VII. Potential Locations

This section discusses the potential locations where terminal groins may be considered. As part of this determination, a literature review of existing sites of terminal groins was completed.

A. Literature Review of Existing Terminal Groin Sites

One of the first steps completed for this study was the documentation of terminal groin sites along the East and Gulf Coasts (Figure VII-1). After an exhaustive review of the literature and multiple contacts with leading coastal experts, the following list of terminal structures was developed (Table VII-1).

Figure VII-1. Potential Study Sites

Table VII-1. Potential Terminal Groin Study Site Locations

Potential Study Site	Adjacent to Dredged Inlet	Comments
Rockaway, NY	✓	
Coney Island, NY	✓	Structure offset 3000' from edge of island
Ocean City Inlet, MD	✓	Jetties
Willoughby Spit, VA	✓	
Chesapeake Beach, VA		Mid-beach structure
Oregon Inlet,NC	✓	Includes revetment
Buxton, NC (Cape Hatteras Lighthouse)		Several historic groins to protect lighthouse
Fort Macon, NC	✓	
Shell Island, NC (removed)		Sandbags
Folly Beach, SC	✓	
Hunting Island, SC		Proposed (not built)
Hilton Head, SC	✓	
Tybee Island (north), GA	✓	
Tybee Island (south), GA	✓	
Amelia Island, FL	✓	
St. Lucie Inlet, FL	✓	
Jupiter Inlet, FL	✓	Structures on both sides of inlet
Baker's Haulover Inlet, FL	✓	Structures on both sides of inlet
Bonita Beach, FL		
Captiva Island, FL	✓	
Boca Grande Lighthouse, FL	✓	
Blind Pass, FL	✓	Structures on both sides of inlet
John's Pass, FL	✓	Structures on both sides of inlet
Clearwater Pass, FL	✓	Structures on both sides of inlet
Honeymoon Island, FL	✓	

After reviewing the above list, it was apparent that the vast majority of structures were located at inlets with most of these adjacent to navigable, dredged channels. Only a few were not located at the end of an island. However, it is important to note that for the ones not located at the end of an island, their placement location was typically due to jurisdictional and / or project sponsor constraints. Such an example is the terminal groin located on the west end of the Coney Island, NY beach renourishment project which was located between a public beach and a private community that originally decided not to participate in the federal beach renourishment project. During the literature review, no terminal groin structures were identified as being located at the "end of a non-inlet littoral cell;" most likely since such a location would be difficult, if not impossible to identify, due to the high variability of waves and current patterns which ultimately dictate sediment transport magnitudes and directions. For example, the historic groins at Cape Hatteras are very near the end of a littoral cell, and even in that case, it is apparent that there are downdrift impacts. Variability in wave, tides and other conditions preclude a realistic, accurate, fixed location of a littoral cell in the middle of an island along the North Carolina coast. Fixed mid-island littoral cells may exist along coastlines with rock headlands, embayments, and other fixed features but those conditions do not exist in North Carolina. In addition, the project team was also informed by Senator Basnight's office that the original intent of the legislation was to only study sites located next to inlets. For this reason and the practical limitations listed above, the study only considered terminal groin structures located next to inlets.

Additionally, some difficulties in selecting structures that could truly be considered "terminal groins" as defined by this study were encountered. This was due to the historical desire to prevent sediment from entering the navigable channels where structures were located. Thus, since these structures had navigation as either their primary purpose, or in conjunction with maintaining an adjacent beach nourishment project, they were typically much longer, higher, and / or impermeable structures that are most properly classified as "jetties," not terminal groins.

Furthermore, several structures were lengthened over time to improve their ability to prevent sediment from entering navigation channels. In other words, the initial structure was built; sand accreted to near the end of the structure; sand began bypassing around / over the structure; increasing amounts of sediment began entering the navigation channel; and then the structure was lengthened to prevent the sediment movement. Hence, these structures, too, would be classified as jetties, not terminal groins.

With the constraints listed above the study team and Science Panel selected the list of five (5) sites that were utilized as potential analogs to potential applications in North Carolina. The five sites all exhibited a range of wave, tide and hydrodynamic forcings that might be experienced in North Carolina as shown in Table VII-2

Table VII-2. Environmental Conditions at Five Selected Study Sites

Study Site	Average Tidal Range (MHHW – MLLW)	Average Offshore Significant Wave Height*	Average Offshore Peak Wave Period*	Adjacent Inlet Width
Oregon Inlet	2.43 ft	3.9 ft	7 s	2,800 ft
Fort Macon	3.93 ft	3.3 ft	5 s	3,700 ft
Amelia Island	5.34 ft	3.3 ft	7 s	10,300 ft
Captiva Island	2.10 ft	2.3 ft	4 s	700 ft
John's Pass	2.40 ft	2.3 ft	4 s	600 ft

*From 1980-99 WIS Hindcast (Typically 15-20 m depth)

The sites also provided a range of inlet management practices, ranging from Fort Macon having the most extreme level of inlet management (dredging) that has been well documented in other sections of the report, to the smaller, less managed inlets in Florida.

Related to the level of inlet management, the five sites also appear to provide the study with a wide range of sediment transport conditions given the historical shoreline behaviors, beach nourishment and dredging activities, and the estimates of ebb and flood delta volumes.

B. Siting Lessons Learned from Five Study Sites

With respect to the structures discussed previously in this report and their locations, some general observations can be made. First, it is clear from the analysis in Section II and Table VII-3 that the amount of material dredged can have a very significant impact which may greatly outweigh any potential long-term shoreline changes resulting from the construction of a terminal groin.

Table VII-3. Dredging Summary

Study Site	Pre – Construction Dredged Volume (cy/yr)	Post – Construction Dredged Volume (cy/yr)
Oregon Inlet	75,178 / 841,972*	273,106 / 366,477**
Fort Macon	563,429	785,429
Amelia Island	n/a	n/a
Captiva Island	n/a	n/a
John's Pass	0	12,435

* Pre construction years: 1949 – 1980 / 1984 – 1988
** Post construction years: 1997 – 2007 / 1998 – 2004

This is to be expected, though, as dredging of navigable inlets creates a sediment "sink." This sink may reduce the amount of sediment that is naturally transported across the inlet resulting in negative impacts to the adjacent shorelines. Thus, any potential negative effects that a terminal groin might have on the shorelines on the opposite side of the inlet may be overshadowed by the influence of the inlet dredging; and the greater amount of material dredged, the smaller the relative potential impact of the terminal groin.

For this study, the most substantial (longer, higher and / or less permeable) terminal groins were typically found where the greatest amount of dredging activity occurs. While this may be obvious, it is worth stating that the more significant the dredging activities, the potentially greater the impacts on adjacent shorelines; the greater the potential need for more nourishment and / or more substantial stabilization structures.

By relation, it is also apparent that the level of inlet management that is already being completed will have a significant impact on the level of system perturbation that the terminal groin structure will have. For example, as shown previously, the terminal groin's impacts on adjacent shorelines are minimal when compared to dredging when dredging volumes and needs are substantial. Conversely, if a terminal groin is being considered for a natural inlet, or one with minimal intervention, the terminal groin's potential impacts will likely be much more noticeable and apparent on adjacent shorelines, and much more care and design optimization would be required to ensure impacts to adjacent areas are minimized or eliminated.

It is also important to note that all five of the study sites do currently require regular beach nourishments as part of the shoreline management within the area. It does appear that the terminal groins have reduced volume losses at the sites and hence lessened potential nourishment quantities.

With respect to locating a terminal groin on the updrift or downdrift side of an inlet, it is interesting to note that both sides were represented among the five structures selected for this study. While an initial thought might be that a terminal groin should be located on the updrift side of an inlet in order to capture sediment, it must be noted that sediment typically moves in both directions along a shoreline depending upon the incident wave activity, and significant reversals in sediment transport direction often occur near an inlet due to the presence of the ebb shoals and other inlet features which transform the waves as they approach the shoreline.

Locating a terminal groin on the "net" downdrift side of inlet, though, may have the additional impact of "stabilizing" the location of a migrating inlet, such as the case at Oregon Inlet. For example, at Oregon Inlet, this impact has also resulted in changes to the inlet cross-section – a general narrowing and deepening over time since terminal groin construction. Great care should be exercised when siting a terminal groin in this setting as the channel may shift and potential undermining of the groin may become a concern.

Based on the existing study sites and the literature review completed, the impacts of terminal groins on adjacent shorelines is difficult to identify if they exist at all if located adjacent to a highly managed, deeper-draft navigable inlet. The relative impact of these structures on adjacent areas is likely increased when sited next to natural or minimally managed shallow-draft inlets. For these locations, additional care and study (geologic setting, sediment budgets, etc.) is warranted to be sure that the terminal groin's impacts are acceptable or can be mitigated through minimal human activities (dredging and nourishment).

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