Walker, Michele

From: Gregson, Jim
Sent: Tuesday, February 09, 2010 5:17 PM
To: Walker, Michele; Willis, Angela
Subject: Fw: Comments on Terminal Groin Report
Attachments: inlet structures.xls; TJ Comments on T Groin Study.doc; Vol equiv factor BB.xls

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To: William.Birkemeier@usace.army.mil ; overton@eos.ncsu.edu ; Warren, Jeff; esciaudone@nc.rr.com ; rogerssp@uncw.edu ; Greg.L.Williams@usace.army.mil ; wcleary@charter.net ; RIGGSS@ecu.edu ; mallinsond@ecu.edu ; cpeters@email.unc.edu ; abrodrig@email.unc.edu ; jmartin@moffattnichol.com ; PTschirky@moffattnichol.com ; Walker, Michele; Gregson, Jim; bob.emory@weyerhaeuser.com ; Underwood, Steve; Stefanski, Guy; Richardson, Ken; Miller, Tancred; Lopazanski, Mike; sbenton45@earthlink.net ; ryoung@email.wcu.edu
Sent: Tue Feb 09 17:10:12 2010
Subject: Comments on Terminal Groin Report

Attached are my review comments on the report. This was a quick review so I am sure, given more time, I would have many more.

Also attached is the spreadsheet referenced in the review comments which shows computations of the volumetric equivalent factors I determined for the east end of Bogue Banks. This clearly demonstrates my concerns on the used of this methodology to adjust for beach fills.

Finally, there had been some discussion in the news media that very few inlets have terminal groins. I made an inventory of 154 inlets using Google Earth (see second attached spreadsheet) from Long Island, NY to the pan handle of FL and noted the number of inlets that have terminal groins (on one side or both), jetties (on one side or both), or some other type of shoreline treatment (radial groins, groin fields, or revetments). Of the 154 inlets, 71 have some type of structure. Of these, 24 inlets have what I would classify as terminal groins (on one or both sides), and 41 have one to two jetties. The other 6 have a mishmash of shoreline treatments. Thus, of the 154 inlets in the sample, 42% have terminal structures in the form of terminal groins or jetties.

So the difficulty in finding suitable case studies was not due to the lack of inlet shoreline treatments, it was due to the limited number of applications that would meet our criteria for a terminal groin.

Tom

Tom Jarrett Comments on State Terminal Groin Study
February 9, 2010

Comments on Terminal Groin Study
By
Tom Jarrett, Member
Coastal Hazards Science Panel

General Comment. The same information about each of the 5 sites is repeated throughout the report. Suggest the general information be provided in Section I and if need be, referenced in the other sections.

Comments on Section II:

a. Provide a table or figure showing the percent wave energy from each direction.

b. Include published information of sediment transport rates (by direction and gross).

c. Include an estimate of the volume of material confined within the fillet.

d. Move table of storms to an appendix. Provide summary of storm frequency and some measure of storm intensity for pre- and post-groin periods.

e. Include a table that only lists the dredging events that were used to compute averages for each period and show computations on how averages were computed. The same is true for beach nourishment volumes.

f. Break the tables of shoreline change and volume change to show only the right or left sides of the inlet in each table.

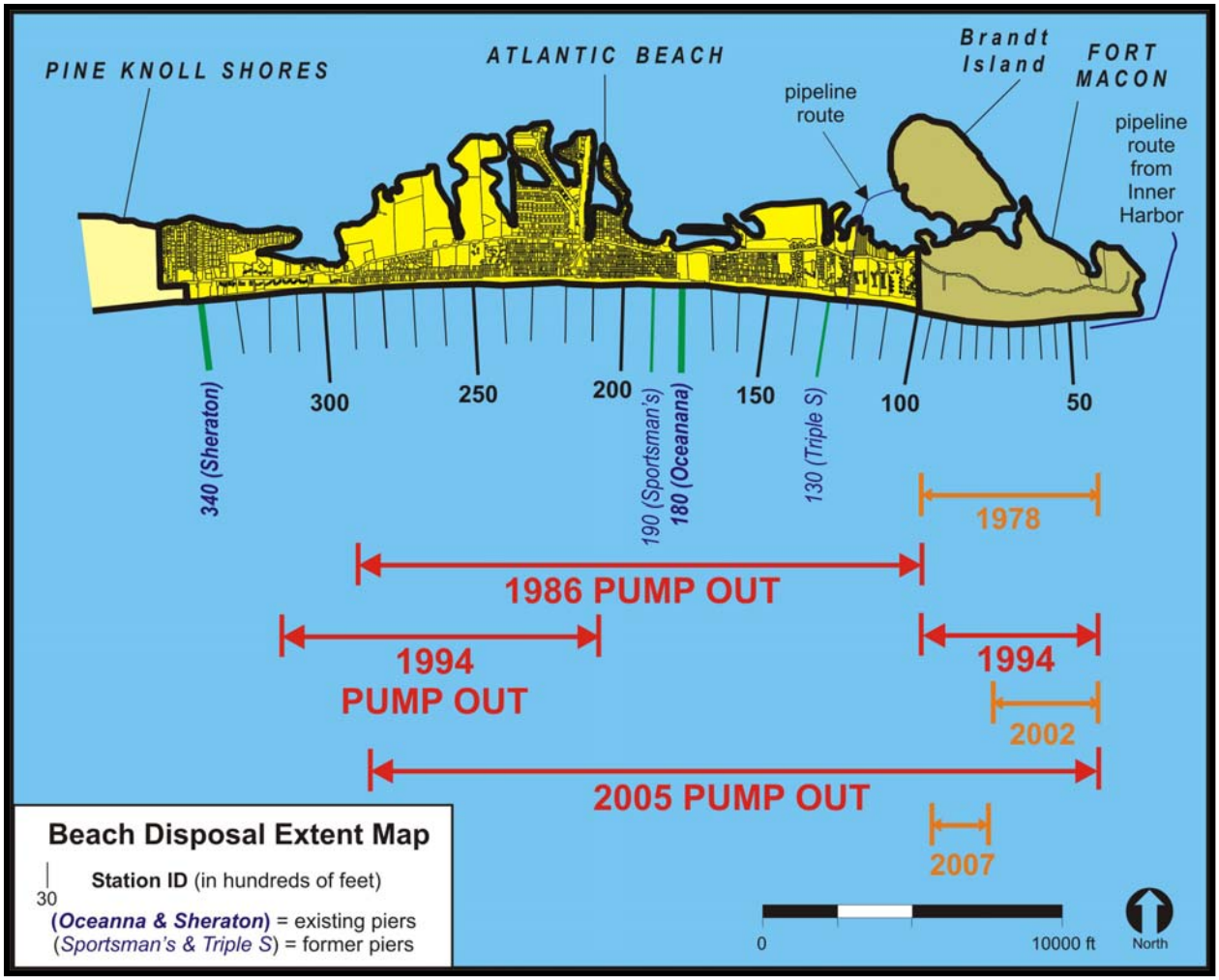
g. An explanation is needed to as to why two shoreline change periods were used for Oregon Inlet for both the pre- and post-terminal groin conditions while only one pre- and post- period was used for the other cases. In other words, what is the significance of the different periods used for Oregon Inlet?

h. I still have major concerns on the conversion factors used to convert shoreline changes to volume changes. I have included a spreadsheet for Bogue Banks that gives unit volume changes (cy/lf) for each USACE baseline station, the average change in the foreshore position (average of +6 and 0 contours) for each station, and the computed volumetric equivalent factor (unit volume change/average foreshore change) for stations along Bogue Banks from Beaufort Inlet (~Sta 40+00) to near the west boundary of Atlantic Beach (~ Sta 340+00). The computed volumetric equivalent factors vary over a wide range including some negative factors.

i. For Fort Macon, Appendix C shows a beach nourishment event in 1973 yet I have no record on such an event. The map below (provided by the Carteret County Shore Protection Office) graphically summarizes when and where material has been deposited west of Beaufort Inlet.

j For Fort Macon, the table showing how the average beach fills were determined needs to show how the actual distribution of the material was taken into account. Note several of the operations placed material farther than 3 miles from the inlet. In this regard, the 1978 disposal cover the area 0 to 1.9 miles west of the inlet (area within Fort Macon State Park), the 1986 disposal extended from 1.9 to 4.7 miles west of the inlet, and the 1994 disposal covered two areas, one from 0 to 1.9 miles and the other from 3.8 to 6.4 miles west of Beaufort Inlet. Since shoreline and volume changes are only being presented for the first 3 miles from the inlet, the report needs to show the adjustments in the volumes placed within this 3-mile area.

k. The computational procedures used to determine dredging averages and beach fill averages is not trivial as this forms the basis of the shoreline change and volume change adjustments made for all of the 5 cases.



Site map depicting the geographic areas, general dates, and USACE stationing for beach disposal/nourishment events associated with dredging activities at the MHCH project. (Atlantic Beach has been the nourished three distinct times – 1986, 1994, and 2005.)

Comments on Section III.

a. As was discussed during the Science Panel meeting on February 8, the geological section should focus on inlet process not shoreline changes. As they now stand, Sections II and III are not complementary nor are they related as each sections presents shoreline change information over different temporal and spatial scales.

b. A summary of changes in the ocean bar channel pre- and post-groin would provide some insight as to how the inlet was impacting the adjacent shorelines.

c. Changes in the inlet characteristics such as width, cross-sectional areas (where available), the size of the ebb tide delta, etc., would be very useful in assessing changes associated with the terminal structures.

Comments on Section IV.

a. This section presents a lot of general information that is not particularly relevant to the question at hand, i.e., what are the environmental consequences associated with terminal groins? Perhaps most of the information should be moved to an appendix and only the information relevant to each of the 5 cases presented in Section IV.

b. Not surprisingly, most of the discussion seems to focus on the impacts of beach fill not terminal groins. While beach fill should be tied to any terminal groin project, beach fill is not the primary focus of the report.

Comments on Section V.

a. With only 5 cases, developing parametric relationships for groin length and height is problematic.

b. The definition of structure length is critical in evaluating the impacts of this parameter. Generally, the shoreline configuration adjacent to a tidal inlet prior to the groin installation is curved in toward the inlet as a result of sediment transport properties dictated by marginal flood/ebb tidal currents and wave transformation over the ebb tide delta. Once the structure is put in place, the shoreline adjacent to the structure will assume an alignment comparable to the alignment of the shoreline not directly impacted by the presence of the inlet. The straightening of the shoreline will occur over a relatively short time period and the degree of pre-groin shoreline curvature will have an impact on the length of shoreline directly impacted by the groin. Once this initial shoreline adjustment occurs, the effective length of the groin is reduced to only that which projects beyond the adjusted shoreline, i.e., that portion of the structure that is subjected to continual interaction with waves and currents.

For example, the severe curvature of the north end of Pea Island in 1988, or just prior to the construction of the terminal groin, necessitated the extension of the groin well beyond the 1988 shoreline in order to reach the point where it would intersect with a straight line

extension of Pea Island shoreline south of Oregon Inlet. The area between the groin and the 1988 shoreline filled rapidly thus reducing the effective length of the groin. The report states the effective length of the Oregon Inlet terminal groin was 1,500 feet but does not show how this length was derived. How the groin length was determined for the other 4 cases should also be provided in the report.

d. The plots of structure length versus shoreline and volume changes should be shown for varying distance from the structure not just for the entire 3 miles used for each case. Obviously, the shorter the effective length of the structure the closer the direct impacts would be to the structure and vise a versa.

e. Groin height should be measured relative to the natural height of the beach berm not mean tide level. The natural berm elevation generally defines the upper limit of significant littoral transport so the lower the structure relative to the natural berm height the greater the volume of sand moving over the structure.

f. Given the limited amount of data (5 cases), the relationships shown by the plots is statistically meaningless. Furthermore, both structure length and height (as well as porosity) all play a role on impacts of the structures on the adjacent shoreline and are not mutually exclusive.

Comments on Section VI.

Hopefully, the analysis will satisfy the legislative mandate but otherwise, the analysis is basically worthless. In many instances, the inlet hazards areas provided by the Science Panel to the study team include significant lengths of shoreline up-coast and down-coast of the inlet and are far removed from any direct and possibly indirect impact of a terminal groin. Granted, the areas may be protected with a beach fill that would accompany a terminal groin, but to imply the terminal groin by itself would affect these shorelines is misleading.

Comments on Section VII.

a. I find it difficult to believe that a properly designed rubble-mound structure would cost less than a steel sheet pile structure. Stones to build the structures in NC must be shipped by either truck or rail from the interior of the State to the coast. It must then be offloaded to a barge for transport to the site. Once at the site, the stones are either offloaded to shore to construct the landward portion of the structure or placed directly off the barge once the structure reaches depths sufficient to float the barge. All of this handling adds cost to each stone. While I have not estimated the cost of stone in some years, my guess is the cost per ton would probably be in the range of $70 to $150/ton.

b. Maintenance costs seem to be excessive. In the case of both the Pea Island and Fort Macon terminal groins, which have been in place almost 20 and 40 years, respectively, little to no maintenance has been required for either structure.

Inlet Structure Inventory	Note: Right or Left refers to looking into inlet from the ocean						
From Google Earth							
State	Inlet	**Terminal Groins?**		**Jetties?**		**Groin Field**	
		Left	Right	Left	Right	Left	Right
New York	Mecox						
	Shinnecock			Y	Y		
	Mriches			Y	Y		
	Fire Island				Y		
	Jones				Y	Y	
	East Rockaway				Y	Y	
	Rockaway				Y	Y	
New Jersey	Shark River			Y	Y	Y	Y
	Manasquan			Y	Y		Y
	Barnegat			Y	Y		
	Little Egg						
	Brigantine						
	Absecon	Y	Y			Y	
	Great Egg Harbor		Y			Y	
	Corson						
	Townsends	Y	Y				Y
	Hereford	Y					
	Cape May			Y	Y		
Delaware	Rehoboth Bay						
	Ocean City			Y	Y		
Virginia	Chincoteague						
	Assawoman (closed)						
	Gargathy						
	Metompkin						
	Wachapreague						
	Quinby						
	Great Machipongo						
	Sand Shoal						
	New Inlet						
	Ship Shoal						

	Little Inlet						
	Smith Island						
	Rudee			Y	Y		
total number of inlets	33	3	3	8	12	6	3
inlets with some type structure	16						
State	Inlet	**Terminal Groins?**		**Jetties?**		**Groin Field**	
		Left	Right	Left	Right	Left	Right
North Carolina	Oregon	Y					
	Hatteras						
	Ocracoke						
	Old Drum						
	New Drum						
	Barden						
	Beaufort	Y					
	Bogue						
	Bear						
	Brown						
	New River						
	New Topsail						
	Rich						
	Mason						
	Masonboro			Y	Y		

Bogue Banks Surveys

USACE BL Sta	Jul-91 Volume to 3500 ft offshore cy/ft	Jul-91 Distance to +6 ft msl from BL ft	Jul-91 Distance to 0 ft msl from BL ft	Nov-00 Volume to 3500 ft offshore cy/ft	Nov-00 Distance to +6 ft msl from BL ft	Nov-00 Distance to 0 ft msl from BL ft	Volume Change 91 to 00 cy/ft	Volume Change 91 to 00 Cu. Yds.
33	2694.1	282	378	2390.1	342	451	-304.0	
40	2444.0	12	115	2234.5	148	233	-209.5	-179,725
50	2322.3	-6	73	2043.8	49	159	-278.5	-244,000
60	2253.8	23	100	1912.9	-18	38	-340.9	-309,700
70	2238.4	65	125	1866.0	-6	101	-372.4	-356,650
80	2241.5	38	163	1806.4	-51	68	-435.1	-403,750
90	2057.3	22	149	1700.6	-34	69	-356.7	-395,900
100	2015.3	66	161	1627.2	45	179	-388.1	-372,400
110	2014.9	130	223	1658.6	77	209	-356.3	-372,200
120	1996.6	174	242	1657.9	50	209	-338.7	-347,500
130	1954.6	177	334	1541.6	52	172	-413.0	-375,850
140	1964.4	219	293	1561.5	99	201	-402.9	-407,950
150	2006.6	235	336	1589.3	111	232	-417.3	-410,100
160	2011.0	280	381	1587.0	146	221	-424.0	-420,650
170	2059.1	273	414	1519.8	151	234	-539.3	-481,650
181	2015.5	244	392	1572.3	162	223	-443.2	-540,375
190	1909.1	169	309	1584.9	155	241	-324.2	-345,330
200	1924.5	204	292	1483.7	159	219	-440.8	-382,500
210	1856.1	170	313	1584.0	180	274	-272.1	-356,450
219	1811.0	168	337	1494.6	184	249	-316.4	-264,825
230	1794.6	175	348	1487.0	190	271	-307.6	-343,200
240	1751.0	111	284	1525.0	88	270	-226.0	-266,800
250	1695.4	50	203	1464.3	170	235	-231.1	-228,550
260	1643.8	42	183	1419.1	154	222	-224.7	-227,900
270	1594.6	28	175	1356.0	146	203	-238.6	-231,650
280	1577.4	23	138	1332.1	158	213	-245.3	-241,950
290	1566.2	26	150	1319.1	107	198	-247.1	-246,200
300	1533.3	42	177	1279.7	103	160	-253.6	-250,350
318	1554.7	84	253	1331.1	148	195	-223.6	-429,480
342	1575.4	106	250	1259.7	147	268	-315.7	-647,160
						ave vol ch	**-329.6**	
						Total vol change		-10,080,745
						Rate vol change		-1,120,083

Change in contour 91 to 00 +6 ft msl ft	0 ft msl ft	Ave Change in contour ft	Ave contour change btwn BL stas	vol change div by ave contour change	
60	73	67		-4.57	
136	118	127		-1.65	
55	86	71		-3.95	
-41	-62	-52		6.62	
-71	-24	-48		7.84	
-89	-95	-92		4.73	
-56	-80	-68		5.25	
-21	18	-2		258.73	
-53	-14	-34		10.64	
-124	-33	-79		4.31	
-125	-162	-144		2.88	
-120	-92	-106		3.80	
-124	-104	-114		3.66	
-134	-160	-147		2.88	
-122	-180	-151		3.57	
-82	-169	-126		3.53	
-14	-68	-41		7.91	
-45	-73	-59		7.47	
10	-39	-15		18.77	
16	-88	-36		8.79	
15	-77	-31		9.92	
-23	-14	-19		12.22	
120	32	76		-3.04	
112	39	76		-2.98	
118	28	73		-3.27	
135	75	105		-2.34	
81	48	65		-3.83	
61	-17	22		-11.53	
64	-58	3		-74.53	
41	18	30		-10.70	
ave contour change		**-21.6**		**15.28**	**ave vol equiv factor**

Walker, Michele

From: Gregson, Jim
Sent: Wednesday, February 10, 2010 9:26 AM
To: Willis, Angela; Walker, Michele
Subject: Fw: Additional Comments on Terminal Groin Report
Attachments: TJ Additional comments on TG report.doc

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Sent: Wed Feb 10 08:26:12 2010
Subject: Re: Additional Comments on Terminal Groin Report
Attached are a few other thoughts on the report. Most important point is the report fails to adequately address the critical issue of beach fill performance near an inlet with and without a terminal structure.

Tom

In a message dated 2/9/2010 5:10:16 P.M. Eastern Standard Time, Jtomjarrett@aol.com writes:

> Attached are my review comments on the report. This was a quick review so I am sure, given more time, I would have many more.
>
> Also attached is the spreadsheet referenced in the review comments which shows computations of the volumetric equivalent factors I determined for the east end of Bogue Banks. This clearly demonstrates my concerns on the used of this methodology to adjust for beach fills.
>
> Finally, there had been some discussion in the news media that very few inlets have terminal groins. I made an inventory of 154 inlets using Google Earth (see second attached spreadsheet) from Long Island, NY to the pan handle of FL and noted the number of inlets that have terminal groins (on one side or both), jetties (on one side or both), or some other type of shoreline treatment (radial groins, groin fields, or revetments). Of the 154 inlets, 71 have some type of structure. Of these, 24 inlets have what I would classify as terminal groins (on one or both sides), and 41 have one to two jetties. The other 6 have a mishmash of shoreline treatments. Thus, of the 154 inlets in the sample, 42% have terminal structures in the form of terminal groins or jetties.
>
> So the difficulty in finding suitable case studies was not due to the lack of inlet shoreline treatments, it was due to the limited number of applications that would meet our criteria for a terminal groin.

February 10, 2010

Additional comments/thoughts on the terminal groin study.

I believe any discussion on the impacts of beach fill should be excluded from the report. Rational for this is one of the primarily alternatives to a terminal groin is beach fill and any application of a terminal groin should also be accompanied by beach fill. Thus the impacts of beach fill for each alternative would essentially cancel each other, i.e., the impacts of beach fill is not a determining factor as to whether or not to allow consideration of a terminal groin. This cancellation of the impacts of beach fill is true provided the nourishment requirements in both quantity and frequency are the same for both alternatives.

In this regard, the report is remiss in not evaluating beach fill performance near tidal inlets that do not have a terminal groin or other type of terminal structure. Pete Peterson hit the nail on the head when he questioned if the application of a terminal groin would indeed reduce the need for beach nourishment. This is **THE** critical question and one that should have been a primary focus of the report.

In NC we have at least 4 good examples of how a beach fill performs near an inlet; namely, the north end of North Topsail Beach, the north end of Figure 8 Island, the east end of Holden Beach, and the east end of Ocean Isle. While the beach fill efforts are not "designed" beach fills in that most are the result of the disposal of navigation maintenance material, the performance of the fills provides some insight on what to expect from an engineered beach fill in these areas.

Unfortunately, documented evidence on the performance of these four fills may be difficult to find but there is adequate antidotal evidence based on visual observations. So the question then is: "if these four inlets had terminal groins would nourishment requirements be less or would the application of the terminal groin simply shift the erosion to some other area on the island as often quoted in the news media?" If the erosion hot spot was shifted away from the inlet would the nourishment rate needed to counter the newly created erosion hot spot be equal to or exceed the erosion rate immediately adjacent to the inlet? If the newly created erosion hot spot does require more nourishment, then the news media and others are correct. However, if a new hot spot is created away from the inlet and the erosion rate is not excessive, this impact could be addressed through the routine application of beach fill. As I have recommended, any consideration of a terminal groin should include a beach nourishment component.

My personal opinion, which obviously doesn't carry much weight, is any newly created erosion hot spots would require less nourishment than that needed to maintain the shoreline next to the inlet and the hot spots could be countered with the beach nourishment component included as part of the terminal groin option.

Tom Jarrett, P.E.
Coastal Hazards Science Panel Member

Walker, Michele

From: Rogers, Spencer [rogerssp@uncw.edu]
Sent: Wednesday, February 10, 2010 10:33 AM
To: 'Jtomjarrett@aol.com'; William.Birkemeier@usace.army.mil; overton@eos.ncsu.edu; Warren, Jeff; esciaudone@nc.rr.com; Greg.L.Williams@usace.army.mil; wcleary@charter.net; RIGGSS@ecu.edu; mallinsond@ecu.edu; cpeters@email.unc.edu; abrodrig@email.unc.edu; jmartin@moffattnichol.com; PTschirky@moffattnichol.com; Walker, Michele; Gregson, Jim; bob.emory@weyerhaeuser.com; Underwood, Steve; Stefanski, Guy; Richardson, Ken; Miller, Tancred; Lopazanski, Mike; sbenton45@earthlink.net; ryoung@email.wcu.edu
Subject: RE: Comments on Terminal Groin Report

Folks,
If sand is not trapped on the Fort Macon shoreline it ends up at the Coast Guard pier. What is the dredging history at the pier?

Spencer

Review of 1 February 2010 version of M&N Terminal Groin Report

By Charles H. "Pete" Peterson, Science Panel member

I submit these comments as part of my "peer" review of the draft study on terminal groins. I may follow-up these comments with additional thoughts as I see the need to submit them.

In my comments, I have attempted to point out significant concerns I have with the document, and have suggested possible findings and/or conclusions that could be drawn from the information that has been gathered.

Before outlining more specific comments on the document, I provide general observations about the major sections and elements of the report:

1. <u>This report is critically flawed by the failure to achieve the necessary interdisciplinary interactions among authors of the various sections, which would be required to conduct an intrinsically interdisciplinary scientific analysis</u>: The critical sections on Engineering, Geology, Environmental Assessment, and Economics show clear indications of being prepared largely independently – in parallel instead of in series with multiple interdisciplinary interactions. This produces redundancies and, far worse, inconsistencies among sections. It also results in various people having to go beyond their own areas of expertise to answer basic questions from other disciplines in order to address questions in their own disciplines. For example, the Environmental Assessment section includes conclusions about whether beach nourishment needs are reduced after installation of terminal groins, which requires expertise, input, and data generated by the engineers and geologists to support such conclusions. In the Engineering and Geology sections, those data, analyses, and conclusions are currently absent. The Economic Assessment was done without understanding of what the 30-year hazard line crafted by the Science panel meant and this section fails to deliver what was promised in the contract, which was analysis of economic risk at inlets with and without a terminal groin under multiple scenarios of sea-level rise and coastal storminess. The explanation for absence of these scenarios was lack of definitive communication with the geologists and engineers to provide necessary projections on which to base the scenarios. The Geology section is redundant of much of what appears in the Engineering section and includes claims and conclusions that conflict with those in the Engineering section. The participating geologist should have been integrated into the engineering such that the consequences of intervening in the natural system with a structure could have been evaluated and explained in the context of how that structure interacted with dynamic processes of sediment erosion, transport, and deposition.

   The nature of the scientific and technical problem presented by the challenge of assessing impacts of terminal groins requires fully integrated interdisciplinary collaboration, not independent disciplinary treatises. The core discipline on which all other components of this report must be built is the geology of sediment dynamics. The engineering analyses must use physical and geological principles to understand how engineered structures of various characteristics interact with sediment dynamics – erosion, transport, and deposition around

ocean and inlet shorelines. Then the environmental assessment must depend on the conclusions reached by the geologists and engineers on the physical and geomorphological changes induced by the terminal groins under a range of conditions to be able to base analyses of habitat and organism responses upon the dynamics of sediment transport changes and geomorphological transformations that are detailed by experts in those disciplines. Similarly, the economic impacts of erection of terminal groins depend upon the consequences of natural sediment movement and shoreline change as compared to modifications induced by the presence of the terminal groins. The failure to conduct an interdisciplinary assessment in this fashion seriously diminishes the accuracy, internal consistency, and usefulness of this report for the intended purposes. This appears to represent a process failure for which there is inadequate time to remedy.

2. No meaningful conclusions can be drawn about the effects of groins from the case studies: None of the case studies are based upon adequate and sufficiently reliable data that could withstand rigorous scientific review. The quality of the data used is too variable, and the number of unmeasured confounding factors influencing inlet behavior too numerous to give confidence that any valid conclusions can be reached. The data analysis presented in the various tables includes assumptions, effects of confounding processes, and uncertainty levels that make it impossible to draw definitive conclusions and thus dangerous to use in making policy changes. I found no compelling evidence in any of the case studies for documented benefits to beaches that have resulted from the terminal groin structures, except for spatially restricted stabilization in absence of major storms that has occurred at the tips of the islands where they have been built. Findings and conclusions should be limited to what can be rigorously concluded from the cases studies. What the information does not reveal about the performance of terminal groins is often the most meaningful conclusion that can be reached.

The case study section is the most important of the entire report because it provides actual data on responses to the establishment of existing structures that can perhaps be considered terminal groins. Many readers will prefer empirical information and here is where M&N assemble such information. I applaud and welcome this empirical approach. The present draft is incomplete, however, in several important ways. First, there were decisions made about various data and how to include them, and this report fails to provide and defend the complete methodology used in making these decisions. For example, beach fill data exist for at least one period south of Oregon Inlet that refer to a 6-mile stretch of beach but this information must be used to compute how much of that fill was applied to the first 3 miles to match the down-drift range used in the assessment protocol. Readers cannot learn how the fraction applied to the first three miles was determined. Similar even more challenging decisions were made about how to treat various dredging activities – whether the source location was or was not within the coastal sand-sharing system and whether or not the deposition location was or was not within the coastal sand-sharing system. All this detail of what was done and the rationale for why needs to be added. Second, there is no attempt to compute whether more or less beach nourishment is done on down-drift beaches after establishment of a terminal groin. This is critical information for environmental assessments of impacts and for economic costing of projects. Third, the engineering computations are presented without any indication of the huge uncertainty associated with them. This issue especially affects the level of confidence possible in the conclusions that may be reached from the empirical computations and thus affects whether a conclusion can be reached. Part

of the explanation for why uncertainty is excluded is the failure to integrate the coastal geologist into the interpretation and writing of this section. For example, the site-specific contributions of confounding processes are not explicitly detailed and have huge impacts on the ability to isolate out effects of the groin alone. Beaufort Inlet is dredged to such a depth (47 feet) that over time a large fraction of the ebb-tidal delta has been lost at the west side of the inlet. This has a huge effect on the sediment budget, the wave energy now reaching the shore, and thereby the shoreline erosion and sediment volumes near and on shore. Similarly, each inlet examined has other major influences that confound the ability to isolate the effects of the groin alone. Assessing whether dredged materials were retained within the coastal sand-sharing system or not is impossible to do with accuracy in any case study. Inadequate presentation of these other sources of change creates a work product that is misleading because it implies that the questions were readily answered without serious uncertainty. In reality these sources of change in the system render the task of assessing impacts of terminal groins impossible at these sites, except perhaps at Amelia Island although that groin possesses only two years of after-construction information.

3. Geologic analysis is elementary and fails to address in any meaningful way the fundamental questions that this study should be answering: The central question that should be answered by this section is the geologic consequences of attempting to "stabilize" inlets and barrier island systems that depend on highly dynamic natural processes as adaptations to sea-level rise and storms. The geologic analysis contained in the report is similar to an introductory textbook in coastal processes, and provides little substance for policy making. What little information exists that is of real value should be integrated into the case studies. The section is woefully inadequate in addressing the consequences of sea level rise (it should use the state's new adopted projections for sea level by 2100) and the consequences of more intense storm activity.

4. Environmental assessment is bloated with data that provide no basis for reaching conclusions or making policy: The environmental assessment can only be done effectively by building upon the conclusions reached by the (now non-existent) partnership between the engineers and geologists in answering the critical questions about impacts of terminal groins. These questions are: (1) Are terminal groins effective in stabilizing the position of the inlet and its shoreline; (2) Do terminal groins influence the balance between erosion and deposition on either side of the inlet and for a distance of 3 miles away; and (3) Does beach nourishment increase, decrease, or stay the same after erection of a terminal groin. Answers to each of these questions have implications for geomorphology, ecological succession, disturbance, and habitat availability, through which all changes to the biological resources flow. Instead of using the results of collaboration between the engineers and geologists to answer these critical questions, the biologists provided their own attempts to answer these questions, producing conclusions that differ from what the data and conclusions are or can be in the engineering section. The conclusions reached by the biologists on these physical, engineering, and geological issues of sediment transport are based on inadequate scholarship and not on rigorous meta-analyses of available information of the sort attempted in the case studies of the earlier sections. As a result, a large fraction of the conclusions in the environmental assessment are either wrong or unsupported by rigorous science. For example, the claim that need for and thus amount of beach nourishment down-drift declines after installation of a terminal groin is based on a personal communication and not a rigorous

data review. All the conclusions in the environmental assessment section need to be completely redone based upon what is rigorously concluded in the analyses done earlier by the engineers in concert with the geologist about these changes in sediment transport. Because the most rigorous conclusion that can be reached by the engineering-geological analyses of the case studies is that the data are insufficient to reach definitive conclusions, except perhaps on the ability of the terminal groin to fix an inlet shoreline in place and limit migration of a migrating inlet, many of the environmental impacts would also need to reflect this uncertainty and be couched as conditional impacts. That is, these should say, for example, that if more beach nourishment occurs down-drift after installation of a terminal groin, then the beach invertebrates would more often be depressed in abundance and the shorebirds and fishes that feed upon them would be deprived of food for longer periods of time.

This environmental section is greatly bloated by inclusion of endless amounts of observational data on sea turtle nesting and bird counts, for which methodologies are not presented that would allow conclusions to be reached about the nature of change before and after installation of a terminal groin. For example, one would need to show that the search effort and approach was held constant across the years and also need information identifying the search area and relating counts to area to provide comparable densities. It is possible that some of the data would meet the criteria for constant methodology over time, but this is not clear from the insufficient information provided. For any data set that might meet these criteria for allowing a rigorous temporal comparison, then a BACI-type of analysis is needed in which the change in density from before to after groin construction at the putative impact site around the terminal groin is compared statistically to the analogous temporal change at one or more reference sites where no groin was installed. This obviously entails some effort but without it, the extensive presentation of descriptive counts can answer no question about potential impacts.

Impacts can be rigorously inferred based upon geomorphological consequences of the presence of a terminal groin and its physical consequences on habitat. However, this interdisciplinary approach based on first principles is not adequately done in the report. For example, the stabilization of an inlet (not ocean beach) shoreline that may result from a terminal groin installation inhibits natural physical processes of sand flat formation, washover to some degree, and creation of new unvegetated habitat for shorebirds. These missing sand flats remove critical foraging habitat for shorebirds and the stabilization of the end of the barrier island can allow vegetational succession to fill in overwash areas, which are critical and limited nesting habitats for many shorebirds and seabirds, including the endangered piping plover. These first-principles relationships to the biological resources and to piping plovers in particular produce a sufficiently compelling prediction of injury that the high likelihood of Endangered Species Act violations would likely preclude construction of a terminal groin at any inlet where piping plovers are known to nest or is suitable for nesting. Yet, nowhere does this or similar analyses and conclusions exist in this environmental assessment section. This section is grossly inadequate for all the reasons documented in my review.

Much of the data and discussion in this section should be removed because it includes no analysis of the consequences of building terminal groins. This section needs to address

directly the question of whether it will ever be possible to receive a permit for a terminal groin at what is now a natural inlet given the endangered species that depend on highly dynamic systems to live and nest.

5. The engineering cost analysis is textbook in its approach but gives little insight into what it will really take to build groins and maintain them over the long term, especially within barrier island systems that are already largely starved for sand: Designing and permitting a terminal groin will become a very complicated process and the estimated costs of this part of the analysis are optimistic at best. The section does not address the increased costs and difficulties of building terminal groins in shallow-water inlets without easy access for barges or perhaps even trucks. The analysis does not factor in the long-term costs of providing for beach nourishment, especially if groins are constructed where there is a documented shortage of suitable sand available for beach nourishment. If sand must be mined from inlets to provide for nourishment, then the total costs of such structures should be compared to the case studies where active inlet dredging is now occurring. Removal costs are grossly underestimated. It will cost $700,000 in legal fees before any removal could even begin.

6. Economic information lacks analysis, and is highly misleading and subject to being abused as disinformation: The economic assessment is really not an assessment at all. This section merely catalogues the assessed value of undeveloped property, structures, and infrastructure within the 30-year hazard zones recently redrawn by the Science Panel for each inlet of the state and totals them. This falls far short of assessing economic risk and will lead to misuse and misinterpretation of the data. It is inconceivable that all the 1.4 billion dollars worth of property within the 30-year hazard zones of all North Carolina inlets will be lost in the next 30 years. Typically, if erosion happens at one side of an inlet, accretion occurs at the other side. So a reasonable scenario is not loss of property on both sides but a pairing of loss and gain in each inlet. This realistic scenario is not pursued, again because the economic assessment was done in a vacuum, not in collaboration with the engineers and geologist in an appropriately interdisciplinary fashion. Even the way in which the Science Panel constructed the 30-year hazard zone was unknown to the economist in writing this section.

By providing only a listing of property values in the state's 30-year inlet hazard zones, the economics section fails also to deliver on the contract, which promised an analysis of economic risk under a suite of different scenarios of sea-level rise and coastal storminess. This analysis is critical because we know that sea level is rising and that the frequency of intense storms is likely increasing as a consequence of global climate change. Furthermore, this appropriately interdisciplinary analysis would also include a comparison of risk of loss without a terminal groin to risk of loss with a terminal groin in place. Absent that analysis under a range of environmental scenarios, the economic assessment fails to answer the fundamental question of the value of terminal groins in protecting property at inlets. The loss of property within the 30-year inlet hazard zone will not occur from inlet movement alone. Even more loss of property is likely to be a consequence of flooding, erosion, and wave damage arising from the ocean shoreline during intense storms and such losses are more likely under higher stands of sea level. Thus again, a simple listing of value of all property in each30-year inlet hazard zone is grossly misleading in that not only will a large fraction of this property survive the next 30 years but also the property that is lost will include a major contribution from ocean processes during storms, which the terminal groin does not

influence. This point would become clear with inclusion of results of the promised scenarios of loss with and without the presence of terminal groins under multiple sea-level and storm frequency conditions. One viable means of inferring the potential benefits of the presence of terminal groins would be to conduct a retrospective analysis of the past 30 years of property losses in inlet hazard zones to determine what percentage of the property within the 30-year hazard zones was actually lost and how that fraction varied with presence and absence of a terminal groin. That could help place this misleadingly huge 1.4 billion dollars in a true and realistic perspective. That perspective is lacking now and the economics section lacks a comprehensive discussion of these issues.

Since there is no analysis in this section that links the numbers presented to shifting inlet processes that have and will occur, the information presented is useless for policy makers. It should be removed from the main part of the report, and included in a technical appendix as background data. The information presented will be distorted and misunderstood as being somehow related to the terminal groin debate. The consultant has not performed most of the tasks agreed upon in his contract, and how to fulfill the scope of work needs to be addressed.

7. <u>The science panel's role in the study does not adhere to the protocol typically associated with rigorous peer review:</u> Because no process is in place for the Science Panel to guarantee that modifications made to the report after review are sufficient, the role of the panel must be redefined to reflect this. It was my understanding that a commitment was made at the outset of the study for the science panel to conduct a peer review (see PowerPoint Presentation presented at kickoff meeting), and that our role was established to provide public confidence that the technical report would adequately integrate the scientific and technical knowledge to produce a rigorous set of conclusions. Now it is unclear if substantive issues raised in review will be adequately addressed in the final report, lacking a process to insure it.

My specific comments and suggested conclusions follow:

Case Studies:

The five case studies show that factors contributing to the condition of the beaches adjacent to a terminal groin include repeated beach nourishment, inlet dredging, channel depth, tidal forcing, storm activity, sea-level rise, natural erosion and accretion processes including longshore transport of sand, along with erosion and accretion as a result of groin presence. Because so many natural and human-related factors interact to influence inlet and beach processes, in my opinion the study found that:

- No simple terminal groins have been built and function anywhere on the East or Gulf Coasts to provide any actual real-life experience with the type of structures that have been suggested for the shallow-water inlets of North Carolina. (Table VIII-1 on page VIII-2 inaccurately implies that most of the structures listed are terminal groins. The Science Panel determined that most of these structures are jetties or are part of groin fields, and did not meet our definition of a terminal groin. The table must be changed. In addition, two figures showing a picture of the Oregon Inlet posses a caption that calls the structure a terminal groin, when this is not so. The terminal groin is attached to a wrap-around revetment going back into the sound. This misleading caption must be modified.)

- Detailing the effects of the terminal groins in the case studies with any high degree of confidence is not possible with data that are currently available. This has been the consensus of the science panel at every meeting, and the case studies need to clearly reflect this consensus.
- Terminal groins can stop inlet migration, at least temporarily. However, long-term stability of dynamic inlet and barrier island systems cannot be achieved by these structures because of effects of intense storms and sea-level rise.
- Beach nourishment is necessary when a terminal groin is constructed. It was impossible to determine if the amount of beach nourishment that is required after a groin is constructed will increase or decrease as a result of building the structure.
- Terminal groins do not stop beach erosion.
- Terminal groins do not ensure that beaches and development will be protected against the impacts of sea-level rise and intense storm activity.

Geologic Assessment:

The geologic assessment concludes that in the high-energy environment that characterizes the North Carolina oceanfront, wave energy, tidal inlet dynamics, storms, dredging, and beach nourishment were all major factors in the sand distribution of these barrier island systems. The chapter concludes that terminal groins do not have a big impact on regional sand transport when looked at in conjunction with the other major natural and anthropogenic effects on the inlet, but can anchor (not stabilize) an inlet shoreline at least temporarily. There is no evidence that a terminal groin decreases beach erosion except in the very near-shore area around the fillet. The assessment fails to address the implications of interrupting natural inlet and barrier island migrations and what consequence that has for the ability of inlets and the barrier islands to maintain themselves in a period of rapid sea-level rise and increased intense storm activity.

Other conclusions that should be clearly stated in this analysis include:

- Terminal groins contribute to narrowing of inlets and the loss of natural inlet shoals and sand spits.
- Terminal groins, by narrowing inlets, funnel storm surge ebb and enhance storm impacts by increasing the likelihood of new inlet creation**.**
- The terminal groin should be the zero point for measuring beach profiles in the case studies. If not, the way that shoreline change is calculated for distance 0-.25 needs to be modified. Using change calculated off the current baseline that extends along the inlet beach produces problematic data. Furthermore, the profile data need to be evaluated based on when they were collected relative to storms and beach nourishment activities. Similarly, when each photograph was taken for shoreline position information needs to be examined relative to recently preceding storm or beach nourishment events.
- Summary results presented at the science panel meeting on Feb 8 include a conclusion that after netting out beach nourishment and nearshore disposal, the beach along 3 miles generally displayed a reduction in eroded volume. The science panel reached a consensus that given the quality of data and the confounding with a number of unmeasured variables involved in these inlet systems, it is impossible to draw this conclusion from this analysis. These

conclusions should be stricken from the report.

- The study also concludes that if 25% of dredged material had naturally bypassed the inlet and deposited on the beach, no negative impacts would be shown on Pea Island or Shackleford Banks. The use of the 25% and 50% by-pass sand scenarios was not supported by the science panel, and should be removed from the document.

Environmental Assessment

The inconclusive results of the analyses of the physical and geological effects of terminal groins, together with a lack of rigorous site-specific conclusions from the five study sites, make it almost impossible to draw conclusion on the effects of terminal groins on habitat. Dial Cordy was charged in the scope of work with the task of assessing the effects of a terminal groin on the natural resources including marine, terrestrial, associated biota, habitats, and protected species. They were also tasked with describing possible mitigation approaches that could be considered as terminal groin permitting requirements. In the conclusions presented at the last science panel meeting, they reported included two additional findings: (1) that terminal groins can reduce the number of "beach placements" needed to manage an erosional hot spot by retaining littoral and placed material; and (2) proper terminal groin designs and placements can minimize littoral transport effects thus maximizing resource use effects. No reliable data analysis is presented to support either of these conclusions, and they should be removed from the report.

All data presented in the report that cannot be used to evaluate the effects of groins should be removed. For instance, the chart in section IV-59, shows counts as do many of the tables and figures contained in the section. Counts tell us nothing about population size: they tell us only that some unknown number of observers went out with unknown sampling effort, and recorded numbers of birds over some area. The information does not include the exact location of the observations, or relate it back to a terminal groin. But an untrained reader might look at this type of chart and think that it is indicative of bird populations near terminal groins. In addition, the Dial Cordy conclusion that a terminal groin "can restore degraded habitat" oversimplifies the modification of a very complex barrier island process and could mislead readers to conclude that terminal groins have net positive influences on bird and plant species. This is not true. Terminal groins mostly degrade habitat by blocking natural geological processes that create, maintain, and renew tidal flats and terrestrial dunes with low vegetation cover.

If no good data exist on which to complete the tasks outlined in the scope of work, then the report should simply say that it was impossible to draw meaningful conclusions based upon the data available and the time frame available for in-depth data analysis. In addition, based upon what is provided in the draft report, I would conclude that:

- Terminal groins have the potential to adversely affect habitat.
- Terminal groins have the potential to adversely affect ecological conditions.
- Fill material used in conjunction with construction of the groin and with later beach nourishment requires compatibility to existing conditions or habitat is destroyed.
- The source of sand for required beach nourishment could cause significant environmental concerns in locations where adequate quantities of beach-compatible sand are limited.
- Most of the study sites did not have sufficient historical information to assess the impacts of the groin on the local ecology and habitat.

- Terminal groins could adversely affect the flux of estuarine dependent finfish larvae through inlets and into primary nurseries.
- Interrupting natural inlet migration will have detrimental impacts on the ability of inlets to maintain themselves and critically important adjacent habitat through natural inlet processes.

Engineering Construction Technique

This section needs to address the fact most groins and jetties at inlets are constructed adjacent to navigable channels, and there is no experience with designing, building, and maintaining such structures in shallow, highly dynamic mostly un-dredged inlets. The Amelia Island structure so far does not appear to be benefiting the beach in any meaningful manner, and calls into question the concept of a "leaky" groin.

Economic Impacts of Shifting Inlets Not Evaluated

The legislature asks the CRC to study "*information regarding the current and projected economic impact to the state, local governments and the private sector from erosion caused by shifting inlets including loss of property, public infrastructure, and tax base."*

The study's scope of work said the contractor would conduct his economic analysis to include three policy scenarios:

(1) A baseline erosion management policy using dredging, nourishment and temporary structures;

(2) An alternative policy using terminal groins; and

(3) An unimpeded inlet shifting with a retreat/removal policy option.

These three policy options were to be applied to a section that projects the actions of federal, state, and local government and private sectors in each case. These same three policy options were to be used to assess likely future property value appreciation scenarios. These options were to be used by Moffatt and Nichol to identify likely locations and magnitudes of future erosion events. Finally, these three policy scenarios were to be applied to the largest task (90 hours) in the scope of work: the assessment of the current and future (50-year horizon) economic value of property losses. None of this work was completed. The contractor was obligated to consult with climate experts, and coastal engineers to identify future sea level, storm event, and erosion potential scenarios. He did not attend most of the science panel meetings when these issues were discussed, and this alone could have provided him with needed information for conducting this scenario analysis.

The finished product only provides values for all property and infrastructure in projected inlet hazard areas, uses a 30-year time line, and assumes no policy scenarios at all. Given that inlets typically move in one direction or another, adding up the value of all properties within the inlet hazard areas on both sides of an inlet is more reflective of catastrophic property losses that would be associated with an intense storm event, during which the terminal groin is not designed to provide any meaningful protection.

In addition to the issues noted above, economic information presented generally fails to give the reader a sense of perspective regarding the relative size of the numbers, and uncertainty (or confidence) in them.

The aggregate value of roughly $1.4 billion in property sounds huge, but the context is lacking. What are the total property values on barrier islands? How much property lies on these islands is at risk? What percentage of the developed values on these islands lies in these areas, and how much lies outside? How does the economic activity associated with these areas compare to that of these coastal economies taken as a whole?

How sensitive are the estimates to various assumptions made about relevant parameters, including inlet processes, catastrophic storms, structural effectiveness (maintenance in lean budget times), other policy efforts (dredging, beach re-building), and future development activities? What do we really know, and how likely is it that we're going to be substantially incorrect?

Ordinary beach erosion (as a consequence of rising sea level, dredging and the catastrophic effects of large storms) is occurring everywhere along the coast. No attempt is being made in the current document to separate out the effects of those forces. Property in inlet hazard areas will be lost during the next 30 years for reasons unrelated to inlet movement, irrespective of whether the groins are in place. It is very clear that the property value that is truly at risk from shifting inlets alone, and which could conceivably be protected by groins, is far lower than the aggregate inventory value presented in the study.

The presentation made at the Feb 8th science panel meeting concluded with four major points including a conclusion that a terminal groin will protect not all areas denoted by the 30-year risk line. These are the economics conclusions that can be drawn from the study:

- It is impossible to determine the economic benefits or costs of terminal groin construction since no one can accurately predict the consequences of building such structures.
- Positive economic values associated with the natural inlet migration processes (fishing, tourism, habitat creation and maintenance, etc.) are quite large, and should be studied. (Inlets are very popular recreational sites because of their natural characteristics, and the value of this recreation is not estimated.)
- Building terminal groins will create a false sense of economic security that might result in greater investments in property in highly hazardous inlet locations, and more extreme economic losses over time.
- Huge economic losses will occur to private property as a result of catastrophic storm events, independent of the presence of a terminal groin. That is why these areas are located in high "hazard" zones.

Construction and Maintenance Costs

The study does not consider the cost of ongoing dredging and beach nourishment, just initial beach nourishment even though it has been discussed and accepted throughout the process that beach nourishment must be part of an ongoing maintenance program for terminal groins. It is impossible to provide such an estimate since the benefits and risks associated with building a

groin cannot be accurately and reliably estimated, but assuming no cost is misleading. The study should discuss how required beach nourishment is going to occur in locations where there is very limited compatible sand available. It should also discuss the implications of mining inlets for sand when no other source of compatible material is available for nourishment that a groin will require.

Major Finding

The major finding of this study is that we do not have sufficient data with sufficiently reliable analyses to predict with confidence the consequences of building terminal groins.

The North Carolina Coastal Resources Commission in 1984 (and later the North Carolina General Assembly) adopted a ban on oceanfront hardened erosion control structures to reflect the conclusion that there was no way to fully anticipate the consequences of building such structures. The Commission has the burden of proof in its permitting process to show unacceptable harm of proposed structures.

The CRC should not be forced to issue permits when it cannot reliably predict impacts of proposed projects. Putting the CRC in such a position will doom the future our public trust beaches. This report does not provide any additional assurances that the science of predicting impacts from terminal groin construction has advanced substantially since 1984. It is still a guessing game as to whether or not groins will have a positive or negative impact on beaches in the short-term, and the current evidence is even more solid than ever that with sea level rise and storms groins will have negative impacts on public trust beaches and natural living resources.

Comments and suggestions for the Draft Terminal Groin Study (February 1, 2010)

Submitted by Rob Young
Program for the Study of Developed Shorelines

I will try to keep these comments as brief and to the point as possible. Some of these issues were raised in the Science Panel meeting of Feb. 8.

Overall Comments

I think that the summary conclusions need to be very frank in laying out what the available data and time constraints allow you to conclude, and what they do not allow you to conclude. The fact that there are many things that we would like to know that have not, and cannot be addressed by this report is no reflection on the work done by Moffatt and Nichol. We have to work with what is available. We must also be brutally honest regarding what we have not been able to accomplish in the limited amount of time.

1) The analysis can draw no conclusions regarding the impacts (positive or negative) that a terminal groin will have on beach nourishment within the vicinity of a project, although it is very clear that large scale beach nourishment has been required post-project in all locations. Any attempt to work this out with the five available data points will be of indeterminable accuracy and dubious value.
2) The analysis can draw no conclusions regarding how far down the beach the impacts (positive or negative) of a terminal groin will be felt. After netting out nourishment several sites show post-project accretion near the structure and increased erosion in miles 2 and three. But, Captiva shows the reverse.
3) The analysis can draw no conclusions regarding the impacts that a terminal groin, placed on the downdrift side of an inlet, would have on natural sediment bypassing across the inlet onto the downdrift island. It is acknowledged that some percentage of dredged sediment would bypass the inlet and make it onto the downdrift beach, but we have no data indicating whether or not a terminal groin could interfere with this process, a major concern of the scientific community in North Carolina. This gap in understanding would be particularly problematic at inlets that are not currently dredged or managed for navigation (e.g. Rich Inlet).
4) The report acknowledges that the morphology of the inlet channel and ebb tidal delta are major controls on the adjacent shorelines. The report also indicates that there can be major changes to the channel; and thus ebb delta, as a result of stabilizing the inlet shoreline using a terminal groin in certain locations (e.g. Oregon Inlet). Yet, an analysis of this important feedback is also beyond the scope of this study. How does a terminal groin alter the dynamics of the inlet and ebb delta, and how does that alteration impact shoreline accretion and erosion? We don't know.

5) The report cannot, and should not make any assertions regarding the economic harm or benefit of building terminal groins in North Carolina. This analysis is not possible with the available data.
6) The report does not address the historical or recent losses of property along North Carolina's inlet shorelines, a critical piece of information in judging the "current" economic impact of shifting inlets in the State.

Specific Section Comments

Section II:
I would recommend pulling out all of the extraneous information that is not used in the analysis (Wave data, wind data, storms, etc) and placing it in the Appendix. It just gets in the way of reading the report and it is not a part of the analysis or discussion. I would rather see the dredging data and renourishment data that is being used for analysis moved from the Appendix and engineering log to the front of the report.
1) Please create a table with all beach nourishment data used in the analysis and indicate where it was placed and how your number differs from the number in the engineering log.
2) I am still troubled by the way that the dredged material is handled at OI. After one nets out beach nourishment from shoreline change one then must ask, is there anything else that might be causing that shoreline change other than beach nourishment. Obviously, at Fort Macon, there is significant sand unaccounted for as a result of dredging and offshore disposal. So one can assume that some of the shoreline change has been a result of the dredging. But, if almost all of the dredge material is, in fact, placed on the beach (as at OI), one cannot assume that the net shoreline change is a result of dredging in the same way that one would at Fort Macon. These two scenarios should be treated differently, and the rationale clearly explained and justified.
3) I am also troubled by the level of uncertainty in the dredging analysis. I am not sure what you expect non-experts to do with your three scenarios of 0%, 25%, 50%. There is so much uncertainty in all of the analysis that the final number becomes guesswork. It is very dangerous to produce a report that allows experts and non-experts alike to "choose a scenario" that best fits there expectations. The truth is, we don't know what percentage of the dredge volumes listed in the engineering logs would have made it onto the first three miles of beach, and we don't know how it would distribute itself. In addition, we don't know how much of that sand would have been blocked by a terminal structure if no dredging were occurring. This results in the final "volumes net dredging and nourishment" being of completely indeterminable accuracy, and therefore, not very useful. I understand that you are working with very little available data, but let's not over-extend what we do have. I think that the most valid approach would be to net out the nourishment and simply discuss dredging impacts qualitatively. For example, indicating that, although we don't know the exact percentage that would have bypassed at Ft. Macon, it would likely have been more than enough to offset and overwhelm any other impacts.

4) For Johns Pass, is there no pre-project shoreline change data better than 1873-1926? Can you discuss the quality of that data? Also, we are missing 13 years of data immediately post construction. Why? The 1974-2007 post-construction period that you use includes 7 years when there were two structures. I thought that we were trying to examine the site when there was only one structure.
5) Sure would be nice to have some analysis of why the first quarter mile at Captiva had a higher post-project erosion rate than pre-project (net nourishment). This seems counter intuitive. Is there anything to learn here?
6) How can Amelia Island be judged as a success when we have so little data, and the data we have indicates massive renourishment and increased erosion? Please explain.

Section III:
There is much in this section that tries to duplicate the analysis in Section II, but only serves to complicate things. The section references two additional unpublished studies of erosion rates at OI and references a public lecture for other shoreline change rates. All of that should be removed. You were tasked with gathering peer-reviewed literature and conducting original, unbiased analysis.
1) This section indicates that there have been significant changes to the inlet channel, ebb delta, and sub-tidal sand bodies of OI since the terminal groin was constructed. This section also indicates that "perturbation" of this inlet system morphology can impact "erosional and depositional changes to the northern tip of Pea Island". Further analysis of these points would be nice. Would the changes resulting from stabilizing one side of the inlet at OI likely result in increased erosion or accretion on Pea Island? This is a more important question for the Geology section to address than to rehash shoreline change rates.
2) Page III-27,28: There is no basis laid in this section for the conclusion that the first 1.5 miles of shoreline have been stable (nourishment, etc not discussed). There is no basis laid for the conclusion that the terminal groin "contributes little to the long-term erosion of the PINWR shoreline south of the fillet". Please define little. The analysis in this section does not support this statement, please remove it.
3) At Fort Macon, this section once again references un-peer-reviewed shoreline change data from a public talk. This is inappropriate. All conclusion based on this data should be removed from the Summary on pg. III-44. Talking about the changes in delta geomorphology is fine, but you have already addressed shoreline change in Section II. There should not be a second discussion based on a second data set without presenting all of that data in detail.
4) There are many instances where Section III tries to make the point that sand is occasionally making its way around these structures to form a small beach or inter-tidal flat. This seems a strained effort to suggest that these are all functioning as "leaky" groins. The problem is that we have no perspective on the degree of beach or the nature of the sand bodies before structure construction. The fact that some sand occasionally makes it around a structure is not surprising, but we learn nothing about the DEGREE of impact the structures have had on this sand movement. Therefore, none of this visual assessment is particularly useful.

5) You should not be using shoreline change data from Olsen and Associates to ensure unbiased analysis. Please remove.
6) Page III-68: Please remove the last paragraph. There is no basis laid for this sweeping conclusion in the Florida section. In fact, many of the conclusions drawn in Section III do not jibe with the analysis in Section II.
7) Section III-70: Please remove the last paragraph. There has been no basis laid for the sweeping conclusion that terminal groins had little effect on the regional sand transport regime. Saying that sand moves past the groin is not the same as saying that the groin has not had an impact on beach or intertidal habitat. This conclusion is very misleading.
8) This section seems to rely much on professional opinion and little on new data analysis (unlike Section II).

Section IV:
I will not comment in detail on this section since it is somewhat out of my area of expertise. I do wish that more effort had focused on examining potential habitat loss, rather than simple counts of organisms.
1) The environmental section should have no independent conclusions regarding the impacts of terminal groins on shoreline change. Any discussion of this should refer to conclusion drawn from Section II.
2) Page IV-68: remove paragraph referencing Olsen Associates indicating groin is meeting its goals. Not appropriate here.
3) Remove all of the engineering design information. Duplicates other sections.
4) Please remove all paragraphs (5,6, and 7) in the Summary and Conclusions that draw conclusions about the benefits of terminal groins for shoreline stabilization and beach nourishment. DC&A is not qualified to evaluate the references they site, nor are they charged with drawing those conclusions, nor is their evaluation of the literature comprehensive, nor are the conclusions supported by analysis within your own report.

Section V:
It was clearly the consensus of the Science Panel that the attempts to derive simple relationships for groin impacts based on only five data points (using volumes averaged over three miles of shoreline where there has been a variable response) is inappropriate and provides data of dubious value. I understand your desire to be able to draw some conclusion from your data, but I do not believe that it is possible given the vastly different settings for each structure, the degree of unquantifiable human impact, the uncertainty in all of your data, and the small number of data points. Based on the time you had, and the availability of data, you will not be able to establish simplistic cause and effect.

Section VI:
Please add the following caveats to your calculations of property values:
1) With the available data, we cannot determine the financial benefits (or economic harm) that may come from the construction of terminal groins.

2) We cannot determine how far down the shoreline a terminal groin may provide benefits (or cause harm).
3) The report should clearly state that in no way is it appropriate to take the total value for property at inlets and assert that all of this property could be lost in the next 30 years or that terminal groins could protect all of it.
4) It would be nice to place the value of property at inlets placed into a larger context of the value of property on each barrier island or the coastal economy in general.

Section VII:
Does not consider the costs of acquiring easements or other legal costs associated with what is likely to be a controversial project in NC.

Comments on Working Draft Report Terminal Groin Study

February 15, 2010

Attached, please find some brief comments on the draft Terminal Groin Study produced by Moffatt & Nichol, Dial Cordy, and Duncan Fitzgerald for the NC Coastal Resources Commission. The comments are brief because of the short review time allotted and other demands on my time. My overall impression of the report is that a noble effort was made but that because of the lack of time and financial resources necessary to produce the study necessary to adequately address the questions and issues posed by the NC General Assembly, the best use of the existing study is to help design a study that would provide the answers necessary.

Stephen B. Benton, NC Coastal Resources Commission's Science Panel on Coastal Hazards,

General -
A number of comments were made by various members of the Science Panel at the last two Science Panel meetings about the tables and figures provided in the report. I will not repeat these here, but do support the comments made. They should be available in the minutes/notes of the meetings and will no doubt also be provided in comments by other members of the Panel.

Section II -
The use of shore parallel baselines for measuring shoreline change works well if the shoreline remains relatively parallel to the baseline. This is how the shoreline change studies used by the NC Coastal Resources Commission for the oceanfront management program and building setbacks were determined since 1979.

However, because of the complex forces affecting shoreline behavior in and adjacent to inlets and technological limits to accurately measuring shoreline position in them, the State of North Carolina has just recently begun to attempt to evaluate shoreline movement at inlets.

There are a number of special problems associated with accurately measuring shoreline behavior in and adjacent to inlets that affected how the North Carolina Coastal Management handled them. Where shorelines curved around the end of the island or where ebb shoals created significant bulges in individual shorelines used for the study, transects perpendicular to the baseline which were not also nearly perpendicular to the shoreline were deleted from the shoreline change measurement data set. This is because the measurements would be apparent changes rather than actual changes and the values not an accurate reflection of shoreline behavior. Similarly, the shoreline datum used for the oceanfront (wet/dry line) was not suitable for inlet shorelines because of the significantly lower slopes typically found on tidally dominated inlet shorelines.

Recent advances in mapping techniques have allowed North Carolina to develop accurate measurement of shoreline position in and adjacent to our inlets. These new studies involve shoreline changes based on baselines that wrap around the curving inlet shorelines and utilize the MHW datum that is much more suitable for inlets than the wet/dry line used along the oceanfront. Using these new shoreline studies, the NC CRC Science Panel on Coastal Hazards has been revising the Inlet Hazard Areas of Environmental Concern. For the first time since the inception of the program more than 30 years ago, we may have shoreline data at the NC inlets that is accurate enough to be used in a management strategy.

Unfortunately, the current study draft is attempting to use the 1970s methodology to determine shoreline change data that is then used to estimate sediment volume changes related to the complex natural and man-made influences such as groins, jetties, seawalls, navigation channel dredging and dredged material disposal or beach nourishment. The questionable accuracy of portions of the shoreline data and sediment volumes computed from them makes any study conclusions based on them questionable and vulnerable to challenge.

Page II-20. In the report, the argument is made that "detailed analysis of sediment budgets is beyond the scope of this study". While it is certainly true that a detailed sediment budget analysis would not be possible with the budget and time allowed for the study, it is clear that the analysis technique utilized for the report is not sensitive enough to be able to determine the impacts of terminal groins, particularly at the two North Carolina sites reviewed. Most importantly, the study does not provide the information needed to evaluate the use of terminal groins at other potential sites in North Carolina.

Fort Macon -
The historical summary is basically shot-gunned, dates are thrown out but no analysis of the relations of dates to other data is provided. For example, wave, tide and storm data is provided in tables, but are not related to pre and post terminal groin construction shoreline change data. There is no apparent effort to determine the effect of earlier structures or dredging impacts.

It is very difficult to document the effects of such a minor element of the total impact of much more significant activities. This is particularly evident at Beaufort Inlet, which has a history of engineered structures that goes back to the Civil War. The navigation channel at the inlet has been dredged clear across the ebb delta well onto the Continental Shelf. This channel completely cuts off all natural bypass of sand in the longshore transport system. The channel also has significantly altered the hydrology on the ebb delta, at the inlet, and well back in the estuaries behind it. This significantly alters sedimentation rates and patterns in areas affected all the way from the estuary through the inlet to the ebb tidal delta.

While the impacts of alterations to the inlet have been substantial, there are several situations unique to the inlets that make these alterations necessary. This inlet provides the entry to one of North Carolina's only two major ports. Dredging a channel across the shelf into the port was essential for the port to function. The terminal groin at the inlet was largely constructed to protect the earthen Civil War fort, a major historical structure. Relocation is not an option for

an earthen historic structure, so a hard structure is basically the only way to provide needed protection. This is a situation similar to the rock revetment allowed for protecting the earthen Civil War fort at Fort Fisher. These situations represent good examples of the flexibility that is built into the NC Coastal Management Program. Though these types of structures are not generally allowed in North Carolina, where there is no alternative, the need is clearly real, and there is a significant public interest, the need can be accommodated. However, with the possible exception of the entrance to the Cape Fear River and Oregon Inlet (which already has a terminal groin), there is no other inlet in North Carolina with comparable public interest issues.

Where major impacts are the result of such a complex mix of players and actions over such a long time period, an important question is what has been the total cumulative impact of all the actives on island processes; including the inlet related process, the habitats they provide, and the offsite island sediment budget. If we understand the system and the impacts to it, a minimization plan could be developed and significant island process and habitat impacts mitigated. Developing this level of understanding could help us better manage other coastal sites that have not been as altered.

The long history of a complex of numerous alterations and structures at Beaufort Inlet also illustrates another issue that has a bearing on the question of the appropriateness of changing the North Carolina rules, which prohibit hard structures such as terminal groins within the Ocean Hazard AEC. No action seems to be effective alone. Some new structure(s), or modification to the structure(s), or increased dredging, or additional nourishment is invariably required to "fix" some unanticipated effect of the original action. Similarly, though not necessarily illustrated at Beaufort Inlet because uplands on both sides of that inlet are publicly owned, the stabilization of uplands adjacent to inlets changes them from properties at significant risk to properties that appear to be stable and safe. In reality, they are at best temporarily safer and at worst, a huge liability on disaster assistance, flood insurance and the local tax base when the inevitable storm impacts them.

Amelia Island -

The data available at this site is not adequate to provide answers to the questions posed by the North Carolina Legislature. My impression was that many more questions about the terminal groins effects were raised than answered.

Overall Findings... -

I am sure the other members of the Science Panel will be commenting in detail about the numbers generated and their significance here so I will not "pile on". One point is made in the report about the shoreline of northern Pea Island becoming accretional after construction of the terminal groin that I do want to comment on, however. Though the shoreline adjacent to the groin may have become accretional during the time periods studied, some of the worst erosion along the Northern Outer Banks occurs to the south of the 3-mile study area. Though this area is beyond the defined study boundaries, the possible effects on this far-field phenomenon of the groin and subsequent activities along the shoreline needs to be investigated.

Section III -
In general, this section provided far more light on the questions raised by the legislature. The report would be much more helpful in responding to these questions had there been more coordination between this section and the coastal engineering and the environmental assessment sections.

III-1 -
The statement is made that "processes are evaluated as to their impact on the terminal groin located at each of the study sites". My understanding is that the focus was to be on the effects of terminal groins on geologic processes and morphology, etc.

III-4 -
The statement is made that "movement of sediment into the backbarrier represents a long term sequestration of sand from the littoral zone, which will not become part of the active inlet and nearshore system until the shoreline transgresses to this backbarrier site." No mention is made that transgression is an ongoing process and sand sequestered in the past is actively being incorporated into the active inlet and nearshore system as it is eroded from the shoreface. This is not a "steady state" process, however. Over time sections of the barrier island system may experience periods of sediment starvation or sediment overfeed. At any rate, sediment sequestering is not an absolute unmitigated disaster but part of the ongoing process of island evolution. Sequestering is integral to the formation of new habitat that a number of coastal plant and animal communities are dependent on. Sequestering is also essential to the formation of a platform on the backside of island systems such as the Northern Outer Banks are dependent on as part of their transgression in response to rising sea level. Oregon Inlet, for example, originally opened approximately 3 km north of its current location. As it has migrated south to its current location, its flood tide delta has formed a platform behind the island that entire distance.

III Conclusions -
This section provides a good summary of short-term and intermediate-term processes as they relate to terminal groins, dredging, etc. It should also discuss the issues relating to longer-term geologic processes. For example, it does not address the impact of stopping the migration of Oregon Inlet on habitat over time, particularly the impacts of plant succession etc. on the northern spit. It does not mention the role of inlet migration on island migration and its response to sea level rise. Stopping the migration of Oregon Inlet has had a significant impact.

Economic Assessment -
The 30-year setback zones within the Inlet Hazard AECs that are currently being developed by the Science Panel for the CRC are very different from the 30-year zone on the oceanfront. Island transgression makes shoreline loss on the oceanfront permanent in the long term. Potential losses here involve both the structures and land under them. In the inlet hazard areas, the coastal processes affecting the adjacent lands are much more complex. Except where an inlet is actively migrating in one direction, structures can be expected to be lost, but the lands will come and go.

Comments on Draft Terminal Groin Report
Bill Birkemeier, 12 February 2010

General Comments

The general explanation of terminal groins that leads off the Geology section should be moved to the front of the report as the introduction and expanded as to be clear as to what terminal groins do (i.e. collect longshore drift, etc) and don't do (i.e. prevent cross-shore transport, etc), how terminal groins are different than other groins and groin fields, and what characteristics/parameters define the length of shoreline they influence. This section and its diagrams can then be used to introduce the analysis performed and can be used as a reference in each of the case studies. For example – in the introduction it can be mentioned that one way to look at the length of shoreline influenced by the groin is to examine the change in shoreline change rates before and after construction and to try to identify a distance from the groin at which the shoreline erosion rate is unchanged from what it was before construction.

The engineering and geology sections have to be merged (I think there was consensus on this) and the results must agree – i.e. the new analysis should agree with the published results or explain why they disagree. The geology section will provide a good lead into each of the analyses.

The report uses a number of arbitrary amounts. For example, use of 3 miles. This length should be longer than needed to compute the influence of the structure, but not too long that it begins to include the influence of something else – an offshore shoal, relic geologic feature, next inlet, etc. Ideally strong conclusions should be independent of arbitrary amounts – i.e. the same conclusion is reached using ~2.5, 3, or 3.5 miles.

This report will not tackle the many sea level rise/climate change issues facing the NC coast. However the impact of sea level rise on the design of a terminal groin and the associated fillet can be addressed. The Corps' has recently released guidance on sea level rise and coastal structures which may be useful.

Groins are known to have an updrift and downdrift impact. Identifying the affected distance is a primary objective of the study, and once defined for each site, that computation should be reflected in the other aspects of the study. If it is difficult to identify the impact because of the complexity, that too is a useful result.

I'm interested in the habitat discussion. Can areal coverage of a habitat, say open beach, be used as a surrogate for the nesting bird population data? The population studies are difficult from the standpoint of consistency of observer and sampling plan – and don't appear to be detailed enough to separate the area affected by the groin from the general area. On the other hand, aerial photographs are available. Would this also provide a way to address Rob Young's comment about computing habitat loss? At Oregon Inlet, Fort Macon, and Amelia Island – the most recent photos show more open beach than in earlier photos. Are these new areas significant for habitat? At Amelia Island, the 2008 shoreline appears similar to the 1994 shoreline, but the 2008 beach is

wider, replacing eroded maritime forest. At Oregon Inlet, the preconstruction shoreline (see Fig IV-8) had no real fillet into the inlet, whereas the post-construction is open beach.

I also agree with Pete Peterson and others that a terminal groin's influence on inlet migration should be better discussed. From a habitat standpoint – is there less open beach habitat on the eroding side of an inlet (look at the inside shoreline at Oregon Inlet just before construction)? Similarly when a terminal groin is placed, do we expect new open beach habitat to form as the inlet narrows (Bodie Island and inside the inlet)? I now know how important elevation is to open beach habitat – but if knowing the amount of open beach within the impact area is useful, it can be computed.

Specific Comments

1)Page II-12 - Fig II-5 shows 1 mi of shoreline but 3 mi is used in the analysis. These photos of shorelines should be full page and show the entire 6 mile region considered.

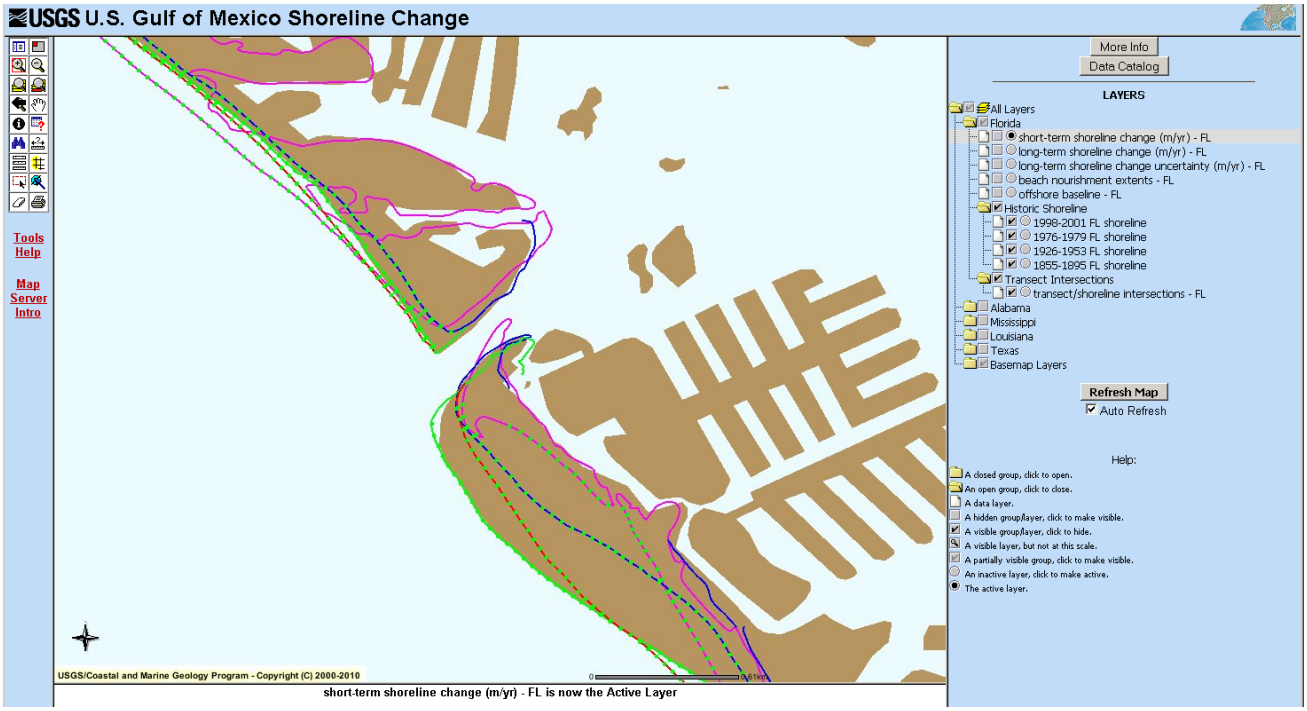
2)Page II-13 – Oregon fillet filled "naturally", also needs correction in Section III. Should also note that the shape of the Oregon Inlet terminal groin was designed to return the shoreline to the 1988(?) or the 1989(?) shoreline. This also explains the wrap-around design of the structure, (see Figure IV-8).

3) Page II-17 – The computations using discrete alongshore intervals are difficult to interpret (at least to interpret "quickly") and since the longshore intervals are arbitrary – it's not always evident what influence the sampling scheme has on the results. Consider showing the raw data and then banding it according to some defined scheme (i.e. inside or outside the zone of influence). For example, Figure III-14 is more informative than figure II-8. The associated tables can be banded if the supporting figures show the brackets over the raw data indicating the banded intervals.

4) Page II-19 – the interval data are plotted at the same vertical scale as the cumulative data, but as a result are too small to see the variation.

5) Page II-20 – as mentioned in the meeting, sidecasted dredge volumes are not included in the computations – this should be mentioned in the text, and denoted in the appendicies.

6) Page II-79 – The Florida DENR profile lines are pretty far apart to extrapolate 50-m spaced shoreline intersects, especially on the south side of John's Pass. What impact does that have on the results? Would the USGS shoreline data found here: http://pubs.usgs.gov/of/2004/1089/gis-data.html be useful? Change rates and uncertainty values are also available.



7) Page IV-2 – A Rob Young, personal communication reference is used for the downdrift adverse effect of groins. Many published works also state this (i.e. USACE Shore Protection Manual, 1984)

8) Page IV-2 – from the bottom 2 paragraphs until the start of section 2 seemed out of place.

9) Page IV-117 – top sentence compares hardened to non-hardened shorelines. Is the impact referred to here due to "hardening" or development?

10) Page IV-117 – second paragraph seems out of place.

Walker, Michele

From: Gregson, Jim
Sent: Tuesday, February 16, 2010 10:26 AM
To: Walker, Michele
Subject: Fw: Subcommittee Presentation

James H. Gregson, Director
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----- Original Message -----
From: Rob Young <ryoung@email.wcu.edu>
To: Gregson, Jim; overton@eos.ncsu.edu <overton@eos.ncsu.edu>
Cc: jmartin@moffattnichol.com <jmartin@moffattnichol.com>; PTschirky@moffattnichol.com <PTschirky@moffattnichol.com>; bob.emory@weyerhaeuser.com <bob.emory@weyerhaeuser.com>; Underwood, Steve
Sent: Mon Feb 15 23:13:47 2010
Subject: Subcommittee Presentation

Hi Folks: Several individuals at today's CRC Subcommittee meeting indicated that M&N is still presenting results from the graphs in Section V pages 15-21. It was my opinion that the science panel reached consensus that it was inappropriate to attempt to establish any generalized relationship using five data points, with volume change averaged over three miles (and showing different trends within that three miles). In addition, you are comparing very different inlet settings with different terminal structures, and varying human impacts. You have no idea of the uncertainty in any of your datasets, or the uncertainty in your conversion from shoreline change to volume change. We have no idea whether or not averaging that volume change over three miles is meaningful or not, because you have not been able to establish how far down the shoreline the groin has an impact. In some cases, dredging is masking any impact the groin may be having. YOU ABSOLUTELY CANNOT ESTABLISH ANY GENERALIZED RELATIONSHIP FROM THESE DATA SUGGESTING THAT THE STRUCTURES, ON AVERAGE, HAVE IMPACTED VOLUME CHANGE BY _____ I ask that you abandon this effort. It is not good science or good engineering. I thought that the science panel has reached clear consensus on this point.

Best
Rob

Robert S. Young, PhD (Licensed Professional Geologist in NC, SC, FL) Director, Program for the Study of Developed Shorelines Professor, Coastal Geology Western Carolina University Belk 294 Cullowhee, NC 28723 828-227-3822, FAX 828-227-7163 ryoung@email.wcu.edu psds.wcu.edu