama and the Florida Panhandle." Bulletin, Association of Engineering Geologists, XXIV (3), 359-362.

5. Although acknowledging natural and anthropogenic changes in sediment supply are difficult to distinguish and that the adopted methodology is highly simplified, the subject report proceeds with an original analysis to quantify longshore sand losses from the east end of Dauphin Island caused by higher waves assumed to penetrate further landward because of channel maintenance that occurred between 1974 and 1989. Steps in the Douglass analysis are outlined in the next paragraphs. This outline sacrifices completeness for brevity to give a ready understanding of the approach. Comments on the reasonableness of the approach and accuracy of its application follow the description.

6. The approach assumed that breaker height off the east end of Dauphin Island is limited to no more than half the minimum water depth where the wave crossed the outer ebb shoal. It is proposed that this limiting depth is zero where Sand Island is emergent and about 7 ft deep for the rest of the area. Wave data from the nearest Wave Information Study hindcast station in about 80-ft depth are input to a form of the Coastal Engineering Research

ROUTING:
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2. CEWES-CC (Mr. Thomas W. Richardson)
3.
4. CEWES-CC-S (Mr. Edward B. Hands)
5. CEWES-CC (Dr. Nicholas C. Kraus)
CEWES-CC-S (Ms. Janie Daughtry) (file)

Center (CERC) formula to obtain an order-of-magnitude estimate of longshore transport rates for existing and assumed ebb-shoal bathymetrys. The empirical coefficient in the CERC formula is derived by calibration with a volume loss interpreted from aerial photographs covering the period 1984 to 1996 and subaerial beach profile surveys made over a more limited time assuming constancy of profile shape as the shore advanced and retreated. This calibration required assuming that the estimated volume loss (30,000 cy/year averaged over the 12-year photographic record) was caused by wave-induced longshore transport.

7. The approach outlined in Paragraph 5 was then reapplied to see how changing the limiting depth from 7 ft to various other values (8, 6, 5, 4, 3, and 2 ft) would affect the results. These results are shown relative to the existing transport rate in Figure 8 of the report. To obtain an estimate of how dredging affected depths over the shoal, the report points out that half the 15,000,000 cy (reportedly dredged between 1974 and 1989) would raise the bottom about 2 ft if spread evenly over a 4-square-mile area. No justification is given for the selection of this 4-square mile area, but it is not an unreasonable choice.

8. The report acknowledges this highly simplified approach requires many assumptions. Not all of these assumptions will be repeated here. Instead, emphasis will be given to weaknesses that seem of greatest impact relative to the report's conclusions and to points of lesser impact that readers might otherwise overlook.

It is crucial to the intent of this report that one assumes wave-induced longshore transport from Reach 1 into Reach 2 is the mechanism depleting Reach 1 of sand and causing the shore to recede. Tidal currents and cross-shore sand transport are assumed to be negligible with no justification offered.

10. It is assumed that 7,500,000 cy of sand would have elevated the outer ebb shoal if it had not been dredged; and that the presence of this volume on the shoal would have reduced longshore losses from Reach 1. Although this assumption is not overly unreasonable, we really do not know where the dredged material would have gone. Other reasonable alternatives exist that would have no effect on the limiting depth and, therefore, no effect on the assumed longshore-loss erosion mechanism. These "no-effect" alternatives include natural bypassing to downdrift shores, sediment accumulation in depths below 7 ft (that would expand the ebb shoal platform), and accumulation landward of the approximately 3-mile-long Sand Island (which would widen the emergent barrier, but have no effect on Reach 1 because waves from that direction were already totally discounted in Douglass' model).

11. Although it is possible to magnify the possible impact of dredging by spreading the 7.5 million cy over a smaller area on the ebb-shoal crest, we should recognize that no one can say now where the material would have accumulated if it had not been dredged. A more thorough study of historic morphology change could evaluate a range of likely possibilities and more firmly establish the probable regions of accumulation for certain portions of the dredged material.

12. The argument connecting channel dredging to Dauphin Island erosion assumes the ebb shoal has lost elevation, but no mention is made of documented historic changes in shoal morphology other than Figure 1, which does not support the assumed decline of shoal-averaged elevations.

13. Figure 1 was drafted to illustrate that the eastern ebb-shoal marginal ridge has been a relatively broad and permanent offshore wave dissipator throughout historic time while the more obvious narrow islands have changed size and position relatively rapidly. Movement and disappearance of these islands has often been cited as rather loose explanations for changing patterns of erosion on Dauphin Island (Lamb ibid, etc.). Degree of wave exposure should consider the changing bathymetry not just mapped presence or absence of islands. Douglass' analysis improves on past references by considering possible, but not necessarily probable, changes in shoal elevation as well as presence of islands.

14. More relevant to the present problem is the discrepancy between this figure's implications and Douglass' first paragraph, "The probable cause of this shift (in sand from the eastern-most mile of Dauphin Island shore to the next westward mile) is a change in longshore sand transport rates due to changes in the wave climate caused by the northwestward migration of Sand/Pelican Island and the loss of elevation of the shoals around the outer portion of the ebb-tidal delta during the past few decades." In contrast to this contention, Figure 1 presents evidence that extensive changes to Sand/Pelican island are frequent, natural, and not directly related to dredging. For example, note the wide variations in positions of emergent sections from 1894 to 1929 prior to much dredging. The first bar dredging was accomplished in 1926 when the project was deepened to 30 ft. Furthermore, it is believed at US Army Engineer District, Mobile that only limited dredging was required in this area up until the channel was deepened in the late 1950s in response to the 1954 Act providing for deepening to a 42 ft channel. Yet the 1921 and 1929 charts show far less island area than earlier or later charts. Lastly, any aerial photograph from the 1990s would show much more subaerial ebb ridge than the last panel (1989) prior to deepening maintenance to 47-ft depths on the bar.

15. To summarize Paragraphs 12-14, Figure 1 does not show that channel maintenance has caused loss of volume or westward movement of Sand/Pelican Island as the report states. Neither does the figure support purported deflation of the ebb shoal or dredging-related loss of elevation on the outer ebb-shoal ridge or on islands east of the channel.

16. If the coefficient c in the report's equation for breaking wave height had a value between 0.5 and 1.0, the apparent effect of changes in the limiting depth would be less.

17. Erosion-control efforts of past decades at the east end of the island were not discussed (and to our knowledge have never been analyzed), but may play a role in defining present problems. These include revetments around Ft. Gaines, jetties, and sand fills, all intended to stabilize and anchor the updrift end of a barrier island that otherwise would be migrating westward just as the west end of Dauphin Island is and just as both ends of the Mississippi barrier do.

18. Reported estimates of the area of beach accretion in Reach 2 are less than half the area losses in Reach 1. How much did variations in water elevation modify the area changes? If the adopted depth of closure had been the same in both reaches, the ratio of volume change between reaches would have been identical to the area ratio change under the constant profile shape assumption. Instead, the volume ratio is reported as about 1. This greater-than-50 percent-change in ratios depends directly on an increase in closure depth from Reach 1 to Reach 2.

There are only four profile ranges from which to estimate closure depths (Table 3). The spread of individual estimates (20-, 6-, 6-, and 20-ft closure at four adjacent profile lines) suggest significant uncertainty about the mean closure depth for Reach 2. The closure depth for active longshore transport should be smaller in a wave-sheltered region than on a more exposed reach. No explanation is given for why closure estimates are deeper in the more sheltered Reach 2 -- a weakness rather than a crucial omission.

19. The assumption that the longshore component of wave energy from the SW quadrant WIS data dominates transport rates to the exclusion of tidal and other hydrodynamic processes is not supported with a solid argument.

20. In Equation 2, H should be H_b, and the angle should be the angle of breaking. It is not clear if or how breaker conditions were estimated from the WIS data. Therefore, values of the transport rate are in doubt.

21. The study appropriately derived a calibrated empirical coefficient for the CERC formula, but it is not specified. Was it realistic?

22. Neither the history of Dauphin Island shore erosion nor of changes in ebb-shoal volumes are given. Did shoreline changes parallel variations in maintenance dredging or natural variations in shoal elevation? Did the shore retreat during early periods when the most critical area around the lighthouse was dry land? Page 8 states, "One implication of these results is that the most landward erosion experienced to date on the east end of Dauphin Island is the portion of the erosion most attributable to the removal of sand near the lighthouse." Is there any evidence of coherence between variations in shoreline change and either natural or manmade changes in shoal geometry? Was disappearance of the island around the lighthouse a result of dredging or some natural phenomena? From unpresented aerial photographs we know that the shoreline in Reach 1 accreted significantly when there was no offshore island breakwater. Are these periods of accretion related to dredging or other processes? None of these questions are answered in the report.

23. Hurricane Elena had a major impact on Dauphin Island in September 1985 but is not discussed even though net volume and shoreline changes from 1984 to 1990 are presented. Storm-induced erosion may be irreversible. Added perspective would be gained by including storm analysis, longer-term changes, and correlation of processes, dredging, and changes on both the ebb shoal and Dauphin Island.

24. Incompleteness of the report's approach is illustrated by taking it one step further to an untenable conclusion. If more dredging lowered Sand Island sufficiently, all longshore losses from Reach 1 would be eliminated in the Douglass model. We expect, however, that lowering of Sand Island would actually increase erosion at the east end. A tighter analysis including neglected processes and more thorough historic analyses would be needed to quantify the impact of dredging.

25. Paragraphs 8 through 24 discuss alternate assumptions and approaches plus other types of incompleteness in the subject report, not actual errors. The report appears to contain some errors, but the corrected values would provide essentially the same results in the Douglass model. Corrections may be relevant to determining the proper response to questions raised, and they are discussed next.

26. Presumably, inclusive values reported in the rightmost column are the sums of incremental changes in volume given in the column to the left, but seven of the 12 nonzero rows are not summed properly. In the eroded Reach 1, combinations of positive and negative errors had only a small effect on the total volume change. There is a large error in Reach 3 where 10,000 should be 100,000. If these discrepancies are not mathematical or typographical errors, they may indicate inconsistencies in interpretation of changes from aerial photographs (due possibly to scale or datum errors). In any case, the data could still be used to support the author's conclusions or other conclusions.

27. The concluding section on Policy Investigations is interesting but does not address authorities for mitigation or steps in resolving Dauphin Island erosion problems.

28. In summary, the report makes a reasonable case that channel maintenance contributes to shore erosion at the east end of the island. Whether the impact was large or small relative to other processes, in our opinion, has not been clearly established. The case is not nearly as simple as the report's main figures (8 and 9) may lead one to believe. Furthermore, any substantial erosion-control effort or modification to dredging practices should be based on a comprehensive evaluation of erosion problems in the broader affected area (not just Reach 1 at the easternmost tip of the Dauphin Island). Optimization to solve only part of a morphological problem often makes the problem worse. Costs and benefits of alternatives would, of course, have to be evaluated.

29. Not only would these steps be required by any federal project, but the simplifications and unsupported assumptions presented in the subject report do not, in our opinion, isolate the cause of erosion even within the limits of Reach 1. They support the possibility that dredging plays a major role. Before trying to quantify that role, the effects of dredging would have to be examined more rigorously and the other erosive processes included in the analysis.

30. If further information is required, please contact Dr. Kraus at (601) 634-2016 or Mr. Hands at (601) 634-2088.

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