5.23. Simulations with the 15.5-ft NGVD x 500 ft channel with a dike across the existing channel significantly reduced the tidal prism of the inlet returning it to a value approximately 17% less than the base condition. Flow in the existing channel (Section 6), particularly the ebb flow, dropped dramatically with the implication that the channel would function as a secondary flood channel (Table 5.4). In this capacity, the remnants of the existing channel would transport sediment into the inlet from off the west end of Emerald Isle and help facilitate the development of the new sand spit. With the dike in place, roughly 84% of the total volume of water flowing in and out of Bogue Inlet would be funneled through Section 4 as this section would accommodate almost 81% of the flood tidal prism and 88% of the ebb tidal prism (Table 5.5). A higher percentage of the flow would also pass through the Eastern Channel (Section 2) and the Dudley Island Channel (Section 3B). The Eastern Channel would continue to be a dominant ebb channel while the model predicts flow predominance in the Dudley Island Channel would shift from flood to ebb (Table 5.4). Farther back in the sound, the volume of water flowing through Sections 8 and 9 during flood increased slightly compared to the Base (Table 5.4), however, peak flood and ebb velocities were not affected. Therefore, these minor flow increases would not cause any erosion of the channels.

5.24. One of the more significant results of the model comparisons was the slight decrease in the inlet's tidal prism for the case that included the 15-ft NGVD x 500 ft channel and dike. This indicates that the 15.5-ft NGVD x 500 ft channel is not overly large and that post-construction adjustments would result in some scour of the channel in order for the inlet to redevelop the same tidal prism that exists under existing conditions. These results are totally consistent with the previous predictions that the 15.5-foot NGVD channel would undergo approximately 300,000 cubic yards of scour during its initial adjustment period. These initial channel adjustments are expected to take one to four months.

5.25. <u>Summary of Model Results</u>. The following conclusions were drawn from the results of the model simulations:

(1) The existing flow regime in Bogue Inlet consists of a sheet flow through the mouth of the inlet, with heavy concentration of flow adjacent to the west end of Emerald Isle. The largest currents are on the order 3 feet per second. Sheet flow also occurs across the sand spit protruding from the northwest tip of Emerald Isle. Inside the inlet, the majority of the flow circulates around the southern and eastern edges of Dudley Island, with a concentration of flow near its southern edge.

(2) The new channel alignment will increase flow through the center of the inlet. However, without a closure of the existing channel, there will still be a substantial concentration of flow adjacent to Emerald Isle. The concentration of flow near the southern bank of Dudley Island will remain.

(3) Velocities in the existing channel can be reduced sufficiently by constructing a dike to close the channel and raising the elevation of the Emerald Isle sand spit to at least +3 feet NGVD.

(4) Simulation of the 15.5-ft NGVD x 500 ft channel with the dike produced a slightly smaller tidal prism for Bogue Inlet indicating that the channel is not excessively large. Post relocation channel adjustments are expected to scour the channel and reestablish the tidal prism of the inlet to its present value.

(5) The relocation of the channel with a dike will change the overall distribution of flow with a higher percentage of the total flow passing through the Dudley Island Channel and the Eastern Channel. The Dudley Island Channel will become an ebb-dominated channel compared to its present flood dominance while the Eastern Channel will continue to be ebb-dominant.

(6) The distribution of flows in the interior channels will remain about the same with the tendency being toward slightly higher flood volumes. Even though flow volumes could increase, these increased flows will not affect maximum velocities in these interior channels.

5.26. Channel Shoaling Analysis. Immediately following the relocation of the inlet channel, adjustments will begin to occur with some shoaling expected along the interior portions of the channel and scour in the outer sections. Following these initial changes, the new channel will begin to behave as an artificially deepen channel constructed across the inlet's ebb tide delta. In this regard, the depths and width characteristics of an inlet ocean bar channel are dictated by prevailing currents, tides, wave action and, sediment transport. When an artificially deep or wide channel is cut through the ebb tide delta, these factors will immediately begin to work toward restoring the dimensions of the channel to its natural depth and width. Accordingly, an analysis was made to estimate the amount of shoaling that could occur in the new channel and obtain an estimate of how long the channel depths would remain at or below the authorized 8-foot mlw depth. Details of the channel shoaling analysis, which are based on a procedure developed by the Wilmington District Corps of Engineers (USACE 1988) are presented below.

5.27. The rate of shoaling that occurs in a channel dredged across the ebb tide delta of a tidal inlet is a function of the depth of the dredged channel relative to the normal depth of the bar channel. The potential for sediment transport in a dredged channel relative to the potential for sediment transport in the natural channel is given by the transport ratio as follows:

$$\text{Transport Ratio} = (d_1/d_2)^{5/2}$$

Where: d_1 = natural bar channel depth below mean tide level (mtl).
d_2 = depth of dredged channel below mtl.
(Note: See Figure 5.11 for definition of terms)

The depths d_1 and d_2 are average depths in the bar channel determined from the gorge of the inlet to the seaward edge of the ebb tide delta across the full width of the channel.

5.28. The transport ratio is a measure of the amount of littoral material that would be transported out of the dredged channel once it deposits in the channel. The amount of material that would remain in the channel and thus cause shoaling, is a function of the Sediment Retention Factor (SRF) defined as:

$$SRF = 1 - (d_1/d_2)^{5/2}$$

5.29. The sediment retention factor only applies to that portion of the gross longshore transport (gross longshore transport = the sum of material moving toward the inlet from both sides), which is intercepted by the channel. Sediment transport past a tidal inlet occurs around the sloping seaward face of the ebb tide delta as well as a result of changes in the bar channel position and alignment. Since the latter bypassing mechanism occurs over a relatively long period of time, the channel shoaling analysis only considers sediment moving past the inlet around the seaward face of the ebb tide delta. Inherent in this analysis is the assumption that the dredged channel position remains fixed. As the channel is cut deeper into the ebb tide delta, a larger percentage of the gross longshore transport would become available to shoal the channel with the remainder of the material moving past the inlet below the bottom of the dredged channel. The degree to which the dredged channel prevents the movement of sediment around the seaward face of the ebb tide delta is provided by the depth ratio (D_R) defined as:

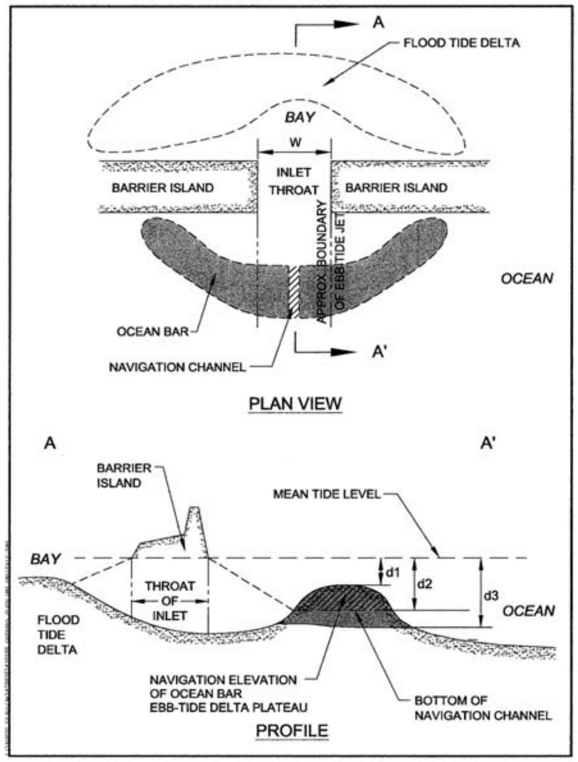

Figure 5.11 Definition Sketch Channel Shoaling Analysis

$$D_R = (d_2-d_1)/(d_3-d_1)$$

Where: d_1 and d_2 have been previously defined and
d_3 = Depth of closure of the ebb tide delta with the ocean bottom. (See Figure 5.11)

5.30. The percentage of the gross littoral transport moving toward the inlet during any time interval that would shoal the deepened channel is a function of the product of the sediment retention factor and the depth ratio as follows:

$$V_R = f(D_R \times SRF)$$

Where: V_R = (channel shoal volume)/(gross littoral transport volume)

5.31. The functional relationship between these variables is not known. The Corps of Engineers developed an empirical relationship based on data from 5 inlets in the Wilmington District, namely, Oregon Inlet, Beaufort Inlet, New River Inlet, Masonboro Inlet, and Lockwoods Folly Inlet. Note that the data used for Masonboro Inlet was for a dredged channel that predated the construction of the dual jetty system. The data used by the Corps of Engineers is given in Table 5.6. The gross rate of sediment transport toward the inlet during the various survey periods was based on previous estimates of sediment transport rates at the various inlets and the percentage of the annual wave energy flux that would normally occur during the survey period. For purposes of this analysis, additional data points for Bogue Inlet were added to the empirical dataset. The supplemental data points for Bogue Inlet are discussed below.

5.32. Supplemental Channel Shoaling Data for Bogue Inlet. The shoaling characteristics for the navigation channel through Bogue Inlet were evaluated for the period July 1996 to November 1997. During this time, the authorized 8-foot deep at mean low water (mlw) by 150-foot wide channel was maintained intermittently by the U.S. Sidecast Dredges MERRITT and FRY. The MERRITT and FRY are shallow draft dredges that operate similar to hopper dredges in that they remove material from the bottom of the channel using dragarms and dragheads that scrape along the bottom as the vessel plies through the channel. However, rather than pump the dredged material into a self contained hopper or bin for eventual disposal offshore, as in the case of a hopper dredge, the sidecast dredges simply move material from the channel to a point immediately outside the channel by pumping the dredged material through a 90-foot long pipe that projects off to the side of the vessel. Obviously, since the authorized channel through Bogue Inlet is 150 feet wide, the sidecast dredges cannot remove the material completely out of the channel with one passage through the channel. Rather, the sidecast dredges must rehandle much of the material more than once. This operational constraint will be addressed later.